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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Forgetting Those Things Which Are Behind

GLANCING over our editorial salutation of a year ago in which we attempted to portray an optimistic view of the year that has just passed, we are struck with the fact that in many respects the promise has not been performed. Tariff legislation, which was then considered to be of primary importance in the revival of business, still awaits the intelligent attention of Congress. Revenue legislation, which was also a factor in the expected return to normal business conditions, was enacted too late in the year to relieve materially the burden under which business was already staggering. The situation with regard to foreign exchange has not been improved, with its consequent prohibition on international trade. In short, it would seem as though the skyrocket career of 1920 has had its inevitable sequel in the descending stick throughout 1921.

On the other hand, the feeling of optimism and confidence with which we approached 1921 has not been dissipated, although the events which subsequently supported and justified it were not apparent at the beginning. There has been increasing evidence of willingness on the part of business men to accept fundamental economic principles and to ignore artificial panaceas and nostrums in their attempts to revive business. This influence has been felt in Congress and is undoubtedly the principal reason why a high tariff bill has not been passed, as might have been expected under existing political conditions. Economic sanity has prevailed over political expediency.

The tariff is but one item in which there has been evident willingness to take the broad international rather than the narrow national view. The Conference on Limitation of Armament is another. Its success has been such that already there is a demand for a second international conference to solve some of the fundamental economic problems that now vitally affect the business of all nations. Add to this the fact that through Federated American Engineering Societies attention has been forcibly directed to the necessity for eliminating waste in industry, and we have a trio of influences that augur well for the future and serve to relieve the pessimism which otherwise might prevail in a cursory review of 1921.

But we are more concerned with the future than with the past. CHEMICAL & METALLURGICAL ENGINEERING has confidence in the ultimate adjustment of our present economic and financial dislocation. We conceive it to be our duty to contribute to that readjustment by rendering sevrice that will enable American industry to attain a higher degree of efficiency than it has ever known. To this end we have determined to expand rather than contract our editorial activities. Two new engineers will be added to the staff and one of the present members will go to Europe for at least six months. This will enable us to consummate plans that have long been cherished and which we believe will react greatly to the benefit of the chemical and related industries.

Two new features will be incorporated in the magazine: One relating to the economics of the chemical industry and the other to mechanical engineering in industrial processes. Qualified editors will devote their time to these activities. A survey of the economic and commercial factors that influence trade in chemicals and related commodities will appear each week, and an effort will be made to interpret financial and trade movements in their relation to the chemical industry. A more detailed statement of our plans will be found elsewhere in this issue in the department devoted to the subject.

The decision to pay more attention to the mechanics of industrial processes and methods of handling materials arises from a desire to supplement our excellent contributions on technology, industrial and scientific research with more articles from the field giving practical details of operation. A mechanical engineer experienced in construction and operation of chemical plants will be in charge of the work.

Sending an editor to Europe for six months should have many practical consequences of great benefit to our readers and advertisers. Through him we shall hope to reflect industrial conditions in Germany, Belgium and France and interpret them for the information and guidance of American manufacturers and consumers. Our future is inevitably bound up with that of Europe and it will only be through intelligent comprehension of conditions in the principal European countries as well as in our own that our industrial leaders will be able to chart their future business course. It will be our purpose to render some small service to this end by reporting at first hand conditions as our representative finds them.

Crumbs of Wisdom Out of the East

AN AMERICAN man of affairs was lately talking to a Chinese gentleman of the old school. The latter was robed in beautiful silk; he was a thoughtful person, but unconvinced that whatever comes out of the West is good for the East. The American was describing the Twentieth Century Limited, and explaining how in 20 hours he had frequently traveled from New York to Chicago, a distance of nearly a thousand miles.

"And when you arrived at Chicago, what did you do?" asked the gentleman of the East. The American could not remember.

Here is a point in philosophy that it may do us no harm to consider. The detached Oriental does not want to go from New York to Chicago except for a purpose, and if possible he would prefer to send some one else on the journey than to make it himself. This is with

no reflection on Chicago or the railway company and its facilities. If he were comfortably settled in Chicago, he would have the same objection to rushing to New York. He is rather more advanced than we are in the art of finding out what he wants and then in proceeding to enjoy it. Another of his merits is that he is less disposed than we are to run away from himself. Very often when we say "I've got no time to bother about" this or that or t'other thing we are seeking another occupation to avoid responsibilities and decisions that we are afraid to meet. What we Americans need to have drilled into us by some kindly mentor is to keep our eyes a little more firmly fixed on the goal, and to make less fuss about the incidents of our travel thither.

H. G. WELLS refers somewhere to a class of people he calls the "Godsakers"; meaning those who are constantly exclaiming, "For GOD'S sake let's do something!" —without knowing what to do. We know very well how futile misdirected efforts are in chemical experiment. This is the very basis of research. But it holds true in nearly every walk of life. The nerve-racking haste to do indefinite things is what makes many of us old before our time, and spoils us for our old age as well.

The Chinese gentleman might give us profitable instruction in other respects. Politics are indeed in a bad way over there, but then the Chinese people do not lean on politics as we do to manage everything they can't manage themselves. We want to be let alone in our own business, but a considerable number of us seem to want the government to step in and regulate the other fellow to our profit. The Chinese is singularly free from such aspirations, for good and sufficient reasons.

Again, he is very loath to go to law. If he has differences with his neighbor, they take their quarrel to two or three of the old men of the community, who decide the matter for them with at least as great a measure of wisdom as a judge can do with several scrapping lawyers to handle. This provides an economical use for their old men, who are not cast aside as "back numbers" in the process. The Chinese are an ancient people with vast experience, and some of the things they know and which we neglect have the merit of truth.

Putting the Cart Before the Horse

THE young man failed to pass his examination in freshman chemistry. Some of us do not take incidents of that sort very seriously, but the freshman in question was one of a long line of persons eminent in scholarship. Cousins, father, uncles, first cousins once removed, grandfather and great-grandfather, all had been in the habit of taking honors. In the young man's case other marks were high, but chemistry was a failure. The father discussed the subject with a professional friend who is also of a scholarly turn of mind. And the sequel was a luncheon engagement between the latter gentleman and the boy.

"The trouble is," said the young man, "I don't believe what they say is so. There's this oxidation business, for instance, that sometimes means one thing and sometimes another. I am told to believe a whole lot of things that may be true and again they may not; but I can't see it. I am interested in what I can see or understand, but I do not believe the professor himself understands the line of talk that he passes out to us. If he does, why doesn't he explain it? The thing does not seem reasonable to me!"

"I am glad," said the older man, "to find someone with a mind like my own. Chemistry really is a subject of immense interest, but from what you have told me they have not been trying to teach you chemistry; they have offered rather a sort of chemical theology. That you resent the teaching of whilom fancies about various chemical reactions indicates to me your good judgment, for you may be sure that in five or ten years from now many of these very fancies will be discarded." The ensuing conversation led into the field of descriptive chemistry, and here the young man immediately found his curiosity excited.

We know very well that we need philosophy all the time; we need to arouse our curiosity as to why things happen, and to keep this constantly alive, in all scientific work. But we venture to express the fear that there is a great deal of unilluminated teaching of the philosophy of chemistry, and this in such a manner as to kill the subject for the student.

Suppose we were discussing persons, and in response to your inquiry about JOHN DOE we were to send you his genealogical chart. It would not give you the information desired. We do not know enough about anybody alive to prepare a complete genealogical chart, and we don't know enough about heredity to compute a man's character, even if such information were available. It is so about things. We want to know why reactions take place, but this desire will remain inert unless our interest is aroused in the reactions themselves.

The way to get at chemistry is to see what it does, to watch its workings, to get imbued with the romance of it. Then students of a philosophical turn of mind will want to know the reasons why. Others will never get beyond the romance of it, because they lack the gift of philosophical curiosity. Here are, let us say, a hundred young men, taking freshman chemistry because it is in the curriculum. Only a few will follow it much further. The others will be interested or not; will get a sense of the subject in their minds so that they will know how to learn what they may want to understand later, according as we set the table for them. It should be a handsome display of what chemistry does; a descriptive display, to open the portals of their minds. Speculations as to the reasons why things happen should come later.

Why spoil the subject for fresh young minds by something that is very like theological dispute, when there is such a great store of beautiful things to show them? It looks to us as though some teachers of elementary chemistry are on the wrong tack.

Psychology in the Selection of Workers

ARE WE NOT neglecting the craftsman? In days gone by he was an important person, but in latter years it seems as though everything, inventors, employers and even his own fellows, had combined to obliterate him. The inventor in devising machinery has tried to get along as much as possible without him and to turn him, when and where he is needed, from a fashioner into a feeder. The employer would naturally rather pay feeders' wages than fashioners' and he has pulled in the same direction. The craftsman's unions, in seeking strength, have taken in the incompetents, and then have been compelled to demand that the work be made simple and easy enough for their incompetents to perform. The multiplicity of unions has also over-

lapped, and the result of this has been to restrict the variety of work that each member may perform.

At the present moment we are not discussing wages or living conditions, save as these are found in work. In this respect we venture the belief that variety is needed for human development. Psychologists have not yet achieved the art of making mental tests to determine exactly and fully how and in what direction a man may develop, but they have gone much further than most of us think. For instance, in one great manufacturing establishment that annually engages a considerable number of graduate engineers, it formerly required from one to two years to determine whither the young man should be guided: either into design, manufacture or sales engineering. Now by the aid of earnest study by trained psychologists they know as much of the native talent and capacity of the young men so taken on at the end of six weeks as they formerly did at the end of two years. Several life insurance companies now select their agents with the help of competent psychological study with a small fraction of the mistakes they formerly made in their appointments. A number of department stores, after long and serious study by competent and experienced psychologists of the problem of selection and administration of their personnel, have developed methods that result in such marked improvements in service that no less than 60 per cent of their charge customers have noted the difference.

Now if among such human material as seeks employment in department stores, the major portion of whom have not got beyond the eighth grade of grammar school, proper methods of selection and training make a great difference in the capacity of the sales forces, is it not time that the rest of us, who have other work to do than to sell tidies and needles and pins and yards of cloth, should begin to look over our staffs of workers?

Every one of us needs looking after, no matter what his position in an organization may be. If we are at the top, the chances are that the family doctor rules us with a far severer rod than the dispensary physician does if we run an elevator. In conferring lately with the head physician of a great college of technology we discovered that the young men of eighteen to twenty-two are really as tender as girls and that absurd little causes will often ruin the career of a young man unless there is an intelligent helper at hand to advise and reason with him and to guide him into ways that are wholesome for him.

How about the vast crowd of men, generically classed as "labor," with nobody to look after them, and of whom a disproportionate lot of splendid fellows are going to ruin and collapse for the reason that nobody does look after them? The union cannot give them mental tests and physical examinations, and nobody else does, and so thousands and thousands are eating their hearts out from some—to them—poisonous idea, or are making for tragedy with only an enlarged thyroid as the signal, and with nobody to know or care. If big department stores find it even profitable from the standpoint of business to engage psychologists in providing for the selection and administration of their forces of necktie men and passementerie women wouldn't it probably pay the rest of us to remember that all our employees are in our business family, and that in both selection and administration we should seek the best? And how do we know that in our own vanity the best is to be found? It would be abundantly worth while for a great many of us to look into the subject.

Wage Disputes In the Coal Industry

THE United States Geological Survey issues, without comment, a report on "strikes" in the coal industry in the twenty-one years 1899 to 1919 inclusive. As will be indicated later, it is possible that the subject matter of the statistics might better be referred to as "wage disputes" than as "strikes."

The showing indicates conclusively that something is radically wrong somewhere. This is distinctly the way not to do it. There is no statement of the total number of men engaged in the industry, and for that reason alone no direct comparison could be made, while the strike statistics are not complete, because they are compiled solely from reports of operators who produced in 1919.

As to the number of men involved in strikes or wage disputes, the latest year in the presentation, 1919, shows the greatest number, with 446,436 men losing a total of 15,693,567 man-days, equal to an average of 35 days per man, while 1910 shows the largest number of man-days lost, 19,250,524, or an average of 88 days per man for the 218,493 men involved.

Of the twenty-one years there were five in which more than 200,000 men were on strike at one time or another. A better appreciation of the importance to society of loss of working time is furnished by striking an average of the twenty-one years which shows approximately 6,000,000 man-days lost per year in the period, equal to 25 working days each for 240,000 men. In other words, the incomplete record of wage disputes in coal mining for more than two decades shows an equivalent of 240,000 workers being idle for one whole month each year.

Some of the twenty-one years showed much more lost time than others. In an effort to see whether the strikes had any connection with business conditions, we divided the years into good years and bad years commercially, using the production and price of pig iron as the criterion. The division made ten of the years bad and eleven good, but the ten years showing the greater amount of lost time fell in five good and five bad years, while the ten years of less lost time had the same incidence. Thus the strikes or disputes were not produced by good times or by bad times. Then another basis of scrutiny was taken, this showing that of the ten years of greater loss of time nine years were even-numbered years and only one, 1919, was an odd-numbered year. This was quite intelligible. For a long time past the bituminous wage scale has been biennial, the settlement falling in the even-numbered years. The exception, 1919, was a year in which men went on strike, claiming that the scale was a war-time scale and should not bind them since the war was over.

Thus it appears that the term "strike" is quite broadly applied. The time seems to have been lost chiefly during disputes as to the new scale. The customary procedure has been for the operators and the United Mine Workers to fail to agree prior to the April 1 of the even-numbered year on which the old scale expires. Then there is a cessation of mining. stocks of coal are exhausted, the market price of coal advances, and an agreement is reached. Somebody pays for the lost time, which incomplete statistics set at an average of one month a year for 240,000 men during twenty-one years. Not a few men have lately concluded that in the last analysis it is the general public that pays for this lost time.

Readers' Views and Comments

Wanted: Jingles of Science

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am endeavoring to collect verses of a more or less humorous nature, whose subject matter relates to the sciences, with the intention of publishing an anthology of such poetry, under the title "Jingles of Science." It has occurred to me that there may be a large amount of such poetry filed away by some of the great number of chemists, physicists, engineers and other scientific men of the country, which at the present time is quite unavailable to me, by reason of its non-publication. Will you kindly grant me space for this appeal to your readers to send me copies of such verses as are available to them, and which, in their opinion, are worthy of publication? Whenever possible, I should like to have the name of the author or authors accompany each contribution. Any verses, grave or gay, referring to any of the sciences, sent to me at 7 St. Paul St., Cambridge, Mass., will be sincerely appreciated and duly acknowledged. CHARLES E. RUBY.

Cambridge, Mass.

Pitiable Plight of Russian Scientists

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your Oct. 26 issue a very noble appeal was printed, urging American scientific men to lend a helping hand to those isolated and starving Russian scientists who still remain within the boundaries of the former state of Russia. As I am a Russian, I can most deeply appreciate the high motives of this appeal and urge that those of means might find some feasible way to help. But while I continually remember those brave men who are carrying on scientific research under incredible conditions of hardship, I make bold to raise my voice to help those who could not bear life in Soviet Russia and left the country with no well-defined aims or definite plans and without the means of leading a life such as would befit a man of culture.

Over two hundred Russians, people of brains and culture, who had followed the national armies of Denikin, Kolchak and Wrangel have met with this hard experience. You can meet Russian professors on the remote islands around Constantinople, you can see them working as clerks and laborers in the railroad depots of the Slavonic states, you can observe them in Egypt, in Greece, interned in the camps erected for war prisoners.

Many of them are with us no longer. Before me lies a long list (published officially by the Bureau of Russian Scientists' Society in Prague, October, 1921) which tells of man after man who found his peaceful rest.

Those dead have laid down their lives that their brothers might live. But these who remain alive are in conditions which even my national pride permits me to call pitiful. Many are separated from their families, deprived of everything but the right to breathe.

Here is not the place to mention how and where they earn their daily bread. Sometimes they do not earn it —because they are weak and ill and downhearted. But always they support their lot in uncomplaining silence. For them I raise my voice. They are within reach. For them so much can be done. Not in the way of charity, but in the way of giving them a chance to work, to continue their researches which have elevated the name of Russian scientists so high and which in the past belonged not to Russia alone, but to all the civilized world.

Shall the world forget them now in the time of their need? Shall they pass out of our sight after all they have done for the world because their colleagues abroad did not proffer them aid?

Should any one desire to receive full information about the non-partisan Bureau of Russian Scientists the writer would be only too glad to give all the information at his command. VSEVOLOD N. KRIVOBOK.

Dept. of Metallurgy,
Harvard University,
Cambridge, Mass.

Explosion of Agitator Charged With Naphtha

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the Nov. 23 issue of your journal, W. H. Pape inquires about the cause of an explosion in an agitator which had just been charged with naphtha. It is a well known fact that oils of the nature of naphtha become charged with static electricity while being pumped through pipe lines, especially lines of small diameter. If this charge is not drained off through a ground wire, there is danger of a spark being caused by the discharge of the electrical charge contained in the naphtha. This is probably what occurred in the case he mentioned, the spark exploding the explosive mixture of naphtha and air above the liquid naphtha in the agitator. I would suggest that the pump lines to the agitator and the agitator itself be well grounded.

Wilson, Pa. WALDEMAR VERNET.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Replying to the article of W. H. Pape on naphtha explosion in your issue of Nov. 23, I recall a similar case which came under my observation about 10 years ago. In that case the agitator was on a concrete foundation, the electric wires were in conduit, the acid, lye and air lines were bonded to the agitator and the charging line was connected to the bottom of the agitator. A batch of naphtha had been pumped up, and the line was being blown out with air when the naphtha exploded.

Experiments showed that the naphtha could not be ignited by blowing air through it—that is, by an overhead line. Then an iron line that had been filled with naphtha, to represent the agitator conditions, was tried. No results were obtained until the experiment was repeated on a damp, cloudy day, when the liquid at the end of the line ignited. This could be repeated under similar atmospheric conditions.

The conclusions were drawn that the explosion was caused by static electricity and the practice of blowing light liquid pumping lines was discontinued. Since then no such fires have developed. The conditions in the case mentioned may have been similar. I. L. KLEIN.

Rossford, Ohio.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Dec. 4, 1921.

NOVEMBER was a month of uneasiness for those engaged in the chemical industries, as a proposed general reduction in wages threatened a strike of 200,000 workmen. However, representatives of both sides got together and owing to the fact that there was a large number of unemployed the workers in Lombardy, Liguria and Piedmont were induced to accept a reduction of 1.65 lire from Nov. 1 to the end of February. This agreement has not yet been accepted by workers in other portions of Italy.

The demand for chemicals continued good and many reductions in price were avoided owing to the fact that Germany had prohibited the exportation of goods unless they had been contracted for in terms of Italian lire. This put an end to the speculation on the rise or fall of the German mark and increased the opportunities of other countries to do business, which were taken advantage of by France, England and the United States.

ITALIAN FERTILIZERS

The excessively dry weather of the fall months and the freezing weather that followed precluded the possibility of the usual rainfalls and discouraged the agriculturists from using fertilizers of all sorts. This was a serious matter for those interested in the manufacture and sale of such products, as they were left with stocks unsold and faced a fall in price. The latter is very probable, as measures have been introduced in Parliament aimed at forcing a reduction in prices, to encourage greater cultivation of the soil.

ITALIAN CHEMICALS

To encourage the manufacture of chemicals the customs officials have been authorized to waive the export prohibition on toluene, dinitrotoluene, lactose, chlorate of potash, tanning extracts, sulphate of copper and potash salts (excepting those required for agriculture). This was caused by the great success in the exportation of chlorate of potash, which amounted in the first 6 months of this year to 1,058 tons, 1,052 tons being destined to England. These exports were made after supplying the home market, only about half a ton being imported in this period. In the first 6 months of 1920 24 tons was imported and in the corresponding period of 1919 102 tons. Exportations of sulphate of copper also were very fair during this period, reaching 2,476 tons, against 4,116 and 800 tons in the corresponding period of 1920 and 1919 respectively. This product was distributed this year principally as follows: 1,190 tons to France, 358 to Jugoslavia, 11½ to Portugal and 700 to Rumania. Imports of sulphate of copper in this period reached only 598 tons, against 791 in 1920 and 35 in 1919. Of that imported this year 401 tons came from England and 57½ tons from the United States.

ITALIAN PURE ACETIC ACID

With the view of encouraging the greater use of pure acetic acid and increasing its production it has been decreed that manufacturers whose product is destined for industrial use will not be subject to the tax of 200 lire per annum which has been imposed on those manufacturers whose product is destined to be used for pharmaceutical or laboratory purposes. The imports of pure acetic acid of all concentrations during the first 6 months of this year were 109 tons, against 271 tons in the first half of 1920 and 85½ tons in 1919. Exports in the same period were 154½ tons in 1921, 110 tons in 1920 and 47 tons in 1919.

LIMITATION OF WORKING DAYS

The dry weather in November caused a scarcity of water power, consequently a limitation was placed on the operation of many manufactories, which were ordered closed for one, two or more days a week. This often interrupted their manufacturing operations and caused no end of trouble and loss. These conditions led the government to study a project for direct control of all hydro-electric plants in the hope of obtaining greater use than at present and of eliminating waste by better distribution of power. In the meantime decrees were issued aimed to increase the efficiency of plants producing electricity by other means.

ITALIAN SUGAR PRODUCTION

As the country produces scarcely enough sugar to satisfy the home demands, the government has issued new regulations regarding its importation, subject to the judgment of the Minister of Finances. Although the consortium arranged at Turin for the distribution of sugar has been eliminated and commerce in this article is now free, the government fixes from time to time the wholesale price.

Imports of sugar of first quality were large during the first half of this year, reaching 66,151 tons, against 5,146 tons in 1920 and 30,106 tons in 1919 during the corresponding period. Of this year's imports, 12,545 tons came from the United States, 6,103 from Belgium, 3,331 from France, 131 from Japan, 36,373 from the Dutch East Indies, 33 from Egypt, 2,149 from Brazil and 3,848 from Cuba.

HYDRO-ELECTRIC DEVELOPMENTS

It has been proposed to transport to Sicily a portion of the electric energy produced on the high plain of Sila, thus placing 50,000 kw. at the disposal of the island. It is proposed to erect stations at Cotrone, in the Province of Catanzaro, and carry the current on strong copper cable across the Straits of Messina to Catania, Caltanisetta and Palermo, a distance of 300 km. The Lys torrent, that descends directly from Mount Rosa to the River Dora, can furnish power for the four stations of Gressoney-Trinité, Chemonal, Gaby and Pont St. Martin. A fifth station is planned to utilize the waters of the Paconella, an effluent of the Lys. This station and that of Trinité would function only in winter, but the others could be used during the entire year.

The electric railway from Trofarello to Ronco will soon be completed, so that it will be possible to travel by electricity from Genoa to Turin. Other lines being electrified are the Ronco-Arquata-Tortona, the Turin-Novi, the Voghera-Bivio-Bormida and the Genoa-Ovada-Alessandria. It is hoped to finish soon the electrification of the Rome-Tivoli and Rome-Anzio-Nettuno lines, after which work for the service of express trains between Rome and Naples will be pushed. So by the beginning of 1923 it is expected that 500 km. of railways will be electrified, making the total in Italy 1,370 km.

As it takes from 18 to 21 months to construct an electric locomotive, the state railways has voted to order 120 at an expense of 169,000,000 lire. Some of these will be used on the lines now in operation and the remainder will be put on the new lines.

The Relations of the Iron and Steel Industry to the Chemical Industry*

The Steel Industry, an Important Consumer of Chemicals, Supplies Many of the Basic Materials for the Chemical Industry and With It Furnishes Our Chief Means of Defense as Well as Our Peace-Time Tools for Material Progress

By JAMES M. CAMP
Director, Bureau of Technical Instruction, Carnegie Steel Co.

CLASSIFIED according to their direct relations to our natural resources and with respect to their dependence for raw materials, our industries are basic or subsidiary, according to the way they are grouped, and dependent. The basic industries are those engaged in the production, or creation, of raw materials by life processes, such as farming; or in the extraction of raw materials from the earth, such as mining or oil and gas-well drilling; or in the conversion of natural potential energy into useful forms, such as our hydro-electric plants. But these industries must be supplemented by a number of others, which, although they are directly dependent upon these basic industries for raw materials and mechanical power, are so intimately related to the former by reason of their being engaged in converting and adapting certain raw materials for use that they must be accepted as co-ordinate to these basic industries and also co-ordinate to one another.

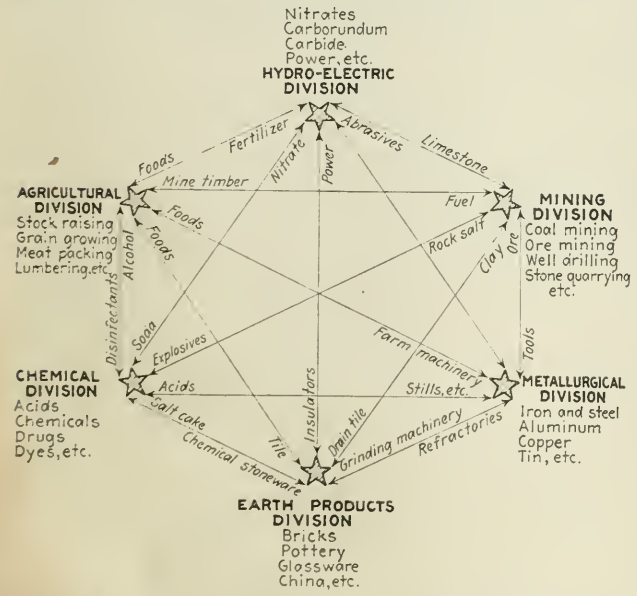

DIAGRAM SHOWING RELATIONSHIP OF THE SUBSIDIARY DIVISIONS OF INDUSTRY TO ONE ANOTHER

Hence, all these closely related industries are to be looked upon as being subsidiaries to our industrial life as a whole.

To explain more fully what we mean to imply by this use of the term "subsidiary" it is necessary to point out that we apply this designation to groups of closely related industries rather than to any specific activity. Thus farming, for example, is really a class term, for under it are included such occupations as gardening, cattle raising, fruit growing and the growing of grain, also the sciences that relate to these arts. From this standpoint we are able to separate our industrial life into a number of divisions, which we shall term the subsidiary divisions of industry. For want of better names, we designate the basic subsidiary division devoted to the production of raw materials by life processes as the agricultural division; that devoted to the extracting of raw materials from the earth as the mining and well-drilling division; and that devoted to the transforming of natural energy as the hydro-electric division. As to the dependent subsidiaries, we call that one devoted to the separation and refining of the metals the metallurgical division; the one devoted to the preparation of refractories, bricks, all clay products, as well as glassware, etc., the earth-products division; and that devoted to the production of chemical compounds, the non-metallic elements and certain of the rare metals, the chemical division. Some of you may think of other industries that should possibly be included as another division, but we believe that any of our industries can be placed under one or another of these divisions.

Interdependence of the Major Divisions of Industry

One of the things we wish to emphasize now is the close relation and interdependence of all these grand divisions of industry. So we would call your attention to the accompanying diagram, which will both demonstrate and vividly illustrate the point we wish to make. This diagram shows that these subsidiary divisions of industry are closely connected and related to one another because they are dependent upon one another for necessary raw materials and supplies, and are each made up of a number of related industries, so important that they are usually spoken of as being, themselves, the basic industries. Each of these industries is accompanied by a list of dependent industries so long that it was found impracticable to show them on this diagram. It is such a subsidiary division of industry, not a small branch of industry nor yet one of the dependent industries, that we have in mind when we refer to our chemical industry. It consists of the chemical industry proper and a great number of dependent industries, which, though they are not engaged primarily in the production of chemicals as such, produce articles of a chemical nature or by chemical processes, or articles that depend mainly upon chemicals. The chemical industry proper has, itself, three branches, which are known as the chemical section, the acid section and the coal-tar section.

Referring to the other part of our theme, we see in

*Paper read before the American Iron and Steel Institute, at New York, Nov. 18, 1921.

our country today a single branch of the subsidiary metallurgical division developed to such a high state of efficiency and on that account occupying such a high position commercially that it casts a shadow over the importance of even the subsidiary divisions. Such an industry is the steel industry. And here lies great danger for us, in that we may be led to attach too much importance to one industry or one division of industry and not enough to the others. Trying to decide which of these grand divisions of industry is the more important is like trying to decide which wheel of an automobile is most important, for they form the vehicle upon which our civilization is riding toward that goal set up for it from the beginning, when man was commissioned to replenish the earth and subdue it.

As the most important branch of the metallurgical division of industry, the steel industry cannot escape certain relations with the chemical industry, and it is interesting to note that these relations, both direct and indirect, are to an unusual extent interdependent. This interdependence is most vividly set forth when we consider these two industries from the standpoint of being consumers of each other's products.

Steel Industry Consumes One-Fifth of Our Sulphuric Acid

In reviewing the chemical products consumed by the steel industry, we find that sulphuric acid heads the list both as to quantity and importance. Statistics showing the quantity of this acid consumed by the whole steel industry of this country have never been compiled. We do know, however, that during the year 1920 the United States Steel Corporation used approximately 280,400 net tons, all of which was concentrated to give, on an average, a gravity test of 60 deg. Bé. This fact leads us to the confident belief that our steel industries as a whole must have consumed last year at least 600,000 net tons of this acid, expressed on the standard gravity basis of 50 deg. Bé. To make a striking comparison, the acid consumed during the year 1919 by the Steel Corporation alone amounted to almost 10 per cent of the total quantity of this acid reported by the Census Bureau as having been made in this country that year.

Of this acid used by us, nearly one-half finally went into the manufacture of ammonium and iron sulphates and thus represented a recoverable outlay, but the remainder represented an actual consumption, from which there was no such recovery of acid or any other direct tangible return for the outlay. As to the direct purposes to which we put the acid, not used in the manufacture of ammonium sulphate, a small portion was used in washing benzene and other homologous compounds produced by byproduct coke plants, a smaller portion was consumed in making chemical analyses, and the remainder was employed for pickling. The pickling process consists in immersing the steel in a warm dilute solution of the acid, and has for its purpose the removal of scale from the surface preparatory to tinning, galvanizing, cold rolling, cold drawing or chipping.

Concerning the necessity for pickling, this operation is absolutely essential in the manufacture of steel wire, of tin and terne plate, of galvanized sheets and tubes, of cold-drawn seamless tubing, and of all sheets requiring a highly finished and polished surface; and, as a means of revealing surface defects in billets and blooms, it is a great aid in the manufacture of high-grade steel, such as that required for forged and heat-treated articles. Other agents could be used for some of these cases, but the cheapness, chemical activity and high volatilization temperature of sulphuric acid make it the most satisfactory reagent that can be employed for this purpose.

The next items in point of quantity consumed by our corporation during the year 1920 were muriatic, or hydrochloric, acid and sulphur itself. Of the 10,200 net tons of the former consumed, some was used for pickling in processes where sulphuric acid is not suited to the conditions, such as the final pickling in galvanizing; some was consumed in our chemical laboratories, where it is used in practically every analysis made; some was neutralized with zinc to form part of the flux used in the manufacture of tin and terne plate; and a small portion was applied to various other purposes too numerous to mention here. The greater portion of the 22,000 net tons of sulphur used by us was consumed in the manufacture of sulphuric acid, which we also make as a byproduct in zinc smelting, but a considerable portion was employed in the manufacture of certain grades of steel, in the galvanizing of sheets and in the erection of acid-proof water-tight brick tanks.

The fourth and fifth items next in importance are salammoniac, or ammonium chloride, and soda. During the year 1920 our corporation required almost 7,500,000 lb. of salammoniac and a little more than 1,120,000 lb. of soda, most of which was in the form of the hydroxide, commonly known as caustic soda, and the remainder in the form of the carbonate, or soda ash. The salammoniac was used chiefly as a flux in the application of tin, terne and zinc coatings, but a small quantity was consumed in the laboratories and shops, where it is indispensable in some work. With the exception of small amounts used in our laboratories and for cleaning purposes the soda was employed in our plants for the neutralization of acids and corroding compounds, such as in the washing of benzene products and the softening of water for boiler use. Its effectiveness and the importance of its use for these purposes are matters that need not be elaborated upon nor emphasized here.

Other Chemical Requirements

Other items that may be of interest to certain organic chemists are the 6,000,000 lb. of palm oil used in the tin-plate plants of the corporation during 1920, the 63,477,000 gal. of fuel oil consumed, and the 3,264,000 gal. of straw oil required for the absorption of benzene and its homologs from our coke-oven gas. Tar oils may be substituted for the straw oil, but no satisfactory substitute for the palm oil has yet been found, though such a substitute has been diligently sought.

A small item is nitric acid, of which we consumed nearly 6,000 lb. in 1920. The use of this acid is restricted to laboratory purposes almost exclusively. During the same year our requirements for the nitrate of soda called for more than 3,500,000 lb. of this salt, most of which was employed in the manufacture of sulphuric acid.

Next comes a long list of chemical articles for which we have no data whatever as to the quantities consumed by the steel industry. Their importance, however, is apparent as soon as they are named or the uses to which they are applied are indicated. This list includes the various chemicals used in our laboratories for analytical purposes, and such substances as lubricants, soaps, salt, carborundum and compressed oxygen. From 1,000 to

1,200 lb. of elementary phosphorus is also consumed in the preparation of phosphor bronzes for use by the steel manufacturers.

The Chemist as a Prospective Customer

Not only are the iron and steel industries large consumers of chemicals, hence good customers of the chemists, but the chemical industries are likewise large consumers of iron and steel. We have been unable to obtain statistics as to the tonnage of iron and steel used by our chemists, but, judging from our knowledge of these industries, we know it must be large. The chemists deal largely with matter in the liquid and gaseous states, hence their apparatus consists of such vessels as stills, retorts, vacuum driers, pipes, tanks and various other containers, many of which are made of iron or steel entirely, while the remainder require these materials in their construction. They have need of much steel in the form of plates and sheets for vessels, ranging from tin cans to tank cars, in which to transport and market their materials. They employ much machinery, such as fans, rolls, pumps, presses, crushers, disintegrators and centrifugal machines, and, of course, require engines and motors to operate these machines. They require steel for their buildings, which usually must be fireproof; in 1919 there were more than 1,300 establishments producing chemicals, 811 of which were devoted exclusively to the chemical industry proper.

Some Waste Products of the Steel Industry

But it is in the sense of a prospective customer that the steel industry should show the keenest interest in the chemical industry, for the former has, to a considerable extent, gradually worked itself into the position of a producer of certain chemicals and raw materials for the latter industries. Thus during the war the scarcity and consequent high price of potash brought about the installation of apparatus for the recovery of this product from the dust in blast-furnace flue gases wherever the amount of potash driven over with these gases would justify the expense. Similarly, a desire to eliminate waste led the steel industry several years ago to begin the manufacture, from spent sulphuric acid, of ferrous sulphate, commonly known as copperas or green vitriol. The production of this salt for the year 1919 amounted to almost 60,000 net tons, practically all of which we can be reasonably sure was produced by the steel industry.

This salt is used in paper making; in the tanning of some leathers; in water and sewage purification; in the manufacture of fertilizer from packing-house waste; on the farm as a spray and disinfectant for the eradication of weeds and the prevention of certain diseases among plants and animals; and in the preparation of inks, certain pigments, shoe blacking, ferric sulphate, stock foods and a few drugs and medicines. A new use for this salt has been found in the briquetting of blast-furnace flue dust, in which process it acts as a cement, making the briquets produced by pressing hard and strong. It is also used in the purification of artificial gas from hydrogen sulphide and hydrocyanic acid gases, for which purpose there are two general methods, known as the dry and the wet methods. In the dry processes the sulphate is mixed with equal volumes of lime and moist sawdust, which are then pressed into a cake and roasted. The roasting burns out the sawdust and leaves a porous mass composed of iron sesquioxide and lime intimately mixed and ready to be charged into the gas scrubber. In the wet processes, which are more efficient in the removal of hydrocyanic acid, the gas is scrubbed with a concentrated solution of the sulphate, and ferrocyanides are obtained as byproducts. A lime and iron oxide mixture similar to that just described for the dry process is now obtained by one of our companies in the purification of mine waters. As this mixture does not require roasting, it is easier to prepare than the sulphate mixture and is very effective and economical as an agent for removing sulphur in coke-oven and other retort gases made from coal.

It should be noted in passing that a similar desire to utilize what would otherwise remain waste products urged us many years ago into the manufacture of cement from blast-furnace slag, of phosphate fertilizer from basic slag, and of paints containing zinc oxide and white lead or iron sesquioxide as base pigments. Although viewed with much prejudice and suspicion in the beginning, the high quality and economic importance of these byproducts of the steel industry are now generally recognized.

Supplying Ammonia and Coal-Tar Products

Again, the change from the beehive to the byproduct method of coking coal has brought the steel industry into the most intimate relationship with the chemical industries, particularly the coal-tar branch. This change has created an almost unlimited supply of ammonia and coal tar, the chief raw material used by the coal-tar chemists. Ammonia can now be produced at the byproduct plant in three forms—namely, as ammonium sulphate, as concentrated ammonia liquor and as ammonium chloride. The chief outlet for this ammonia lies in the direction of the fertilizer industry, for which purpose the sulphate is employed. The salt is seldom applied alone to the soil, but is used in the various fertilizer mixtures, for which purpose it is well adapted because it will neither revert the acid calcium phosphate nor react with the other fertilizer ingredients to render unavailable any part of its own nitrogen content. It is especially beneficial to some of our soils which contain an excess of the alkalis and to other that lack sulphur. In the latter it fulfills the double purpose of supplying both nitrogen and sulphur, two elements essential to plant growth. A process for recovering ammonia in the form of the chloride, which happens to be the form in which about 90 per cent of the fixed ammonia is given off by the coal, has been recently developed so as to be applied on a large scale. The perfecting of this process will make it possible to produce this salt in large quantities and possibly in a highly refined state. Thus another element has been added to the list of coke byproducts, and the field for the disposal of byproduct ammonia has been widened.

Omitting alcohol and the compounds of sulphur and hydrocyanic acid that can be made or recovered from coal gas, the other products of the byproduct plant are the chemical compounds benzene, toluene, xylene and naphthalene, and the mixtures known as light-runnings, wax, resin and tar. Commercially, the first three compounds, as well as mixtures of these substances, are known as benzol, toluol and light and heavy naphtha. These compounds, together with tar, form the raw materials for the coal-tar branch of our chemical industries. The finished products that can be made from these raw materials are numbered by hundreds, but, classified, the finished coal-tar products consist of dyes, color lakes,

explosives, disinfectants, medicines, phenolic resins, flavors, photographic chemicals and perfumes, in about the order of their total money values per annum. According to the statistics compiled by the Census Bureau, the weight of these products for 1919, excluding disinfectants and explosives, amounted to 82,532,400 lb., and they were valued at $84,515,500, or an average price per pound for all finished products of about $1.05. A comparison of this average price with the 1919 prices obtained for the crude products at the coke works, which ranged from ⅛c. per lb. for tar to 10c. for the purest naphthalene, shows how the values grow in passing through the hands of a chemist. In addition to these finished coal-tar products, there were produced in unknown quantities several crude and intermediate products, the total value of which is stated to be approximately $49,000,000.

The Rise of the Coal-Tar Industry

At this point it may be of interest to note the rapid growth of this branch of our chemical industries. In 1914 the total value of all the coal-tar chemical products produced in this country was approximately $9,000,000, and with the exception of tar refiners and about seven small plants engaged in assembling imported intermediates into dyes, there were no establishments devoted solely to the manufacture of finished coal-tar products of any kind. Now, according to the recent census taken by the United States Tariff Commission, the total number of firms engaged in the manufacture of coal-tar products in 1920 was 213, of which 82 were engaged in the manufacture of dyes alone. These firms produced more than 206,000,000 lb. of the semi-finished products known as intermediates and more than 67,000,000 lb. of finished dyestuffs. The discrepancy between the tonnage of intermediates and finished dyes is brought about in two ways—namely, some of the intermediates are produced from other intermediates, hence may appear twice in our total, while others may be used for the manufacture of other substances than dyes. All of these intermediates can be made from benzene, toluene, xylene and naphthalene, and are very numerous, as many as 46 being derived from naphthalene alone. Concerning the number of dyes, our chemists made 360 separate dyes in 1920, some of which were never made before. We hesitate to give any figure as representative of the number of other coal-tar chemicals, for new ones are being discovered with bewildering frequency. If we can do so without appearing unduly boastful, we would like to declare in this connection that American chemists during the past 5 years have led the world in the discovery of new coal-tar chemicals.

Another comparison of perhaps greater interest to us is this: The 82,500,000 lb. of finished coal-tar chemical products produced in this country during the year 1919 is equal to only a little more than one-third of the total weight of the benzene products and less than one-tenth of the tar produced by the Steel Corporation alone during the same period. Now, the processes of the coal-tar chemist are all synthetic, so that his finished products generally show a gain in weight over the basic raw materials, except in the case of tar, of which only about 15 per cent is available for synthetic purposes. So, keeping in mind that the Steel Corporation probably made considerably less than half of all the tar and primary benzene products produced in this country, we have evidence enough that the production of coal-tar chemicals was not limited by a scarcity of raw materials. Yet, for this reason or that, we have found the coal-tar chemists importing some of these same raw products.

Need for Better Relations Between the Two Industries

Let us cite one case to illustrate a point we wish to make. A certain byproduct coke plant operator, under the impression, which he had gained in dealing with the coal-tar chemists themselves, that for the manufacture of certain naphthalene dye intermediates the purest naphthalene obtainable was required, proceeded to install at great expense apparatus wherewith he would produce practically c.p. naphthalene, or at least naphthalene with melting and boiling point ranges of 1 deg. This gentleman then felt reasonably sure of getting a good portion of the business in high-grade naphthalene, but less than 2 months after completing his fine new plant he found his best customer importing naphthalene at 3c. less per pound than he was asking—yes, but of inferior grade and with a boiling point range five times as great. Now, either this dye maker had intentionally misrepresented his requirements with the idea of getting something for nothing, if he could, or he suddenly discovered he did not need as good a grade of naphthalene as he thought. This incident illustrates a lack of sympathy and co-operation between these two industries that we hope is, or will soon become, very rare.

Fortunately, and also unfortunately, the steel industry does not rely upon the coal-tar chemical industry in disposing of these coke byproducts and neither does the coal-tar chemical industry rely upon us for its supply of raw materials entirely. The steel industry finds a ready sale for all its benzene and toluene and a part of the naphtha as motor fuel, while the remainder of the naphtha and all of the naphthalene and tar can profitably be used as fuel in the steel mills. On the other hand, the coal-tar chemists can look to the gas manufacturers for many of their basic raw materials, and, indeed, so far as the refining of tar is concerned, they rather prefer certain gas tars to coke-oven tar, as the former usually contains a higher percentage of the more desirable light and middle oils. This is the unfortunate side of this condition, that it does not promote the spirit of sympathy and helpfulness that goes with a mutual dependence. All tar, however, contains a high proportion of pitch, for all of which it is difficult to find a ready market But the coal-tar refiner would be relieved of his "burden of pitch" and the byproduct coke operator would receive more money for his tar, if some plan were evolved wherein the tar could be roughly fractionated at the coke plant, where the pitch could be mixed with raw tar and used as fuel or charged into ovens and converted into coke.

Some Indirect Relationships

Leaving for a time the points of direct contact between these two industries, let us examine briefly their indirect relationships. For, whether the matters just discussed are viewed with concern, as being of importance, or with indifference, as becomes trifles of little consequence, the steel and chemical industries are indirectly connected in ways that are vital to the welfare of both. To prove this statement the mere mentioning of a few of these direct relationships is all that is needed.

One of these indirect relationships has to do with the

fact that certain products of these two industries are absolutely interdependent for their effectiveness. We consider, for example, the dependence of liquefied and compressed gases upon the high-tension seamless steel tank, and then reflect that without the development of and the demand for such gases there would be no demand for the tanks. In the latter case the steel industry would have missed a good business, for, taking the case of compressed oxygen alone, the 1,200,000,000 cu.ft. or more of this gas compressed yearly requires the constant use of about 2,000,000 tanks to contain and market it. Similarly, we find steel tubing and ammonia working together in our ice plants, drills and powder in our mines, firearms and explosives on our battlefields and on our hunting grounds, and automobiles and gasoline or benzene everywhere.

Again, we find that the steel and chemical industries are connected in a similar indirect but vital manner through their more direct relations to certain other industries. In a word, both steel and chemicals are first essentials to many industries. We have already pointed out the interdependence of our basic subsidiary industries, upon which all our other industries depend, and now we wish to call your attention to the fact that some of our most important special industries are so completely dependent upon steel and chemicals that if they were denied either of these two classes of materials, these industries would be totally ruined. A notable example is supplied by the electrical industries. Without chemicals for batteries and insulating materials, or without steel for magnets, armature cores, transformer cores and other vital parts of electrical machinery, the whole industry would be handicapped and certain branches would be impossible. Similar conditions with respect to steel and chemicals prevail in the telephone and telegraph industries, the textile industries, the rubber tire industry, and in many other industries of more or less importance.

Our National Safety and Our Industrial Progress Dependent Upon Steel and Chemicals

Before leaving our subject we would speak of one other phase of the indirect relations between these two industries. This matter, while it is less tangible than those things we have just been discussing, is nevertheless of vital importance. We refer to the common relation of the steel and chemical industries to the welfare and safety of our country. It is self-evident that the strongest nation is the independent nation—that is, the nation that does not have to rely upon its neighbors for any of the basic or critical supplies. Such an independence is based upon two commodity factors—namely, natural resources and the industries to develop them. As to the natural resources, this country has been blessed with a full line with the exception of combined nitrogen, which deficiency, fortunately, can now be supplied by our by-product coke ovens and our prospective nitrogen-fixation plants. Fortunate for us, also, we can now say, although not with pride, since we were forced to it, that the last link in the chain of our industrial independence has been forged. This link is about to be subjected to the severest commercial tests, and whether or not it can withstand the tension of selfishness, prejudice and ignorance at home and the strain of competition from abroad depends upon how big a load we permit these things to become.

This new link in our industrial chain you will recognize as the coal-tar branch of our chemical industries. Its present importance to us in peace times is indicated by the value of its products for 1919, which we have just stated. Its future importance we can only imagine, for it is still in the rough and capable of much further development. Indeed, none of our other industries presents such a field of unexplored potentialities. For its importance in war times, we need only to refer to its position in the late World War. If Germany ever again is the maker of our dyes, German poison gas will again suffocate our soldiers. To overcome prejudice and misrepresentation at home, let all our people know we can and do make as good dyes as were ever made prior to the war. Dyes, like the different varieties of steel, can be misused and also injured by the way in which they are applied. The excuse we so often hear that our colored textiles fade because they are dyed with American dyes is a fallacy that may cover either cupidity or ignorance in the proper use and application of our dyes. To overcome the mistakes of ignorance, which, by the way, are mainly of a commercial nature and not of the technology of coal-tar chemistry, requires time, experience and the closest co-operation of all those concerned. Since they compose the two groups that would be most seriously affected by the destruction of this industry, the last part of this statement should be especially emphasized among both the makers and the coal-tar chemists, who, we fear, are not always so frank and business-like in their dealings with us or with the public as they should be, for their own good.

While we maintain that all our industries are equally important to the physical comfort and general welfare of our people, we can also say that no others have contributed so much to our safety and progress as the steel and chemical industries. In times of war they have supplied our chief means of defense and in times of peace they have furnished us with tools wherewith we have hewn our way to material successes. And now we plead for more sympathy and co-operation in these industries to the end that each may continue to contribute more and more to the security and prosperity of our own nation and to the advancement of all mankind.

Pittsburgh, Pa.

Italian Olive Oil Industry

The Italian Government is considering a project for joining all the growers of olive trees into an association to do away with antiquated methods of cultivation, reports the special correspondent of CHEMICAL & METALLURGICAL ENGINEERING. The association is to be maintained by the payment of a fee varying according to the number of plants cultivated by each member.

The Italian exports of green olive oil during the first half of 1921 were 1,394 tons, against 798 tons in the corresponding period in 1920 and 416 tons in 1919. Of these, 621 tons went to the United States, 92 to France, 137 to England, 53 to Switzerland, 10 to Australia, 26 to Tripoli, 110 to Argentina, 38 to Brazil, 17 to Chile and 20 to Uruguay.

The Italian imports of green olive oil in the first 6 months of 1921 were only 4 tons. Imports of edible, or pure, olive oil were 2,441 tons, against 814 tons in the first 6 months of 1920 and 5,720 tons in the corresponding period of 1919. Of the edible product imported in the first half of 1921, 203 tons came from Greece, 328 from Spain, and 1,239 from Tunis, the remainder being divided among other countries.

Manufacture of Cellulose Nitrate for Pyroxylin Plastics

Preparation of Tissue Paper or Linters for Nitration—Methods of Nitration: The Pot Method and Its Modifications; Nitration in Centrifuges; the Displacement or Thomson Process—Purification of Cellulose Nitrate: Washing; Pulping; Bleaching; Drying by Various Processes

By J. R. DuPONT

As a general rule, pyroxylin plastics are prepared by mixing a certain grade of cellulose nitrate with camphor and denatured alcohol. Sometimes for the sake of economy the camphor and alcohol are replaced partly or entirely by substitutes which will produce a more or less perfect plastic. Pyroxylin plastics are usually marketed under a trade name such as celluloid, viscoloid, pyralin or fiberloid.

Of the many possible cellulose nitrates, all of which have the general formula $C_{24}H_{40-n}O_{20-n}(ONO_2)_n$, only those having a nitrogen content of from 10.5 to 11.4 per cent are used in the manufacture of pyroxylin plastics. These are generally known as nitrocellulose, pyroxylin or soluble cotton, and their manufacture is a highly specialized operation, since the properties of the finished plastic are largely dependent upon those of the pyroxylin used.

Types of Cellulose Used as Raw Material

Many kinds of cellulose have been recommended for the preparation of cellulose nitrate to be used in making pyroxylin plastics, but so far, in Europe and in America, only two are used: tissue paper and cotton linters. The tissue paper is made of specially prepared and bleached cotton rags, weighs from 20 to 25 g. per square meter and has a thickness varying from 0.0025 to 0.0035 in. It has to be of very uniform composition and color, free from specks, hard knots or sizing, and is delivered to the plastic manufacturer in rolls weighing from 200 to 300 lb.

For use in this industry, cotton linters are submitted to a special purification to remove dirt, hulls and grease, and they receive the best bleaching possible, keeping in mind that an excess of treatment will be prejudicial to the quality of the finished product. So far in this country tissue paper has been mostly employed, but in Europe cotton is quite often used, and by employing proper acid mixtures cotton gives as good cellulose nitrate as paper. From an economical point of view it seems probable that in the future linters will supplant paper in the manufacture of pyroxylin plastics, as the cost of the former is about one-third that of the paper. Of all other different kinds of cellulose tried (flax, wood pulp, etc.), none so far has been utilized because of too poor nitration obtained or too colored nitrates produced.

Drying of Cellulose

As received the tissue paper or cotton has a moisture content too high to permit direct nitration, consequently it has to be dried before being used. This drying operation is very important, as too much moisture in the cellulose (above 1 per cent) will cause the following troubles: Weakening of the acid bath; irregular nitration, which will give a poor solubility; low yield caused by the breaking up of the cellulose nitrate fibers as a result of the rise of temperature produced by the contact of water with the acids; production of muddy acid, which will be prejudicial to the making of a first-class transparent plastic; acceleration of the production of N_2O_4, which will affect both the yield and the stability of the cellulose nitrate.

Drying the tissue paper is ordinarily done after it has been cut into strips of various sizes, which are carried by air displacement into a closed room, where, by hot air circulation, the drying is effected. In the case of cotton, the drying is done by placing the carded linters in heated and ventilated chambers, where they stay a variable time according to the moisture content, the temperature of heating and the efficiency of the ventilation.

Linters may be dried more efficiently in continuous driers similar to those used in the textile industry, since these give a greater production and also more uniform drying.

Nitration Bath

The nitration bath is formed from a mixture of nitric and sulphuric acids in variable proportions, and each factory has adopted a special formula which gives the best results for a determined cellulose. In general the ratio of nitric to sulphuric is about 1 to 3. This corresponds to a percentage composition of: HNO_3, 19 to 20; H_2SO_4, 60 to 61; H_2O, 21 to 19.

Table I shows the results of laboratory research on different nitration baths. These data were obtained on paper using 50 g. for each nitration, with a ratio of acids to paper of 100 to 1. As would be expected, in practice the yield obtained after washing and bleaching is considerably lower and is around 145 to 148 per cent.

TABLE I. LABORATORY RESULTS WITH VARIOUS NITRATION BATHS

	Mixed Acid						Cellulose Nitrate		Solubility in:	
No.	HNO_3, Per Cent	H_2SO_4, Per Cent	N_2O_4, Per Cent	H_2O, Per Cent	Temp., Deg. C	Time, Min.	Yield, Per Cent	N_2, Per Cent	5 Per Cent Camphor	Acetone
1	20.68	60.54	0.89	17.89	30	30	165.6	11.44	96 3	98.8
2	17.03	64.69	Trace	18.28	29	30	161.8	11.21	98.2	99.8
3	17.03	63.95	....	19.02	30	30	161.6	11.00	97.7	99.9
4	17.46	63.96	....	18.56	29	32	161.4	11 02	92 8	99.6
5	16.87	64.15	....	18.98	30	30	156.9	11.05	98.1	99 8
6	16.52	64 89	....	18.69	31	30	160.5	11.16	99.1	99.9
7	16.04	64.08	....	19.88	30	30	155.7	10.83	99.7	99.9
8	15.91	64.96	....	19.13	29	30	156.2	10.82	94 9	99.7
9	15.64	64.00	.. .	20.36	29	31	153.0	10.14	97.9	99.8

Time of Nitration

The nitration time is variable according to the composition of the mixed acid, the kind of cellulose used

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and the temperature of the acid. In case of tissue paper the speed of reaction is in direct proportion to the thickness and also to the temperature at which the nitration is conducted. For economical results the time of nitration is rarely over 60 minutes—that is, the total duration, including the filling of the pots with acid, the dipping of the paper and the whizzing of the cellulose nitrate. This leaves the real time of nitration varying from 25 to 35 minutes, which is enough if the composition of the mixed acid is correct.

For linters a longer time of nitration is generally employed, but by increasing the temperature of the acid, which will speed up the reaction, practically the same time can be used.

Temperature of the Mixed Acid

The temperature of the acid varies according to the cellulose used, and each manufacturer has adopted a temperature which gives him the best results. When working with tissue paper the acid temperature is kept around 30 deg. C.; with linters near 35 deg. C. The higher the temperature of the acids the quicker will be the reaction but also the greater the chance of breaking up the fibers of the cellulose nitrate formed, which will lower the yield.

Combined with too much moisture in the cellulose, excess of heat will produce partial decomposition of the cellulose nitrate. Not only is this practice, often observed, a costly one, but also the acid is soon contaminated with N_2O_4 which, in amounts above 1 per cent, will affect the yield and lower the stability of the cellulose nitrate produced. The most trouble arises during the period of warm and damp days when it is difficult to keep down the acid temperature and artificial cooling has to be employed.

Quantity of Acid Used

The type of cellulose and the method of nitration have a direct influence upon the amount of mixed acid required for nitration. With tissue paper the ratio of acid to paper is generally 100 to 1, but if the paper is stirred during nitration the proportion can be reduced to 85 to 1. In the case of linters the ratio is usually between 50 to 1 and 60 to 1.

Typical Plant Data

Table II gives data which are typical for the commercial production of cellulose nitrate from tissue paper and linters.

Nitration Methods

Three general methods of nitration are employed in pyroxlin plants: Pot method, centrifuge method and displacement process.

Pot Method

Hand Dipping With Individual Pots.—In this first method, which was much used in the early days of celluloid manufacture, the dry cellulose was dumped in stoneware pots containing the mixed acid; after nitration, which required from 45 minutes to 2 hours, the cellulose nitrate was separated from the spent acid by different means, but all based on exerting pressure on the cellulose nitrate. After most of the acid was thus expelled, the nitrate was drenched in water. As the loss of spent acid was very great and owing to the difficulty of washing the compressed cellulose nitrate, the next step was the introduction of the centrifuge as a means of separating the spent acids from the finished product, a method which is practically the only one used today.

The capacity of the pots used at first was only 8 to 10 gal.; as the production was small, the capacity was later increased to 100 gal. The small pots were ordinarily carried by hand to the acid-extracting machine, but as the larger ones were too heavy, they were made stationary, supported by two iron posts. By a cock the acid was drained off after nitration and the cellulose nitrate forked into the whizzer. The abundant fumes obtained during the process were collected by a hood and carried outside by a fan.

Table Method.—In order to get a greater production and reduce to a minimum the size of the nitration room, the pots were placed on a turntable, and this table method (which was first designed by Hyatt) is still used with but very little modification.

The apparatus is composed of a circular turntable upon which six or eight iron pots of special shape are supported by iron arms. Outside the table is a whizzer so placed as to reduce to a minimum the splashing of the acid when the pots are dumped. Above the pots and the whizzer is a large hood where the fumes are collected and sent outside by a suction fan. The apparatus is operated as follows: The first pot is filled with mixed acid at the proper temperature and the dry cellulose is placed by hand in the acids and dipped with aluminum forks or by a specially constructed stirrer; this done, the table is turned by hand so that the second pot is placed in front of the acid feed pipe. The second pot is then filled with acid, the dry cellulose immersed and the operation repeated. The number of pots on the table is determined by the duration of the nitration, so that when the last pot is ready to be filled with mixed acid the nitration of the first is completed and it can be dumped in the whizzer. With an average of 45 minutes for the total time of nitration, using eight pots, a complete turn of the table takes place every 45 minutes, each operation taking the following time: Filling the pot with acid, 3 minutes; dipping of the cellulose, 4 minutes; duration of nitration, 31 minutes; dumping and whizzing of the cellulose nitrate, 5 minutes.

As the pots have a capacity varying from 15 to 30 lb. of cellulose, the production per hour varies from 232 to 464 lb. of cellulose nitrate, admitting an average yield of 145 per cent. As to labor, six men are required to take care of the table. This method of nitration, used in the United States principally for the nitration of tissue paper, has the following disadvan-

TABLE II. TYPICAL PLANT DATA

	Nitration of: Tissue Paper	Linters
Composition of mixed acid:		
HNO_3	21.13	19.59
N_2O_4	0.32	0.21
H_2SO_4	60.54	60.70
H_2O	18.01	19.50
Ratio of acids to paper or linters	90.1	60.1
Temperature of nitration, deg. C	30	36
Duration of nitration, minutes	30	30
Total duration, minutes	45	45
Yield, per cent	148.2	149.3
Nitrogen content, per cent	11.29	11.34
Solubility in 5 per cent camphor alcohol solution, per cent	98.7	99.4
Solubility in acetone, per cent	99.7	99.8
Viscosity, seconds	95	74
Analysis of spent acid:		
HNO_3	19.70	18.80
N_2O_4	0.40	0.30
H_2SO_4	60.12	60.21
H_2O	19.78	20.69

tages: Irregular solubility of the cellulose nitrate due to the fact that the cellulose is generally dipped by hand with no stirring during the nitration; great loss of nitric acid fumes, as the pots are not covered. In addition, the fumes are very troublesome for the men and keep the cost of repairs very high. For these reasons the table system of nitration is generally replaced by the use of special nitration units as used in the manufacture of cellulose nitrate for the making of explosives.

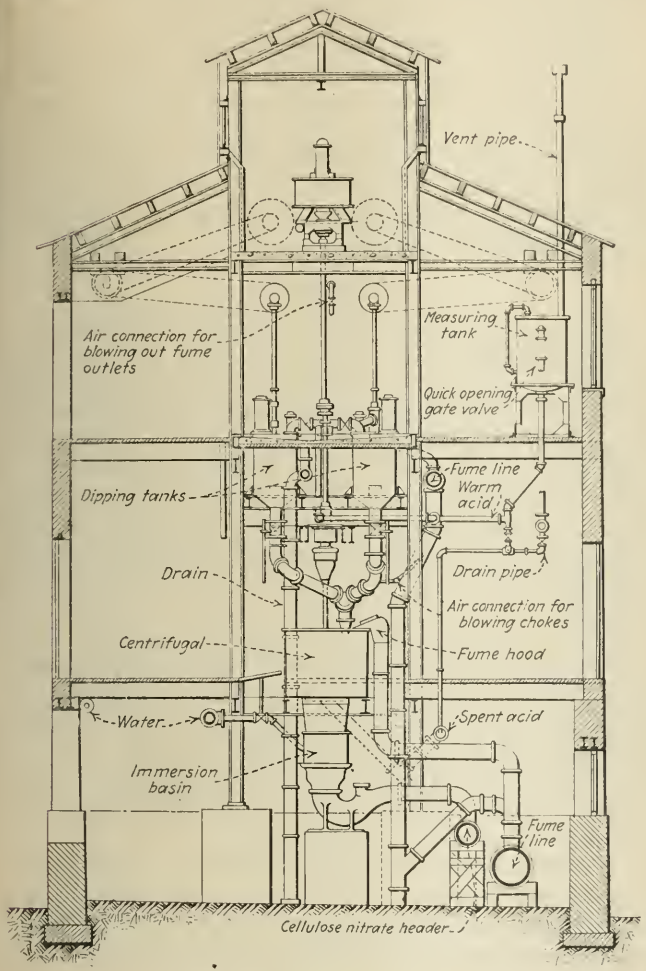


FIG. 1. CELLULOSE NITRATE PLANT USING MECHANICAL DIPPING TANKS

Mechanical Dipping Tanks.—This special machinery is composed of four separate dipping tanks and one centrifuge, forming one unit. Each tank (which is made of special acid-resisting iron) is cylindrical and provided with two stirrers which not only stir the cellulose during the nitration but effect the dipping of the cellulose when placed in the acids. Situated at the bottom of each dipping tank is a pipe of large diameter closed by a valve, connecting the tank with the centrifuge which is situated on a floor below. Fig. 1 gives a general idea of the arrangement of a plant of this type. A series of dipping tanks is shown in Fig. 2.

The nitration operation is carried on as follows: The tank is first filled with mixed acid of the correct temperature. The cotton or shredded paper is then dumped in the acid, being quickly immersed by the rotating stirrers. The nitration is permitted to go on, generally 30 minutes, and when completed the bottom valve of the tank is opened and the acid and cellulose nitrate fall directly into the centrifuge, where the acid is whizzed out, going by gravity to the spent acid tank. The centrifuge has a bottom discharge which permits the direct dumping of the cellulose nitrate into the first washing tank. The capacity of the dipping tanks is ordinarily about 1,600 lb. of mixed acid and the total duration of the nitration is generally 45 minutes. Using a ratio of 1 lb. of linters to 50 lb. of acid, the total production of a unit per 10 hours would be 2,560 lb. of cellulose nitrate, admitting a yield of 150 per cent. The centrifuge shown in Fig. 3 has a diameter of 42 in. and is directly driven by a 40-hp., 440-volt electric motor turning at 1,170 r.p.m. This system of nitration has many advantages over the other methods—it reduces the labor required, minimizes the production of fumes and gives a very uniform nitration—so that in the future it will be entirely used.

Centrifuge Method

In this method, used mostly abroad, the nitration is made directly in a centrifuge with a basket specially constructed to keep the mixed acid away from the bearing of the machine. The basket can be rotated at two different speeds and can be emptied of the spent acids by a cock placed on the side of the casing. The principle of this method of nitration is based on the fact that if the basket of the centrifuge is made to rotate at a low speed (30 r.p.m.), the acid will be kept constantly in motion and will thus give a better nitration.

When the nitration is completed—that is, after 25 to 35 minutes—the acid-draining valve is opened and the high speed (1,000 r.p.m.) is put on, so as to remove as much as possible of the spent acid. This centrifuge, in which the temperature of the acid can be controlled (as the casing of the basket is jacketed), has a maximum production of 300 to 450 lb. of cellulose nitrate per 10 hours, admitting an average yield of 150 per cent, varying with the capacity of the basket. This method of nitration, which presents certain ad-

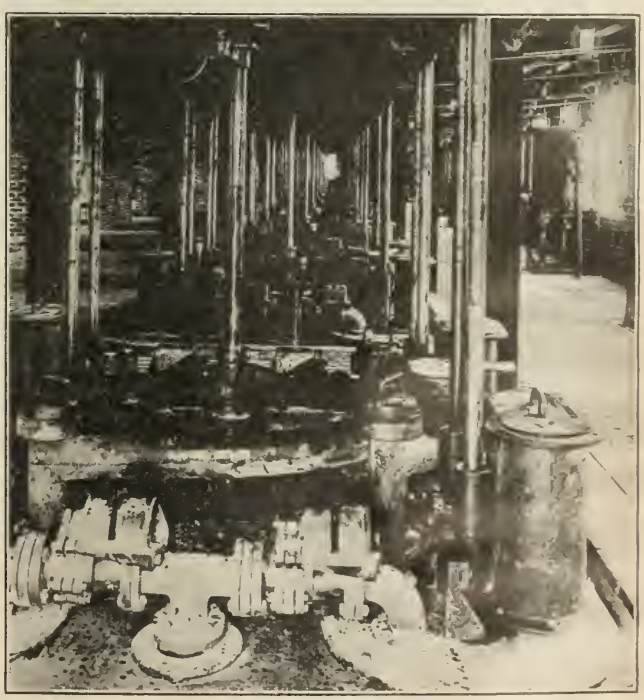


FIG. 2. MECHANICAL DIPPING TANKS FOR NITRATION

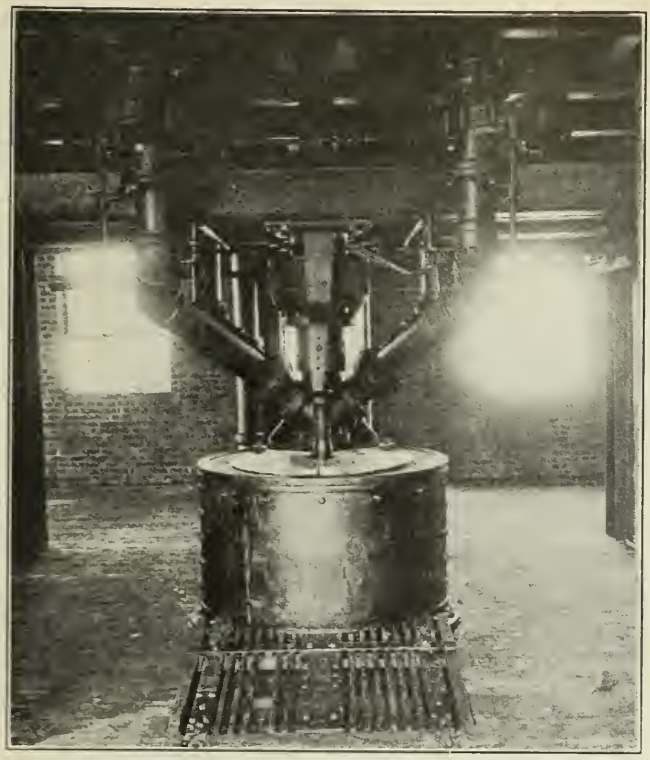


FIG. 3. CENTRIFUGE FOR CELLULOSE NITRATE

vantages, has not met with much success, on account of the cost of the installation, which is great when large quantities of cellulose nitrate are required.

Displacement Process

The displacement or Thomson process is based on the fact that if water is carefully run on the top of mixed acid in which cotton is nitrated and the acid drained out slowly, the water will displace the acid from the cellulose nitrate, not causing mixing of water and acid, which would liberate heat and thus cause decomposition of the cellulose nitrate.

The apparatus used is composed of four low cylindrical earthenware vessels, forming one unit; the conical bottom of each vessel supports a removable perforated bottom plate and terminates at the lower end in a cock for draining the acid. Fitting the top of the cylinder is a perforated plate, and on the side of the apparatus are two pipes supplying the acids and the water. A hood carried on a rail collects the fumes during the dipping of the linters, the fumes being sent outside by a fan. The process of nitration is as follows:

The hood is placed above the vessel which is filled with the mixed acid (700 to 800 lb.) and from 20 to 22 lb. of dry linters is dipped in the acids. This operation completed, the perforated top plate is placed above the linters so as to keep them immersed in the acid; then about 1 in. of water is slowly run on the top of the plate so as to prevent the formation of fumes. The hood is carried off and the nitration is then permitted to proceed from ½ to 1 hour. The nitration competed, the bottom drain cock is opened and at the same time water is permitted to run on the top of the plate. Great care should be taken so that the speed of the acid and the water is the same; the maximum speed for the withdrawal of the acid is around 17 lb. per minute.

The acids up to a density of 1.65 are kept in a special tank and considered as true spent acids which will be fortified with strong mixed acids to be used again in subsequent nitrations. The weaker acids are sent back to the acid manufacturer, keeping in mind that acids that are too weak will attack the iron containers. The total duration of the operation is 2½ hours, this corresponding to a production of about 500 lb. of cellulose nitrate per unit in a 10-hour shift.

This process has many advantages, which stated briefly are: Reducing to a minimum the production of troublesome fumes; lowering the amount of acid consumed; eliminating the use of a centrifuge; reducing the time of washing and consequently the quantity of water used, etc. However, few celluloid factories have adopted this process, as it is practical only when linters are used.

Washing

As soon as the nitration is completed, the cellulose nitrate is dumped into a tank containing a large quantity of water, where the mass is vigorously agitated by hand or mechanically, so as to reduce to a minimum the heating which will result from the contact of water with the acid. From this first washing tank the cellulose nitrate is sent ordinarily by gravity to the washing tank proper, situated on the floor below. If the prewashing is not properly made, decomposition of the cellulose nitrate will take place, a fact too often observed.

The real washing of the cellulose nitrate made with tissue paper is done in wooden tanks of rectangular or elliptical shape, which are generally covered with perforated aluminum sheets and in which a hollow drum supporting aluminum paddles is rotated, assuring the constant motion of the cellulose nitrate in the water. By changing the water frequently, the cellulose nitrate is washed until nearly neutral.

The time of washing varies with the retention of acid by the cellulose nitrate, but from seven to ten changes of water are required, the machine being kept in motion for 30 minutes between changes.

Pulping

After the cellulose nitrate has been washed, it is pulped in beating machines in the same manner that cellulose is converted into paper pulp. However, the

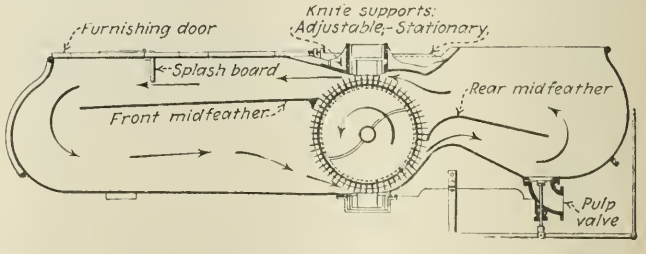


FIG. 4. DUPLEX BEATER FOR PULPING CELLULOSE NITRATE

ordinary type of beater is generally replaced by the Duplex beater, which, as will be seen from Fig. 4, has two sets of stationary knives, thereby doubling the production of the machine.

Although pulping permits better bleaching and the production of a more stable cellulose nitrate, it is not always practiced in factories using tissue paper, as the loss during the operation is great if the installation is not right. Nevertheless it would seem that this

operation is indispensable for the production of a first-class cellulose nitrate and that the loss of flock might be minimized by installing save-alls of the right kind.

Bleaching

The bleaching of the cellulose nitrate is very important for the production of transparent and ivory plastics, and each factory has adopted formulas which vary with the grade of cellulose employed. The two methods generally employed use potassium permanganate and chlorine, respectively.

When employing potassium permanganate, a solution of 2 per cent of the weight of the cellulose nitrate is used and the water is made slightly acid with sulphuric acid. As soon as the reduction of the potassium permanganate is complete, which takes from 1 to 2 hours, the cellulose nitrate is washed and the brown color is removed by oxalic acid or, better, SO_2.

In the second method, chlorine is employed, using solutions of bleaching powder or liquefied chlorine generally of 1 per cent strength. The time of bleaching varies from ½ to 1 hour. Great precautions have to be taken to remove all trace of chlorine, and sometimes sodium thiosulphate or, better, sodium sulphite is used as an anti-chlor, since chlorine present in the cellulose nitrate will rapidly cause decomposition.

After bleaching, the cellulose nitrate is given from seven to ten washings with hot water and, during the first three, a solution of sodium carbonate is added so as to neutralize exactly the acidity of the cellulose nitrate. Great care must be taken to remove all traces of alkali, which, if left in the cellulose nitrate, will have a tendency to provoke discoloration of the finished celluloid. At this stage the nitrated cellulose is ready to be dried, and before this operation the finished product is whizzed so as to reduce the water content to about 35 per cent.

Purification of Cellulose Nitrate From Linters

The purification process as given above is what is generally followed for cellulose nitrate made with tissue paper, but when linters are used, the treatment has to be made very carefully so as to obtain a stable finished cellulose nitrate. Generally the prewashing is followed by boiling the cellulose nitrate in circular boiling tubs with slightly acidified water, the operation lasting generally 4 hours. After boiling, the cellulose nitrate is pulped and sent to the poaching tanks (Fig. 5), where the bleaching and finishing of the purification are accomplished.

For the washing and purification only filtered and treated water can be used, and many factories have trouble in obtaining or keeping the water up to standard.

Drying the Cellulose Nitrate

The drying of the cellulose nitrate can be done by the following methods: 1. By pressing. 2. By pressing and heating. 3. By centrifuging with alcohol. 4. By alcohol displacement. 5. By alcohol and pressure.

Drying by Pressing.—The pulped cellulose nitrate after whizzing is first pressed in slabs 20 x 20 in. and of average thickness of ¾ in., between heavy cotton sheets in which the slabs are wrapped. The special hydraulic press used develops a pressure of 3,000 to 3,500 lb. per sq.in., and when enough slabs are made they are piled and placed in another hydraulic press working with the same pressure. When most of the water is thus extracted, the pressure is cut off and the wet wrappers are replaced by dry ones and the slabs again submitted to pressure; after repeated pressing, generally twelve to fifteen times, the cellulose nitrate is considered dry—that is, it has a water content varying from 1 to 1½ per cent. This method, in which only the cotton wrappers are dried by heat, is used mostly in Europe, where labor is cheaper.

Drying by Pressing and Heating.—In this process the wet cellulose nitrate is first mixed with camphor and generally run through a rotary cutter to obtain a perfect mixture, and slabs are made as previously explained. The slabs are pressed so as to reduce their water content, then are taken out of the wrappers and transported to drying rooms, where the temperature is continuously kept at 37 deg. C. by means of hot air circulation. From 18 to 24 hours is required to dry the cellulose nitrate. This method, employed here and abroad, gives a finished product with a variable moisture content, is wasteful of camphor, and tends to develop acidity due to the prolonged heating.

Drying by Centrifuging With Alcohol. — This process of drying, mostly used in Europe, requires the use of a special centrifuge in which the basket has two perforated walls leaving an annular space in which the pulped cellulose nitrate is packed. The machine can be made to run at low or high speed and the alcohol is admitted by a perforated pipe placed in the center

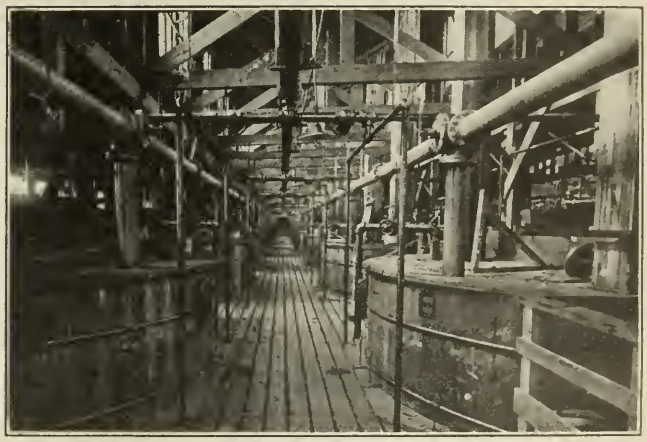


FIG. 5. POACHERS FOR CELLULOSE NITRATE FROM LINTERS

and held in place by the cover of the centrifuge, which can be made air tight. After the moist pulped cellulose nitrate has been packed in the basket and the cover put in place, the high speed is shifted on so as to remove most of the water; this done, the machine is made to run at the low speed, and a known quantity of weak alcohol from a preceding operation is sent through the feed pipe; this alcohol displaces the water. This partial drying is followed by the use of 90 per cent denatured alcohol, which completes the drying process. Finally the high speed is put on so as to reduce the alcohol content of the cellulose nitrate as much as possible. The total operation takes about 1 hour, including the filling and the emptying of the machine, or a daily production of about 2,000 lb. of cellulose nitrate with an alcohol content of about 35 per cent. The alcohol required to obtain thorough drying is around 3 lb. per pound of cellulose nitrate.

Drying by Alcohol Displacement.—In this method of drying the moist pulped cellulose nitrate is placed in cylindrical tanks having conical bottoms, supporting

a perforated plate. The tanks, generally six in number, are placed in a circle, in the center of which is the centrifuge. A tank containing 90 per cent denatured alcohol is placed overhead and other tanks situated on a floor below collect the diluted alcohols which are forced on the cellulose nitrate by compressed air. This process works as follows: The cylindrical tanks are filled with the wet cellulose nitrate and in the first 90 per cent denatured alcohol is admitted. When the cellulose nitrate is completely covered with alcohol, the valve situated at the bottom of the tank is opened and the alcohol drained and collected and sent to the second tank. The first tank is then filled again with strong alcohol, and the alcohol drained from the second tank is sent to the third tank, from which it is sent to the tank containing the weak alcohol to be distilled. The alcohol collected from the second run in tank 2 is then sent to tank 3 and strong alcohol sent to tank 1. At this stage we have the first tank containing strong alcohol and cellulose nitrate free from water. The second tank contains medium strength alcohol and needs one more treatment with strong alcohol. The third tank contains only weak alcohol and will require two more treatments with medium and 90 per cent alcohol to be dried. As soon as the cellulose nitrate is dried—that is, after three treatments—it is dumped into the centrifuge so as to remove as much as possible of the alcohol. This method, in which loss of alcohol by evaporation is to be expected, requires about 2 lb. of 90 per cent alcohol to 1 lb. of pyro.

Drying by Alcohol and Pressing.—This is the dehydration process used by smokeless powder manufacturers. The wet cellulose nitrate is placed in a specially constructed hydraulic press having two pistons moving in opposite directions, the bottom one supporting a heavy perforated plate. The pistons fit exactly the cylinder of the press and a pipe placed at the top of the cylinder brings the alcohol. The bottom of the cylinder is first closed with the bottom ram and the wet pulped cellulose nitrate is placed in the cylinder and covered with a bronze plate. By means of the top piston a pressure of 3,000 lb. per sq.in. is exerted on the cellulose nitrate, forcing the water to run out through the bottom perforated plate. The top piston is then raised and denatured alcohol at 90 per cent is admitted on the top of the cellulose nitrate and sent through the cake under a pressure of 250 lb., which is then followed by a pressure of 3,000 lb. so as to expel most of the alcohol from the cellulose nitrate. The alcohol content of the dehydrated cellulose nitrate varies from 25 to 28 per cent, the strength varying from 87 to 89 per cent. The quantity of alcohol necessary for the dehydration varies from ¾ to 1 lb. per pound of cellulose nitrate treated. The diluted alcohol is collected in tanks and submitted to distillation. About 1 per cent of the cellulose nitrate is dissolved in the alcohol during the dehydration, but the loss consists chiefly of lower cellulose nitrates, the removal of which gives a cellulose nitrate of better stability.

When the cellulose nitrate is dried, it is ready to be mixed with camphor and alcohol and transformed in pyroxylin plastics.

For the illustrations accompanying this article, the author is indebted to the Charleston Industrial Corporation and the Downington Manufacturing Co.

A subsequent paper will deal with the manufacture of pyroxylin plastics.

Annual Report, Bureau of Mines

A brief summary of some of the investigations conducted by the Bureau of Mines during 1921 is given in the following paragraphs, which are based upon the annual report of the director.

An investigation of losses of crude oil through evaporation in storage and in transportation, conducted during the year by the bureau, disclosed losses of startling magnitude. It was found that in the few days in which crude oil is stored on the lease before being taken by the pipeline, the aggregate loss per year from evaporation amounts to about 122,000,000 gal. of gasoline in the mid-continent field alone. This has a value, at 22c. per gal., of $26,840,000, and represents about 3 per cent of the total gasoline produced in the United States from all fields and all sources. A large percentage of this loss could be prevented by the use of efficient equipment.

The bureau has pointed out the considerable losses which have resulted from the failure of many refineries to recover gasoline from uncondensed still vapors. The significance of this investigation is shown by the fact that one refinery in the mid-continent field is now recovering from still vapors approximately 400 bbl. of gasoline daily which before the installation of this equipment was either lost or burned as fuel under the boilers and stills. The value of fractionating towers at petroleum refineries, by means of which some companies have increased the yield of gasoline from crude oil by as much as 5 per cent, or 16⅔ per cent of the total gasoline yield, has been demonstrated. A special process, devised at the San Francisco station of the bureau, for cracking heavy oils and tars promises the recovery of large yields of gasoline and other lighter products, hitherto regarded as unrecoverable.

Production of Helium

The experimental helium plant at Petrolia, Tex., conducted under the authority of the Army and Navy Helium Board, was in operation during the year at various times, and helium was produced for short periods. A study of the practicability of storing this rare and non-flammable gas in mine workings was made at the bureau's experimental coal mine at Bruceton, Pa. At the cryogenic laboratory in Washington, D. C., liquid air in quantity is now being produced. The primary object of this laboratory is to investigate gases and liquids at low temperatures, with special reference to the separation of helium from natural gas.

Molybdenum and Zinc

The bureau investigated the properties and possibilities of molybdenum, of which the United States possesses the largest known deposits.

The cost of production of zinc, with the standard retort process, is now so high that it endangers the position of zinc as a cheap metal. Plans have been formulated for an investigation of proposed methods for the electrothermic metallurgy of zinc, with a view to increasing the recovery of metal and lowering production costs.

Methods for preparing caustic magnesia were investigated which determined that high-grade magnesia can be made from some varieties of magnesite hitherto believed to be unsuitable for this purpose. The bureau investigated dolomite as a substitute for the more costly magnesite in preparing refractories, and demonstrated that there can be obtained from Ohio dolomite a product superior in magnesia content to Canadian magnesite.

Deoxidation and Desulphurization in the Heroult Furnace

Three Methods of Working Up a Heat of Steel Are Described in Detail—Composition and Characteristics of Slags Are Noted, and the Opinion Is Expressed That Good Steel From Poor Scrap Is Merely a Question of Knowledge and Skill

By F. T. SISCO
Metallurgist

FOUR characteristics and advantages of electric steel are, in the order of their importance from the standpoint of an electric steel salesman:

(1) It is made to close chemical specifications.

(2) Free from excessive segregation.

(3) Free from more than traces of sulphur and phosphorus.

(4) A thoroughly sound and deoxidized product may be made.

Furnace practice as developed in the past few years has made the first advantage a certainty. Practically all electric steel is now being made in any desired analysis and to any tolerance in the specifications. The second item—freedom from excessive segregation—is a matter of mold design, use of proper sink-heads, correct pouring temperature and sufficient cropping. This question will not be discussed here.

By most manufacturers the third characteristic is met to a surprising degree, much of the electric steel now being turned out containing less than 0.02 per cent of both these elements. In fact, it is altogether probable that too much attention is being paid to the reduction of the phosphorus and sulphur, particularly the latter, sacrificing complete deoxidation and thorough soundness.

After close observation of Heroult furnace practice in four plants and covering a period of 8 years, the author has concluded that much is yet to be desired as far as quality in electric steel is concerned. Electric steel from the Heroult furnace may and does surpass the best basic open-hearth and even the best acid open-hearth steel in quality, but with few exceptions is still decidedly inferior to crucible steel. This inferiority is partly caused by insufficient knowledge of the proper conditions for deoxidizing the metal, and partly to the wrong assumption on the part of the electric furnace melter that the function of his final slag is primarily to desulphurize. As a result, he makes his slag with that in mind, removes all of the sulphur possible and depends upon ferromanganese, ferrosilicon and occasionally aluminum, added in the last 15 or 20 minutes, to accomplish his deoxidation. This dependence upon a ferro-alloy to deoxidize a bath of molten electric steel is putting the process in a class where it approaches open-hearth practice and is bound to produce a product that in some cases is little better than good open-hearth steel.

The great advantage of the electric furnace is the flexibility and accuracy of control of the heat, permitting any slag or an oxidizing, a reducing or even a neutral atmosphere. Not to take advantage of the reducing conditions possible to form a slag so reducing in character that deoxidation will be nearly complete without the aid of a ferro-alloy is to neglect one of the most salient features of the electric furnace.

The superiority of crucible steel is due to the perfect deoxidizing conditions obtained by melting muck bar or any first-class scrap in an atmosphere entirely free from oxygen, the melted charge being permitted to lie quietly until solid and gaseous inclusions present in the base used have time to rise to the top. This cleaning action is aided to a slight extent by the presence of one or more ferro-alloys melted with the scrap, which have in themselves a strong affinity for oxygen. To make a product equal to crucible steel, the electric furnace must duplicate these melting conditions as nearly as possible. Not only that, but the electric furnace, to be a commercial success, must produce a product equal to crucible steel from a cheaper base.

The metal ready for the deoxidizing slag (or white slag as it is commonly called), whether melted under oxidizing conditions in the electric furnace itself, as is the case with units of 8 tons or less, or delivered molten from an open hearth, as in the larger furnaces, is generally low in carbon, almost free from silicon, phosphorus and manganese and nearly saturated with both oxides and gases. It is the function of the white slag to aid in the complete removal of these oxides and gases, whether present in large or small amounts. Incidentally the slag also removes the sulphur more or less completely.

The amount of oxides and gases present in the molten bath depends wholly upon the melting practice; three general classes are: (1) Melting without oxidation. (2) Melting with partial oxidation. (3) Melting with complete oxidation.

Melting Without Oxidation.—This practice is confined almost wholly to melting for high-grade tool steels and ball-bearing steels where the base material is very pure. For making high-grade carbon tool steels a base of muck bar and washed metal is melted down either alone or combined with a varying amount of rolling mill crop ends in which the sulphur and phosphorus are both under 0.02 per cent. In charging the raw material, a small amount of limestone is placed on the bottom of the furnace and building the white slag commences as soon as there is a pool of molten metal around the electrodes. With this practice oxidation may be almost wholly prevented, the only function of the white slag being to aid in the removal of such oxides as are present in the raw material charged. This practice results in a steel which may easily be made the equal of the best carbon tool steel made by the crucible process and is duplicated on alloy steels by using a charge made up wholly of butts, crop ends and discards from their own mills. Needless to say, this practice produces the best electric steel, but is not able to compete in price with steel made from a cheap scrap or molten open-hearth metal.

The important feature of melting under a white slag is the use of a charge that is within the specified

TABLE I. MELTING WITH PARTIAL OXIDATION

Furnace No. A. Heat No. 1687

	C	Si	S	P	Mn	Cr
Analysis Desired	1.00/1.15	0.15/0.25	0.02	0.02	0.25/0.45	1.35/1.65

Time		Lb.	Metal Tests						Slag Tests									
			C	Si	S	P	Mn	Cr	SiO_2	FeO	Al_2O_3	MnO	CaO	MgO	CaS	CaC_2	Cr_2O_3	P
2:05 p.m.	Previous heat tapped																	
2:20 p.m.	Began charging, limestone	750																
	Scrap, chromium butts	6,530	1.05	0.20	0.020	0.020	0.35	1.45										
	Mixed bearing scrap	2,610	1.00	0.20	0.030	0.025	0.35	1.10										
	Mixed low-phos. scrap	5,960	0.40	....	0.040	0.040												
					About													
2:55 p.m.	All scrap charged	15,100	0.80	0.15	0.030	0.030	0.35	0.75										
3:00 p.m.	Power on														S			P_2O_5
5:40 p.m.	Melted, fluorspar added	35	0.62	0.03	0.026	0.013	0.25	0.42	9.37	9.25	2.78	2.76	51.15	12.47	.026		9.32	0.63
5:55 p.m.	Oxidizing slag off																	
6:00 p.m.	White slag added, lime	650																
	Coke	200																
	Spar	150													CaS			P
6:25 p.m.	Slag partly white		0.65	0.036	0.025	0.014	0.25	0.43	8.73	3.42	2.97	0.25	63.87	11.17	1.62		0.63	0.026
6:35 p.m.	Slag all white, partly carbide		0.67	0.031	0.017	0.014	0.26	0.44	10.27	1.38	2.55	0.13	64.27	10.26	1.98	1.70	0.25	0.008
6:40 p.m.	Ferromanganese, 80 per cent, added	23																
6:45 p.m.	Slag strongly carbide		0.68	0.031	0.015	0.014	0.37	0.44	9.26	0.97	3.24	0.19	65.87	10.47	2.13	2.87	0.06	0.004
6:50 p.m.	Ferrochromium, 64 per cent Cr. 6 per cent C	260																
7:00 p.m.	4 Shovelsful mixed slag added																	
7:15 p.m.	Bath stirred, slag strongly carbide		0.78	0.057	0.014	0.015	0.38	1.49	13.42	0.87	2.65	0.17	63.06	9.65	2.07	2.65	0.37	0.006
7:20 p.m.	7 Shovelsful mixed slag added																	
	Washed metal added	850																
7:35 p.m.	Added ferrosilicon, 50 per cent	65																
7:45 p.m.	Heat test quiet, slag carbide		1.02	0.210	0.013	0.016	0.37	1.47	9.73	0.65	2.28	0.09	66.45	10.28	2.23	3.67	0.04	None
7:50 p.m.	Heat tapped																	
	Ladle		1.04	0.206	0.012	0.017	0.36	1.48	10.03	0.72	2.78	0.11	65.63	10.03	2.11	3.43	0.05	Trace

Note: Furnace doors open more than in regular practice due to taking extra slag and metal tests.

limits in phosphorus, as none is removed in melting, and of material as free as possible from rust and scale.

Melting With Partial Oxidation.—This method is undoubtedly the best where a cheaper base is used and where fairly high-carbon steel is made. The practice consists essentially of charging limestone on the bottom of the furnace and then loading in the scrap. This consists of ordinary low-phosphorus material (0.04 per cent) such as crop ends, boiler plate and (if alloy steel is to be made) nickel or chromium-nickel scrap from automobile plants or rolling mills, or forging billet and bar crops. A clean scrap free from rust and scale is used and the charge regulated as much as possible so the carbon when melted will be 0.10 to 0.30 per cent below the requirement. The charge is melted cold and the slag which has formed is removed as soon as the charge is all melted. The resulting bath contains most of the oxidizable elements except silicon and phosphorus, which latter has been reduced by the very basic slag from about 0.04 per cent to below 0.02 per cent. Since the molten charge contains most of the carbon and manganese, the absence of more than small amounts of oxides is assured. The remainder is then eliminated by aid of the white slag which is immediately built up as soon as the first slag is removed. Table I gives a furnace log of a heat melted in this manner.

Melting With Complete Oxidation

This practice, the most common, has the advantage that the scrap is freed except for traces of all oxidizable elements—carbon, silicon, phosphorus and manganese. A portion of the sulphur is likewise eliminated down to the point shown in Table II. Complete oxidation is necessary when a low-carbon product is desired, and this process permits of the use of a very cheap grade of scrap, phosphorus as high as 0.08 to 0.10 per cent being reduced with ease to below 0.02 per cent. To facilitate the active oxidation which takes place, limestone is charged on the bottom of the furnace. Iron ore or roll scale, to furnish the oxygen, follows. If much fine scrap

TABLE II. MELTING FOR COMPLETE OXIDATION

Furnace No. B. Heat No. 1276.

	C	Si	S	P	Mn
Analysis Desired	0.60/0.70	0.15/0.25	0.02	0.02	0.25/0.45

Time		Lb.	Metal Tests					Slag Tests								
			C	Si	S	P	Mn	SiO_2	FeO	Al_2O_3	MnO	CaO	MgO	CaS	CaC_2	P
7:35 a.m.	Previous heat tapped															
7:55 a.m.	Began charging { Limestone	600														
	Roll scale	50														
	Scrap, country mixed	7,550			0.06±	0.10±										
	Shell scrap, (1 lb.)	3,070			0.045	0.035										
	Crop ends, carbon	2,530	1.00	0.25	0.020	0.020	0.25									
	Hay	1,720			high	high										
					About											
8:35 a.m.	All scrap charged	14,870	0.60	0.08	0.055	0.070	0.35									
8:40 a.m.	Power on													S		P_2O_5
11:05 a.m.	All melted, roll scale added	50	0.08	0.01	0.046	0.013	Trace	20.37	17.78	3.25	7.68	41.45	7.13	0.037	....	2.37
11:25 a.m.	Oxidizing slag off { Recarburized	80														
	Electrodes															
11:30 a.m.	Bath wild, added crushed ferrosilicon	13														
11:45 a.m.	White slag on, lime	600														
	Coke	175														
	Spar	150												CaS		P
12:15 p.m.	Slag partly white		0.52	0.024	0.037	0.014	Trace	8.75	4.78	2.26	Trace	66.27	10.42	1.93	0.48	0.013
12:30 p.m.	Slag all white		0.53	0.025	0.028	0.014	Trace	10.32	1.87	1.89	Trace	65.43	9.37	2.18	1.51	0.006
12:35 p.m.	Added ferromanganese, 70 per cent	70														
1:00 p.m.	Slag strongly carbide		0.57	0.032	0.019	0.014	0.36	10.87	1.02	2.07	0.37	67.38	7.46	2.59	2.78	Trace
1:05 p.m.	Added 5 shovelful mixed slag															
1:30 p.m.	Slag strongly carbide		0.58	0.030	0.018	0.015	0.36	12.65	0.96	3.25	0.27	65.82	8.17	2.67	2.45	None
1:45 p.m.	Added ferromanganese, 70 per cent	5														
1:50 p.m.	Added ferrosilicon, 50 per cent	70														
2:00 p.m.	Heat test quiet, slag carbide		0.60	0.186	0.016	0.015	0.38	14.03	0.90	2.96	0.17	63.71	9.65	2.85	2.86	None
2:05 p.m.	Heat tapped															
	Ladle		0.64	0.197	0.014	0.016	0.38	14.27	0.84	2.73	0.13	64.87	10.29	2.79	2.16	Trace

Note: Furnace doors open more than in regular practice due to taking extra slag and metal tests.

uch as clippings or punchings are used, or if the scrap s rusted, the amount of ore or scale may be reduced. n the case of very rusty scrap, no ore is necessary. The charge is melted at a high temperature, oxidation being nearly always complete by the time the metal is melted. When very high-phosphorus scrap is used, more ore is often added as soon as the bath is nearly melted. This oxidizing slag, corresponding in analysis to the first slag in Table II, is removed entirely. If medium- or high-carbon steel is to be made, carbon in the form of crushed coke or electrodes is added to the bare metal to bring the carbon up to within 0.10 to 0.20 per cent of the required analysis. If the bath should then boil violently, a few shovelsful of crushed ferrosilicon would be added to kill the wild metal. White slag is now added in order to deoxidize and produce a sound steel. A deoxidizing slag must do the greatest amount of work in this melting practice, since oxidation is carried to a maximum. Great skill is required in this deoxidizing practice to produce a sound steel.

This class of practice includes duplexing. Metal as received by the electric furnace from the open hearth is in a very similar condition as to chemical analysis and amount of oxides present as ordinary scrap melted in the electric furnace with complete oxidation. In duplexing open-hearth metal for the production of high-grade ordnance and armor plate, the present practice is to deoxidize partly by adding 12 per cent ferrosilicon to the open-hearth metal just before tapping. This is good practice and decreases the amount of work thrown upon the electric furnace.

In every case, whether the melted steel is not oxidized at all, partly oxidized, or wholly oxidized, the function of the deoxidizing or white slag remains the same—to aid in removing oxides and gases, to reduce those oxides which rise to the surface of the bath and to eliminate sulphur.

White Lime Slags

There are two methods of building white slags. The first makes a white lime slag, pure white in color, which disintegrates rapidly in air to a fine white powder. It contains lime, coke and spar in the ratio of about 10 to 1 to 1 and contains about 70 to 75 per cent bases and 15 to 25 per cent acids (see Table III). As a slag it is not strongly reducing, but serves more as a covering for the metal while the bath slowly frees itself from its occluded oxides and gases. In building this slag lime is thrown onto the bare metal until it is covered. On top of this blanket of lime is scattered powdered coke. It is certain that some calcium carbide forms around the arc, which is immediately broken up by the atmospheric oxygen in the furnace as it spreads out from the electrodes, the carbon burning to carbon monoxide, CO. Fluorspar is added until the slag has the proper consistency. Some melters use silica sand and even powdered glass instead of fluorspar. Fluorspar, however, is a much better thinning agent than silica sand and has the advantage that it is a more active desulphurizer. In addition, it is undesirable to reduce the proportion of bases any more than is necessary to secure fluidity.

Deoxidation with this white lime slag is primarily a mechanical process, the small amounts of oxides and silicates in the bath slowly rising until seized by the slag and held partly in chemical combination and partly in suspension. Deoxidation, too, is never very complete with this slag. Even after the bath has been under the slag for 3 or 4 hours, metal tests show considerable wildness. When the heat is ready to tap, deoxidation is accomplished by adding ferrosilicon with a thorough rabbling as soon as the alloy is melted. When silicon specifications are low, it is almost always necessary to rabble in aluminum to put the bath in such condition that the metal will lie quietly in the molds after pouring.

There is only one advantage in using this slag: There is no appreciable carbon absorbed from the slag. The only possible justification for the use of a white lime slag is when very low-carbon steel is desired; even then the practice should be modified somewhat by having some carbide present. The disadvantages are many:

Deoxidation is too slow and too uncertain, making it necessary to add ferrosilicon or aluminum or both. While ferrosilicon or aluminum is very efficient and deoxidizes a bath completely in a few minutes, it is practically impossible for the heat to free itself from the non-metallic reaction products formed by the reaction between entrapped oxides and gases and the ferrosilicon or aluminum in the short time between the addition and tapping, causing "slag spots," which, even though they may be microscopic in size, are nevertheless sources of weakness. There is also no certainty that harmful oxides will be rendered harmless by silicon. Too often, in practice, a final heat test lies quietly, while the ingots poured are so "blowy" that they have to be scrapped. White lime slag and the more common white slag containing very small amounts of calcium carbide have no redeeming features with the exception of the fact that no carbon is picked up by the metal. The practice of using these slags in conjunction with subsequent additions of deoxidizers in the form of ferroalloys cannot be too strongly condemned; a steel is produced which may be passable in some instances, but usually it will not be of a grade that brings repeat orders from the buyer.

TABLE III. TYPES OF ELECTRICAL FURNACE SLAGS

	White Lime Slag—Not Reducing	White Carbide Slag—Very Reducing
SiO_2	17.57	7.48
FeO	1.33	0.35
Al_2O_3	3.12	2.17
MnO	0.36	0.05
CaO	62.45	65.82
MgO	11.65	13.78
CaS	0.87	2.26
CaC_2	None	4.54

Desulphurization with a white lime slag proceeds according to the reaction

$$CaO + \left\{\begin{matrix}MnS\\FeS\end{matrix}\right\} + C = CaS + CO + \left\{\begin{matrix}Mn\\Fe\end{matrix}\right\} \quad (1)$$

the carbon being present in small amounts from coke added to the slag and from the electrodes. It is probable that reaction (1) is aided by reaction (2) when calcium carbide is not present in considerable amounts:

$$2CaO + 2\left\{\begin{matrix}MnS\\FeS\end{matrix}\right\} + Si = 2CaS + SiO_2 + 2\left\{\begin{matrix}Mn\\Fe\end{matrix}\right\} \quad (2)$$

through small amounts of metallic silicon either added intentionally or reduced from silica (SiO_2) by the arc. It is also aided by reaction (3):

$$2CaF_2 + 2\left\{\begin{matrix}MnS\\FeS\end{matrix}\right\} + Si = 2CaS + SiF_4 + 2\left\{\begin{matrix}Mn\\Fe\end{matrix}\right\} \quad (3)$$

through the combined effect of small amounts of silicon and fluorspar.

In any case, when a white lime slag is used desul-

phurization depends on basicity, temperature and the saturation point of that particular slag for calcium sulphide. It is doubtful whether high sulphur (0.06 to 0.08 per cent) could be removed without the presence of considerable amounts of calcium carbide, but a sulphur content of 0.03 or 0.04 per cent can easily be reduced to 0.02 per cent or below with the white lime slag.

White Carbide Slags

The carbide slag, the most common of electric furnace finishing slags, is preferably composed of lime, coke and fluorspar in the ratio of 6 to 2 to 1, varying slightly with furnace conditions and with the steel made. The slag ingredients are mixed thoroughly on the floor before being charged. Approximately 1 lb. of slag mixture is used for 15 lb. of metal, the larger hot-metal furnaces taking less slag in proportion than the smaller furnaces working on cold scrap. Immediately after removing the oxidizing slag and any necessary recarburization the well mixed slag material is thrown on the bath. In 20 to 30 minutes, with a high temperature, a slight frothing begins around the electrodes and gradually extends to the banks. The slag is in good condition 30 to 40 minutes after being added. It is now only necessary to add lime, coke or spar in small amounts to maintain proper slag conditions until the heat is ready to tap. The gentle boiling or frothing of the bath slowly dies down; about an hour after the slag is in condition it is perfectly quiet. A metal test will show very slight bulging and practically no sparking when deoxidation is complete. Ferrosilicon is now added to give the required analysis and the heat is tapped. With a proper carbide slag, less than 10 per cent of the ferrosilicon is lost, 90 per cent or more alloying with the metal.

The slag when spread on a plate disintegrates slowly in the air to a grayish powder and when moistened with water smells very strongly of acetylene. As shown in Table III, it will contain from 0.5 to 2 per cent carbon, equivalent to 1.40 to 5.6 per cent calcium carbide.

A Disadvantage of the Carbide Slag

The one disadvantage of the carbide slag is the large absorption of carbon by the bath. An extreme case of this absorption was shown by an order of low-silicon steel made at an Eastern plant. Carbon was specified 0.65 or 0.75 per cent and silicon 0.08 per cent or under. In an effort to insure complete deoxidation without the aid of silicon an extra heavy carbide slag was used. Forty-five minutes before tap the bath contained 0.58 per cent carbon. No carbon was added in any form except in the slag-making materials, yet the ladle test showed 0.71 per cent carbon, 0.13 per cent being picked up from the slag in 45 minutes. The steel as poured held 0.027 per cent Si, none being added to the heat, and a thorough inspection of the rolled bars showed the steel to be remarkably free from surface seams and cracks. The slag immediately before tap contained 5.78 per cent calcium carbide.

In average practice, using fair scrap and melting down to retain carbon and manganese, the average absorption of carbon by the metal from the slag is 0.03 to 0.05 per cent. This absorption is nearly constant and is allowed for, as shown in Tables I and II.

The principal advantage of the carbide slag is its intense reducing power, shown by the reactions

$$CaC_2 + 2FeO = CaO + 2CO + 2Fe \quad (4)$$

$$CaC_2 + 2MnO = CaO + 2CO + 2Mn \quad (5)$$

These equations show the end results of some very complicated reactions. By the aid of the calcium carbide the greatest part of the deoxidation takes place during the deoxidizing period exactly when it should and not in the final 15 minutes, aided by a ferro-alloy.

By careless furnace practice the carbide slag may easily become as inefficient as the white lime slag—in fact it may easily turn into a white lime slag through neglect. Atmospheric oxygen coming into the furnace through frequent opening of furnace doors reduces the efficiency and deoxidation power of the slag to a point where it is very little if any better than the white lime slag.

A visual examination of a carbide slag will show the effect of an oxidizing atmosphere. A spoonful of slag is removed from a point midway between the electrodes and the bank, permitted to solidify in the spoon, and then knocked out and examined. On the surface exposed to the air the slag will have the pure white color of lime, while next to the metal of the spoon the dark gray of the carbide will be plainly noticeable.

Deoxidizing With Air-Tight Furnace

An extensive investigation of the plan of deoxidizing with a practically air-tight furnace was undertaken a few years ago in connection with a contract for 600 tons of ingots for 12-in. armor-piercing shells. A 6-ton Heroult furnace was used and the scrap was a mixture of nickel-steel crop ends, chromium-nickel gears and flashings, boiler plate and punchings. Oxidation was carried to completion, the oxidizing slag being removed by hand rabbling. A well-mixed carbide slag was then shoveled into the furnace, and the doors were closed and sealed with fireclay. After 30 minutes one door was opened sufficiently for additions of alloys and further slag material, and then sealed again. This practice was followed for about 100 heats. Steel was poured into regulation shell molds without sinkheads. On stripping, the surface of the ingots was in every case found to be free from pits, and the top surface showed complete absence of oxidation bubbles. A report from the forger stated that every heat forged perfectly, all shells passing inspection easily. Physical tests were in every case satisfactory and usually superior to requirements.

Every heat tapped had a slag that was intensely reducing. Although slag analyses were not made, each ladle slag after dumping into the pit and cooling with water gave an odor of acetylene that could be detected within a radius of 50 ft.

Carbon absorption was calculated at 0.06 per cent, each heat being tapped on 0.46 to 0.48 per cent to meet a specification of 0.50 to 0.60 per cent.

It is unquestionable that the exclusion of atmospheric oxygen from the furnace produces a more completely deoxidized metal and leads to better slag conditions. It is also beyond possibility of doubt that deoxidation in the furnace by aid of a slag high in calcium carbide produces a better steel more consistently than a simple treatment with a highly basic lime slag and subsequent deoxidation by a ferro-alloy before tapping.

The amount of oxides in the metal determines the amount of calcium carbide that must be maintained in the slag. By carrying a simple lime slag, a charge of muck bar and washed metal and rolling mill crop ends may be deoxidized to make a thoroughly sound steel. By having 1.0 to 2.0 per cent calcium carbide, a steel melted with partial oxidation, the carbon and manganese

remaining to a large extent in the metal, will be deoxidized satisfactorily. But a steel containing a large amount of oxides, when melted low in carbon by the use of ore or on a metal duplexed from an open-hearth furnace and not partly deoxidized in that furnace, requires a very heavy carbide slag, preferably one containing 2 to 5 per cent calcium carbide.

For general purposes when making miscellaneous alloy and tool steels from ordinary scrap, the best furnace practice for a consistently satisfactory product, is:

(1) Melt to retain part of the carbon and manganese; remove phosphorus by means of a very basic slag, omitting ore or other oxide and using clean scrap.

(2) Unless absolutely necessary do not recarburize on the bare metal after the first slag has been removed. If a small amount of carburization is necessary after all alloy additions, use clean pig iron or washed metal. In an emergency, run the electrodes down into the bath.

(3) Mix the deoxidizing slag materials thoroughly, using 5 or 6 parts of burnt lime, 2 parts of powdered coke and about 1 part of clean gravel fluorspar, and add 1 lb. of this mixture for 15 to 18 lb. of metal immediately after the complete removal of the first slag. When melting clean scrap the amount may be reduced to 1 lb. of slag for each 25 lb. of metal.

(4) Use high power for at least 30 minutes, until frothing of the slag is gentle and uniform over the whole bath.

(5) Exclude atmospheric oxygen as much as possible during the deoxidizing period.

(6) With these conditions present and using a scrap not exceeding 0.04 or 0.05 per cent sulphur, desulphurization will proceed automatically to a residual of 0.015 per cent or lower.

Desulphurization with a strong carbide slag proceeds according to the reaction

$$2CaO + CaC_2 + 3\left\{\begin{matrix}MnS\\FeS\end{matrix}\right\} = 3CaS + 2CO + 3\left\{\begin{matrix}Mn\\Fe\end{matrix}\right\} \quad (6)$$

This reaction, too, is the result of more complicated reactions and is generally in conjunction with reaction (1). Reactions (2) and (3) likewise occur when carbide is present, but are secondary in importance to reaction (6).

Many variables influence the desulphurizing power of the carbide slag, although this slag is much more sure in its action than the white lime slag. In order to have much carbide in the slag, the temperature must be high; therefore desulphurization proceeds rapidly. Likewise the carbide slag is always extremely basic. As before stated, it has been proved by countless trials that fluorspar is a distinct aid in desulphurization and in this respect is much superior to silica sand for slag making. Carbide slag saturated with calcium sulphide runs slightly higher in S as the temperature, basicity and amount of calcium carbide increase. It has been possible at times when working with slags very high in carbide to have these hold as much as 4.50 per cent calcium sulphide; this, however, is exceptional, 3.5 per cent saturating the average slag.

A peculiarity of carbide slags that has been largely overlooked by metallurgists, is that the efficiency of the slag as a *deoxidizing* agent decreases rapidly as the saturation point of the slag for calcium sulphide is approached, and this point is easily approached when the lime and coke used both contain up to 1 per cent sulphur. For this reason low-sulphur lime and coke should be used for the slag and a scrap base containing more than 0.05 per cent sulphur should be avoided, if the steel is to be sound, both completely deoxidized and desulphurized.

As one-tenth of the sulphur, sometimes even more, is removed in melting and oxidizing (see Table II), the deoxidizing slag must remove about 0.03 per cent—more than half the original sulphur. This can be done easily with a fairly pure slag, without impairing its efficiency as a deoxidizer.

A peculiar feature, at present not well understood, is the decreased power of a strong carbide slag for removing sulphur when the furnace is kept nearly air tight. In the 600-ton order above mentioned, in which a thoroughly sound and nearly perfectly deoxidized product was attained, in every case without exception the carbide slag removed less than one-third the sulphur, whereas in average practice with no precautions to exclude atmospheric oxygen from the furnace (Table II) sulphur losses amount to 70 per cent and often reach 80 per cent. The scrap charged for the shell steel contained an average of 0.03 to 0.04 per cent sulphur; allowing 10 per cent of this to be removed in the oxidizing period, it is readily seen that the carbide slag absorbed very little, since the analysis of the 100 heats showed sulphur contents of 0.023 to 0.031 per cent.

It may be conceded that steel containing 0.03 per cent sulphur is exactly as good as if the sulphur content were 0.015 per cent. The amount of manganese sulphide present with the higher sulphur is so small and in good steel is so well distributed that possibility of harm from this source is nil. Far more harm and injury may be done by attempting to reduce the sulphur to 0.015 per cent at a sacrifice of complete deoxidation.

Desulphurization vs. Deoxidation

Three things are possible in the deoxidizing period in the Heroult furnace: (1) Desulphurization without thorough deoxidation. (2) Thorough deoxidation with little desulphurization. (3) Thorough deoxidation with complete desulphurization.

The first condition exists when a very basic lime slag containing no calcium carbide is used; the resulting steel is not good, even if the sulphur is reduced to a trace. Practically all of the deoxidation must be carried out by means of ferro-alloys added at the end of the heat.

The second condition prevails when a very basic slag containing considerable calcium carbide is used in an air-tight furnace; an exceptionally sound steel is regularly and consistently obtained, a steel free from blowholes and slag inclusions but only a small percentage of the sulphur has been removed. This practice is to be recommended, however, in preference to the first.

The third condition is difficult to realize in practice; yes, doubly difficult, since the average melter has been educated to believe that deoxidation is secondary in importance to desulphurization, the very opposite to the truth. This third condition is met partly by a strongly reducing carbide slag and by keeping the slag strongly reducing by further additions of lime and coke from time to time. While the doors are not sealed tight, they are kept closed as much as possible so that the carbide present will not be oxidized much by the air. Table II gives the complete history of a heat of carbon

chisel steel made from a poor grade of scrap and oxidized completely, the bath recarburized and deoxidized by means of an average carbide slag. The heat represents ordinary practice and is neither very good nor very bad. The heat was poured into 9 x 9-in. ingots, the ingots were chipped, reheated and roughed to 2½-in. square billets. The billets were chipped but not pickled. Finished rolling was into mill length ¾, ⅞ and 1 in. octagon. Approximately 15 per cent of the finished bars were scrapped on account of seams.

In contrast to this, Table I shows the history of a heat of first-class ball steel. This heat was also poured into 9 x 9-in. ingots. The ingots were chipped, reheated and roughed to 4½-in. gothics. The top and bottom discard was nicked by the hot saw and fractured. The gothic billets were pickled and chipped, very little chipping being necessary, and were finished to 2-in. and 2½-in. rounds, mill lengths. Less than 5 per cent of the heat was rejected for surface defects on inspection.

Good Steel Requires Thorough Deoxidation

The author has seen 40-ton heats of chromium-nickel steel for navy guns, after 4 hours' electric refining, that were chemically, physically and microscopically the finest steel possible to make by any process. On the other hand, he has watched a melter throw shot aluminum by the shovelful into the ladle of a 20-ton electric furnace heat to quiet it enough to pour. He has seen 6-ton heats, made from the best-selected open-hearth and electric furnace scrap, that would scarcely stay in the molds and the cross-section of the ingots resembled a piece of Swiss cheese. On the other hand, he has seen 6-ton heats case-hardening gear steel of an analysis 0.08 to 16 per cent carbon, 3.50 per cent nickel and 2.00 per cent chromium, that rolled into a 100 per cent perfect product.

Whether duplex is better than cold-scrap electric steel has been argued pro and con for the past 10 years, the controversy waxing hottest during the war. It may be said once and for all that the quality of electric steel does not depend upon the base used; good scrap, bad scrap, molten open-hearth metal, molten bessemer metal, whether melted in 1-ton or 40-ton lots may all be refined and deoxidized completely and thoroughly with the proper slag made under the proper conditions and handled by men who know how. Naturally, the more nearly the steel is deoxidized before the final electric furnace slag is applied the easier deoxidation will be, but the complete deoxidation in any case is merely a matter of correct slag conditions for the proper time.

Charleston, W. Va.

Italy Considering Limitations on the Exportation of Metals and Waste Metals

The recent decree providing that the customs officials at Italian frontiers and seaports may permit the exportation of lead, copper, manganese and zinc metals, lead residues, ashes of iron pyrites, waste copper, tin, zinc, brass, bronze, aluminum and nickel is not working satisfactorily, reports the special correspondent of Chemical & Metallurgical Engineering. It has led to the exportation of large quantities of these products to Germany, Czechoslovakia, Austria and other countries, to the deprivation of home producers. Accordingly a petition has been presented to the Minister of Industries, setting forth the damage already suffered and likely to be suffered later and asking that the decree be abrogated for the present.

Oil and Coal as Plastic Fuels

A new combination of oil and coal in a plastic fuel which suggests large possibilities was recently described* by Walter E. Trent of Washington, D. C. This was the first public discussion by Mr. Trent of the process on which he has been working for several years and on which the Bureau of Mines has been co-operating for some time past. He described further the commercial possibilities of the process, some features of which were given in Chemical & Metallurgical Engineering of Aug. 3, 1921, p. 182.

That coal, oil and water can be premixed in just the right proportions for water-gas manufacture and can be simultaneously introduced into the generator in intimate contact with one another is one of the most interesting possibilities suggested by Mr. Trent's work. The process is based upon the reaction by the coal and oil which follows mixing oil with a suspension of very finely ground coal in water. The coal is ground wet and to the suspension oil is added equal to about 30 to 40 per cent of the weight of the carbonaceous matter present. The oil and coal agglomerate into a plastic mass which is very easily separated from the water and ash.

Commercial Scale Plant in Operation

Mr. Trent has built a commercial-scale plant at the former yards of the Virginia Shipbuilding Corporation, Alexandria, Va., where the layout contemplates a completed plant to handle 1,000 tons per day of raw coal. At present the first of four units having a daily capacity of about 250 tons is the only one complete. Mr. Trent is operating this plant regularly on a variety of coals, including many experimental tests of 50-ton and larger lots to determine the suitability for use with his process.

A number of experiments have been made on production of city gas from the amalgam both by distilling this in ordinary coal-gas retorts and by treatment of it in water-gas machines. Apparently gas, byproduct and coke yields are very satisfactory even with relatively inferior coals. The results in water-gas equipment have been equally encouraging, Mr. Trent reports. Tests have also been conducted on a limited scale as to the application of the amalgam for manufacture of producer gas. Mr. Trent states that by this means very good yields of a producer gas approximating 400 B.t.u. per cu.ft. will probably be obtainable.

The plastic material can be burned on certain types of stoking and boiler equipment, and further tests along these particular lines are now under way. Considerable use of the material as a domestic fuel is also being practiced locally in Alexandria, but Mr. Trent points out that the fuel, though otherwise very satisfactory, is certainly exceedingly dirty for domestic use and on this score quite objectionable in many circumstances.

Mr. Trent contemplates experimentation on the low-temperature distillation of the amalgam by special methods now under development. By this means he hopes to recover not only the original oils used but also the byproducts from the coal and to make smokeless fuels in the form of almost ashless briquets. This has been done on a small scale, but the large-scale work is not yet under way. The Bureau of Mines has made a study of certain of the fundamentals involved in the distillation of these amalgams.[1]

*Before the Washington Section, A.S.M.E., Nov. 22, 1921.

[1]See Davis, Place and Scott, "Destructive Distillation of Mixtures of Oil and Coal," Chem. & Met. Eng., vol. 25, No. 25, p. 1131, Dec. 21, 1921.

Low-Temperature Carbonization in England

A Survey of British Practice in the Carbonization of Coal at Low Temperatures and a Detailed Description of the Construction and Operation of the Experimental Plant of Low-Temperature Carbonisation, Ltd., at Barugh, Near Barnsley

BY DAVID BROWNLIE
Manager and Director, Brownlie & Green, Ltd.

THE general principles of the process of low-temperature carbonization are already well known and many articles and papers have been published on the subject, both in America and in Europe. The essential facts of the three processes of carbonization as they are carried out in Great Britain are shown in Table I.

It may seem a simple matter to carbonize coal at a lower temperature, but in practice the difficulties are extraordinarily complicated. When coal is heated it softens and swells and the maximum expansion seems to be at about the temperature of 550 deg C. (1,022 deg. F.). The consequence is that in an ordinary retort the residue is wedged tight in the retort as a slightly viscous mass and cannot be withdrawn. In high-temperature carbonization this trouble does not exist, because as the temperature increases the viscous materials are decomposed and the coke contracts again in volume, so that it comes out of the retorts without trouble. When the hot coke is taken out of the coke ovens into the air it gives a short flash of flame and is then quenched with cold water, retaining its shape and texture. If the hot residue from the low-temperature process is handled in this way, it blazes furiously because of the higher percentage of volatile matter (9 to 10 per cent) present, and when quenched with water it cracks up, loses its texture and eventually falls to "breeze."

TABLE I. YIELDS FROM ONE TON OF AVERAGE COAL (25-35 PER CENT VOLATILE MATTER) IN THREE PROCESSES OF CARBONIZATION (BRITISH PRACTICE)

Process	Low-Temperature Carbonization	High-Temperature Carbonization	
		Gas Works	Coke Ovens
Temperature of carbonization	1,000 deg. F.	About 1,800 deg. F.	About 1,800 deg. F.
Gas	6,000-6,500 cu.ft. of rich gas, 700-750 B.t.u. per cu.ft.	12,000 cu.ft. of medium quality (city) gas 550 B.t.u. per cu.ft.	11,500 cu.ft. of poor quality (coke-oven gas 450 B.t.u. per cu.ft.
Liquid	20 gal. of oil (fractionated to 3 gal. motor spirit, 8-9 gal. Diesel oil and 8-9 gal. lubricating oil	10 gal. coal tar	8 gal. coal tar
Sulphate of ammonia	15 lb.	25 lb.	28 lb.
Residue in retort	1,568 lb. of smokeless fuel (9-10 per cent volatile matter)	1,512 lb. of soft coke (about 1 per cent volatile matter)	1,568-1,624 lb. of hard metallurgical coke (less than ½ per cent volatile matter)

DIFFICULT PROBLEMS IN RETORT CONSTRUCTION

As regards the material of the retorts, the ordinary firebrick retort is porous at the high temperature to the gas formed, which then burns outside the retorts. This does not matter much in high-temperature processes except that 5 per cent or so of the gas is wasted, but for low-temperature carbonization it is fatal, since this gas burning in the retort flues alters and raises the temperature, so that all control is lost, in addition, of course, to the loss of rich gas.

Another difficulty is that coal is a bad conductor of heat, and to submit every portion of a given mass of coal to a definite temperature of 550 deg. C. (1,022 deg. F.) means that the carbonization must take place in comparatively thin layers.

It is often stated that if low-temperature carbonization is required, all that is necessary to do is to lower the temperature of the ordinary retorts. The result of this is to form coke on the outside layers in the retort and practically unchanged coal inside. A mixture of half-baked coal and coke is not the product desired, which is a homogeneous product in a peculiar physical condition of porosity and texture.

One of the most difficult problems to solve was the material of the retorts. The difficulty with cast iron or mild steel is that when subjected to a continuous red heat it begins, almost in a few weeks, to waste away and also to "creep" or alter its shape. If cast iron could be used, it would be an ideal material, because it is a good conductor of heat, absolutely non-porous to the gas produced in the process, and can easily be cast accurately to any dimensions required.

In the early days of the gas industry in Great Britain, when the wear and tear on the retorts was much more severe than for low-temperature carbonization, although the temperature in those days certainly not as high as in the present gas industry, cast-iron retorts were used and usually lasted several years. This probably led to Parker's persevering tests with cast iron. The attempts were finally abandoned, however, and firebrick retorts were constructed, on the original advice of Prof.

FIG. 1. GENERAL VIEW OF EXPERIMENTAL PLANT AT BARUGH, NEAR BARNSLEY

V. B. Lewes. It is very likely, however, in the future that cast iron may be experimented with again in view of present research into the constitution of metals.

Experimental Plant at Barugh, Near Barnsley

With this brief outline of some of the problems presented by the low-temperature process, it is the intention of the writer to describe in considerable detail the experimental plant of Low Temperature Carbonisation, Ltd., which is located at Barugh, near Barnsley, in the center of the Yorkshire coalfields. This plant is in reality a good-sized works, as may be from Fig. 1. It consists of a unit of twenty retorts with a capacity of about 30 tons of coal a day, and with a complete recovery plant, coal washers, scrubbers, benzene-rectifying house, gasometers, producer gas plant, power station, etc., sufficient to handle the products from four or five times the present number of retorts. However,

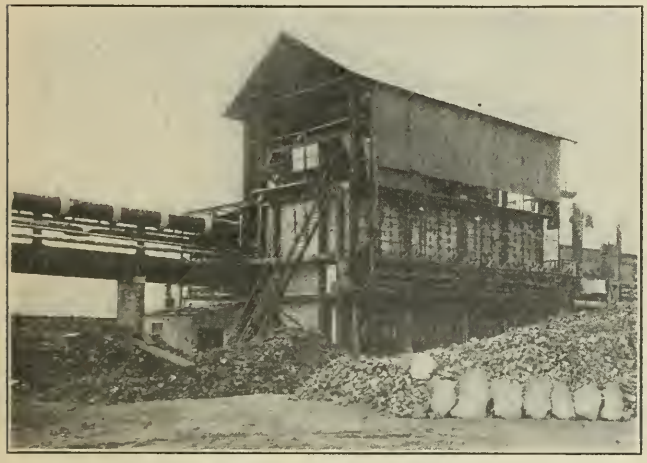


FIG. 2. VIEW OF RETORT HOUSE

since the whole process depends on the retorts, the company decided to confine itself to one unit of twenty retorts until complete success was obtained, as the erection of future units of retorts is a simple matter.

Each of the twenty retorts consists of a coal hopper at the top, a carbonizing retort beneath, and below this retort, a cooling retort, as shown in detail in Figs. 2 and 3.

The coal to be carbonized, which has first been washed, is fed into the hoppers, and each hopper holds exactly one charge of coal. These hoppers can easily be supplied mechanically with the coal by means of a horizontal scraper or other conveyor, so that when one hopper is emptied it is immediately refilled automatically. At present these hoppers are filled by small hand-propelled trucks, but this is simply a minor detail to be remedied in a larger scale installation. The charge, which consists of 10 cwt. (1,120 lb.) then lies in the hopper for 7 to 8 hours while the charge below in the retorts is being carbonized. During this time is becomes warmed by the heat of the retort, serving the double purpose of preventing heat loss from the retorts and warming the charge so that it loses moisture and does no damage to the red hot retort when the time comes for it to be dropped down. Between the bottom of this hopper and the top of the retort is a heavy rotary door or valve, operated by hand by means of a long lever, as shown in Fig. 4. When the retort below has been emptied, the attendant pulls the lever and lets the warmed charge of coal in the hopper fall into the hot retort. The retorts are of the vertical pattern, the inside dimension of each retort being about 9 ft. 0 in. x 6 ft. 6 in. x 11 in. They are built of firebrick cemented with fireclay into one unit of twenty retorts complete with all the necessary flues. All future plants, no matter how large, will be an aggregation of these standard units of twenty retorts each.

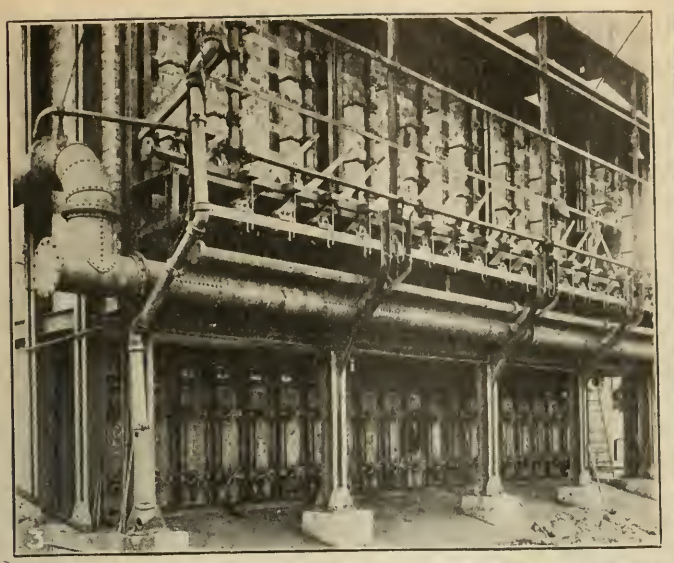
Description of Retorts

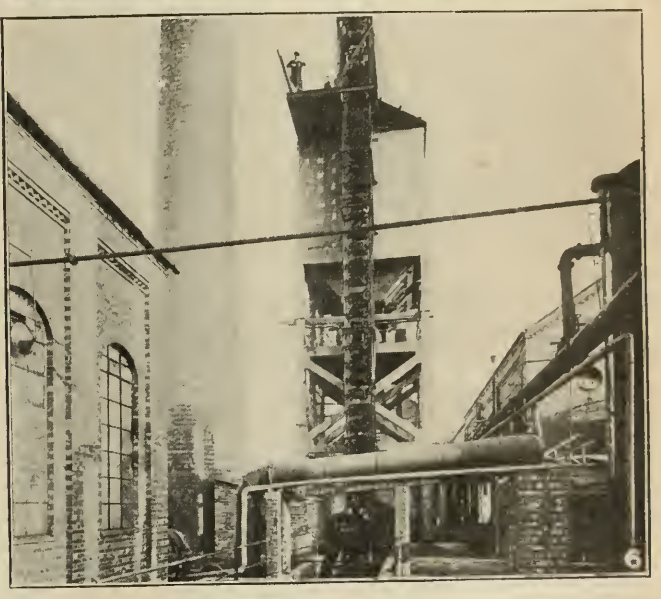
Inside each retort are two vertical perforated cast-iron plates extending for practically the entire height of the retort; the distance between these plates is about 4 to 5 in. The coal falls down into the retort from the hopper above, and fills each of the two empty spaces between the side of the retorts and the plates, but it cannot fall between the plates. That is to say, when full, each retort contains two vertical masses of coal 9 ft. 0 in. x 6 ft. 6 in. x 3 to 3½ in. thick, separated by two perforated iron plates, and an empty space 4 to 5 in. wide between the plates.

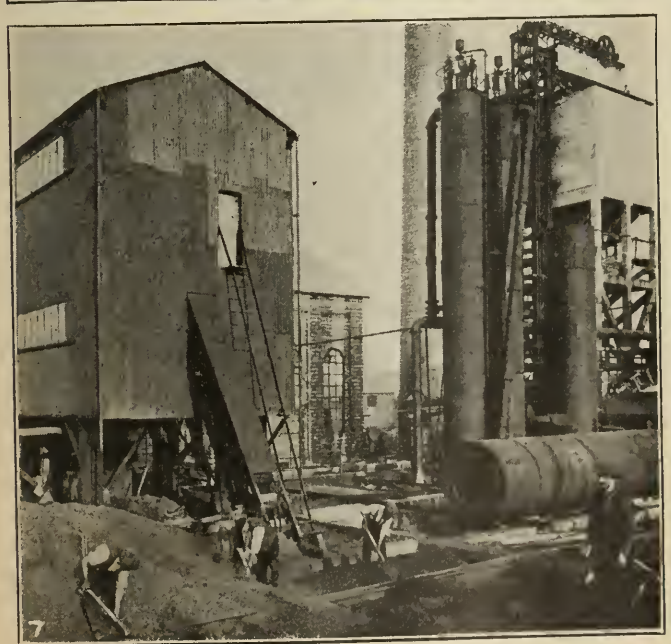
Heating the Retorts

The retorts are heated by a series of burners on the outside (as shown in Fig. 2) supplied by producer gas (or if necessary by the rich gas from the process); the burner flues between retorts are situated horizontally one above the other. The exit flue gases pass downward at the end of each horizontal flue, and into a similar flue below, regenerated at each flue by supplementary burners until the bottom of the retort is reached, where they then pass through the "recuperators" to the chimney exit of the plant. The fresh cold air supply for the burners passes through these recuperators and is thus preheated. The amount of heat lost by the whole battery of retorts is remarkably small, and the complete installation has a heat efficiency of about 75 per cent. The heat required to carbonize 1 ton of coal is about 2,500,000 B.t.u., equivalent to about 10 per cent of the coal—that is 2 cwt. (224 lb.) of coal or coke per ton. In a modern coke oven the heat required to carbonize 1 ton of coal is about 3,000,000 B.t.u. The burners are provided with spy holes in the brickwork, and the necessary temperature of about 650 deg. C. (1,202 deg. F.) in the flue outside, equivalent to about 550 deg. C. (1,022 deg. F.) inside the retort, can be obtained by adjusting the gas supply in accordance with the color of the flame. The latter operation is based on experience gained originally by the aid of pyrometers.

The exact temperature to use depends to some extent on the nature of the fuel required, the quality of the coal used and the yield of different products (depending on the market prices at the moment), but the figures previously given are about the average. The carbonization then proceeds for 8 hours, although it is possible that this time will be cut down in the future to 7 hours, or perhaps even to 6. To prevent the gas leakage through the sides of the retort, the top of the retort communicating with the empty space between the two vertical plates is connected direct to the exhausters, so that there is a slight suction down the center of the retort. Because of the perforated plates practically every portion of the heated mass of coal (in thin layers) is in direct communication with the suction space. Consequently, the distillation products, all gaseous at the temperature of 550 deg. C. (1,022 deg. F.) pass directly out of the coal into this central chamber through the perforations and up out of the retort. They have not to pass, as with an ordinary retort.







FIGS 3 TO 8

Fig. 3. The unit of twenty retorts.
Fig. 4. Charging coal into retorts from coal hoppers.
Fig. 5. Withdrawing low-temperature coke from cooling chambers
Fig. 6. Conveying coal from washers to carbonizing retorts.
Fig. 7. Coal washer and benzene scrubber.
Fig. 8. General view showing 20-in. concrete gas main to retort house.

through a mass of hot coal a number of feet in height, which partly decomposes the products and at the same time causes a pressure in the retort, thus increasing the tendency for these products to pass through the fireclay sides. This objectionable tendency in an ordinary retort is helped also by the chimney suction in the burner chambers outside of the retorts, and any suction at the top is lost after passing a few inches down into the mass of coal.

With these retorts containing the perforated plates, however, the suction is applied at once to every portion of the mass, and no gas at all passes through the retorts the reverse way into the flues. The gaseous products pass out of the retorts into the recovery portion of the plant in the usual way, and the after-treatment is the same as that of a coke oven.

Discharging the Hot Fuel

When the carbonization is completed, the attendant, by means of a hand lever, opens a heavy horizontal circular or rotary door in the bottom of the retort and by means of another handle on the top actuates a simple mechanism which causes the two perforated iron plates to come close together inside the retort with a slight shearing motion, so as to obviate any tendency of the residue to stick in the perforations. The consequence is there is now a clear space of 2 in. or so all down one side of the huge slabs of hot fuel and the pressure due to the expanded mass no longer exists. The two slabs thus fall out of the retort bodily without the slightest trouble. Underneath each retort is a special water-jacketed cooling chamber constructed of steel, of exactly the same internal dimensions as the retorts. These steel cooling chambers are in reality waste-heat boilers, the jackets being able to work at 100-lb. steam pressure. Water is circulated through these jackets, and the hot slabs of fuel, in the almost complete absence of air, lie in these cooling vessels while giving up their heat to the cooling water. In practice the temperature of the water in the jackets is generally over 212 deg. F. and steam is generated at about 5 lb. pressure. These jackets are also arranged to be heated by the exit gases from the recuperators which come in contact with the surface of the jackets at about 300 deg. C. (572 deg. F.) and finally leave at about 130 deg. C. (266 deg. F.). The steam raised in the exit chimney of the plant is employed in making the producer gas, in distilling the tar and in other useful operations. The vertical side of these cooling chambers is composed of a door, which is opened, and the fuel pulled out by hand rakes on to the sloping cement floor (see Fig. 5) and slides down to the store or direct into trucks, being a hard, porous, compact solid, only warm to the hand. The product is so hard that it is superior in this respect to briquets. The pieces are thrown into railway cars in the same manner as coal, and travel quite as well as coal itself; the breeze formed is infinitesimal. Thus the product is now arriving regularly at Marylebone station (London) from Barnsley, 200 miles away, in perfect condition.

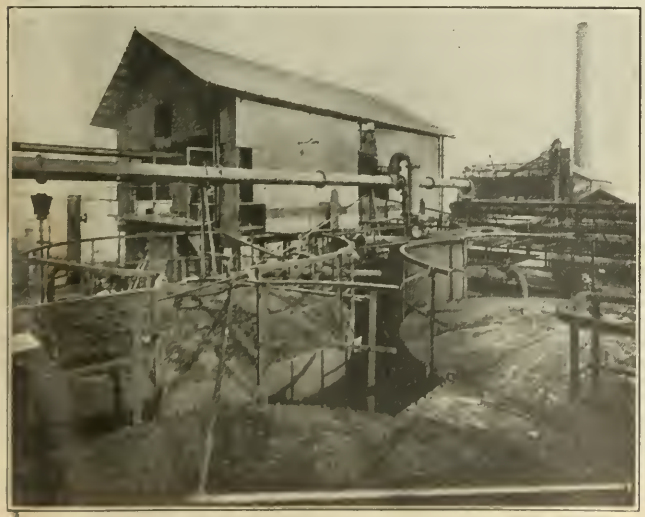


FIG. 9. RETORT HOUSE, WITH STORAGE TANKS FOR OIL IN FOREGROUND

Economic Considerations

The cost of labor and attendance in working a complete low-temperature carbonization plant is about the same as that of a coke-oven plant. The whole of the recovery side of the plant, constituting about 60 per cent of a complete low-temperature installation, is practically identical with that of existing high-temperature carbonization processes. The balance sheet of the whole process is very satisfactory, even on a conservative estimate of the market value of the various byproducts of gas, motor spirit, Diesel oil, lubricating oil and sulphate of ammonia produced, especially since the fuel can replace coal in practically any operation, household or industrial.

The coal used, while it must be of the dimensions of ordinary slack, can be of the most varied composition. A remarkable achievement is that two parts of non-coking coal can be mixed with one part of coking coal and used to produce a very satisfactory smokeless fuel. The importance of this will be obvious, as it means that practically all the coals of Great Britain can be subjected to this process. Another noteworthy achievement is that a large proportion of fine slack and dust, now practically a waste product of the collieries, can also be utilized, and the importance of this to the colliery industry can hardly be overestimated.

Gas. As already noted, the yield of gas is considerably lower, 6,000 to 6,500 cu.ft. per ton, as compared with 12,000 cu.ft. in the average high-temperature gas works. However, the gas is richer, since it yields about 700 to 750 B.t.u. per cu.ft., as against 550 B.t.u. for city gas and 450 B.t.u. for coke-oven gas. Naturally the composition of the gas depends on the quality of the coal used in the low-temperature retorts, but as compared with city gas it is richer in methane and olefines and has a much higher illuminating power. Roughly speaking, with average coal of about 30 per cent volatile matter, the composition of low-temperature gas is about 27½ per cent hydrogen, 48 per cent methane, 10 per cent paraffine hydrocarbons, 3 per cent olefines, 7½ per cent CO, 2½ per cent CO_2, and 1½ per cent nitrogen.

Oil. The oil from the process resembles crude oil in appearance and is quite different in composition from coal tar. It has a specific gravity of about 1.06 and contains less than 1 per cent of free carbon, while coal tar has a specific gravity of about 1.18 with a large amount of free carbon, generally over 6 per cent, which is caused by the excessive decomposition resulting from the higher proportion of the simpler and lower organic compounds of the benzene and cresol groups, with no phenol and an almost entire absence of the higher hydrocarbons of the type of naphthalene, anthracene, carbazol, etc.; the percentage of pitch is also much less. About 45 per cent of the low-temperature oil comes

over between 160 and 300 deg. F., while with coal tar the figure is only about 12 to 14 per cent.

It is curious that cresols, which are very valuable for wood preservatives, are present in large quantities in this oil, corresponding to about 3 gal. per ton of coal. In coal tar the chief product of this class is phenol or carbolic acid, and there is very much less cresol. Naphthalene is entirely absent in low-temperature oil and present in large quantities, 5 to 10 per cent, in coal tar, which reduces the value of the latter in comparison.

The large amount of motor spirit produced, about 2 to 3 gal. to the ton of coal, depending on the quality, is a very valuable product. It has a particularly low freezing point, about —50 deg. F., whereas benzene is about +40 deg. F.

The fraction above 300 deg. F. amounts to about 42 per cent. It is then treated by steam, whereby valuable lubricating oils are removed, leaving about 34 per cent of pitch; and from this further heavy lubricating products such as vaseline can be extracted. In this pitch residue there is less than 6 per cent of free carbon, whereas in the ordinary pitch from coal tar there is a very large amount, generally about 28 per cent.

A large portion of the oil, after removing the pitch, can be used direct as Diesel oil, corresponding to 8 or 9 gal. per ton. It works perfectly, starting from cold and giving results of about 0.5 to 0.55 lb. of oil per brake horsepower.

Sulphate of Ammonia. This is extracted from the gas in the usual way by means of sulphuric acid, the yield being about 15 lb. per ton of coal, less than the high-temperature carbonization processes because the decomposition of the nitrogenous matter in the coal is less drastic due to the lower temperature.

Smokeless Fuel. This is a hard, crisp and porous solid, which contains about 8 to 9 per cent of volatile matter. The actual B.t.u. is about the same as the coal from which it is manufactured, but the effective heating value is for many uses higher because of the emission of much more radiant heat in the burning. Like coke, it is absolutely smokeless. Black smoke is of course due to the escape of unburned matter, as the rate of combustion is too slow to complete the oxidation before the smoke can escape. For this reason anthracite, which contains very little volatile matter, and coke, which contains none at all, are absolutely smokeless. As the fuel from the low-temperature process is also smokeless, it would appear that any amount of volatile matter up to about 12 per cent can be burned without trouble, but when over this, black smoke begins to appear. It is also clean and not dusty like coal, and ignites almost as easily as coal, unlike coke, which is very difficult to light. Like coke it too is a highly efficient fuel for steam generation because of the high radiant heat.'

2 Austin Friars,
London, E. C., 2.

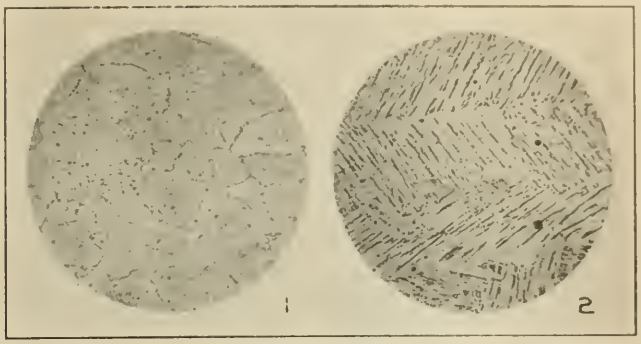
Tests of Rubber Goods

Standard methods of testing rubber goods of all sorts are described in the new (fourth) edition of Circular 38 of the Bureau of Standards, which is now available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 20c. per copy. The circular also includes a brief discussion of crude rubber and the manufacture of rubber goods, both the composition and the methods of manufacture.

Oxygen and Nitrogen in Welds*

By S. W. Miller

IT IS known that a weld made with a low-carbon steel wire for welding rod is usually an over-oxidized steel casting, and its maximum strength cannot be in excess of 52,000 lb. per square inch. If nickel steel wire (S.A.E. 2320) is used, however, its strength can be kept up to 58,000 lb. per square inch by careful and competent workmen, and its state of oxidation is much less. This seems to be due to the formation during welding of a tough viscous slag, which is probably due to the formation of nickel oxide. This coating on the weld is very thin, but seems to be sufficient largely to protect the metal from the action of the air. Whatever the cause may be, the microstructure of the weld



FIGS. 1 AND 2.

Fig. 1. Gas weld in sheet steel. Notice large grain size due to heat. Small dots are ferrous oxide. A few particles of carbide at grain boundaries. Etched. ×200.

Fig. 2. View in weld made with 0.20 carbon, 3½ per cent nickel steel wire. The carbon is largely preserved by the nickel, making the weld pearlitic and stronger than one made with ordinary wire. ×100.

shows it to be much more free from ferrous oxide than ordinary weld metal. (Compare Figs. 1 and 2.) Any material will answer that will give equal results. But nickel steel is readily obtainable and, until other alloys are found, I feel that nickel steel should be used for important work.

It is just as necessary to have high quality in the base metal as it is in the welding rod, and I might say at the beginning that I have never found a bad welding steel that was not full of sonims, nor a good welding steel that was not free from them, except in one or two instances. I believe it is possible to make a bad welding steel by improperly annealing good material, especially in sheet, where the effect of oxidizing atmosphere is much greater in proportion than in plate, because of the thinness. The effect is to make the material brittle, presumably by permitting the oxygen to penetrate the grain boundaries, being in effect an incipient burning. It has been shown that by heating in a reducing atmosphere at a temperature below the Ac_1 point the brittleness was removed, which would seem to show that oxide films at the grain boundaries caused the trouble.

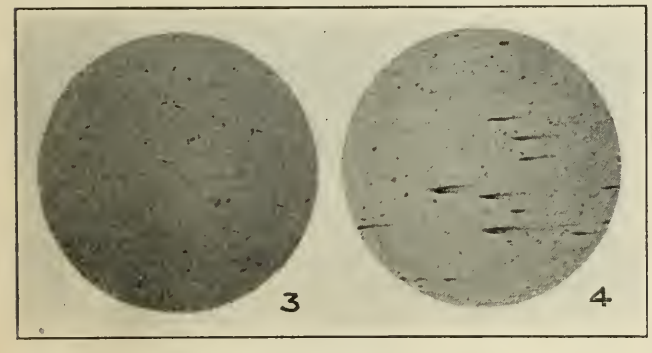
The nature of the non-metallic impurities that cause trouble in welding I am not sure of, because they are usually very small, but as the metal just around them seems to be porous to a greater or less extent, it would seem that they must be oxides or silicates. It is also quite probable that the porous part is filled with gases, because bad welding material spits when it is heated to the welding point, indicating that gas has been

*Extracts from a paper read before the American Iron and Steel Institute, Nov. 18, 1921.

formed in some way. It is also noticeable that in preparing a specimen for the microscope the later grindings, if done on soft cloth, remove the material around the sonims and give the unetched section the appearance of being spotted with a lot of comet tails, which of course are much larger than the actual size of the particles of impurities.

I think it is perfectly safe to say that the microscope will always determine whether a steel will weld properly (see Figs. 3 and 4), except where it has been put through an annealing process which would damage it at the grain boundaries. I also feel that chemical analysis shows nothing of the welding qualities within wide limits, unless the steel is badly off.

The microscope shows better than any other instrument the nature of the defects in welds, and when this is known, and not until then, precautions can be taken to avoid them. Generally speaking, there are two avoidable defects, which are in reality one—first, lack of fusion in the weld metal itself. (Fig. 5.) The tendency in welding steel is to underheat the plate, because it is much heavier in section than the welding wire, in which case the melted wire may fall into the V without being fused to it. The same thing may happen in the weld. When this occurs there is a thin film of oxide between the two layers of metal, and this of course destroys the strength of the piece. In addition to this there is the oxidizing action of the water vapor in the gas welding flame and that of the air on the finely divided metal passing through the electric arc. If the gas welding flame be not properly adjusted, or if the torch be of poor design, there is the additional possibility of free oxygen being present and causing



FIGS. 3 AND 4.
Fig. 3. Good welding steel. Sonims few and small. ×35
Fig. 4. Poor welding steel. Sonims larger and more numerous than in Fig. 3. ×35.

serious trouble. An improperly made weld will show streaks of oxide or other impurities which are frequently very small and thin, and yet the first evidence of distortion of such a weld is at these defects, just as the first evidence of distortion in a piece of steel is at similar defects. During the welding operation these defects appear as bright white spots or streaks in the case of gas welding, which can be floated to the surface and removed. In the case of electric welding this is not possible, except to a limited extent, because whatever impurity is in the electrode must go into the weld. The films or streaks referred to are frequently clearly visible under the microscope, but many times rupture occurs at the grain boundaries in both gas and electric welds, where there are no evidences of any films even at the highest power of the microscope. (Fig. 6.) These ruptures must be at the austenite grain boundaries, because to them the impurities are rejected during the solidification of the metal. In cases of welds where it is possible to distinguish between the gamma and the alpha grain boundaries, as is possible when there is much pearlite, I have never seen a case of rupture at the alpha boundaries. This would seem to be quite natural,

FIGS. 5 AND 6.
Fig. 5. Defective gas weld, full of laps. ×200.
Fig. 6. Electric weld. Grain boundary rupture; no evidence of defect before straining. ×200.

because the alpha grains are formed by the recrystallization of the gamma grains, and if there be any impurities at the gamma grain boundaries it is not possible for one grain to grow at the expense of another one past such impurities.

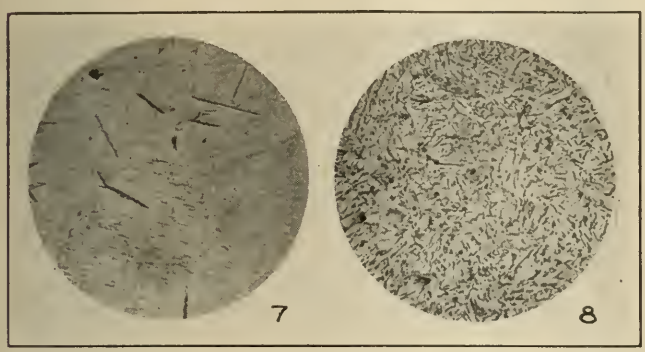
It would scarcely be expected that any ordinary heat-treatment would alter the character of the ruptures in welds, and if defective welds were heated in an oxidizing atmosphere it might be expected that they would become more brittle. Such tests as I have made indicate that this is true. On the other hand, I have found that electric welds which were very brittle as made were notably improved by heating several hours in a strongly reducing atmosphere at a temperature of about 600 deg. C. This would indicate that the difficulty is one of oxide.

Prevention of Oxidation

Oxidation should evidently be less severe in the case of gas welds than in electric welds. First, because the temperature is not so high, and second, because of the protecting influence of the envelope flame, which is composed of hydrogen and CO burning to water and CO_2. In the electric arc the temperature is very high, and the metal passing over the electrode to the weld is very finely divided, with naturally great oxidation. It will appear clear that if the melted metal could be covered with a protecting slag, oxidation would be much lessened. This has been done for a number of years in electric welding by coating the electrodes with compositions of various kinds which produce slags of various viscosities. If the slag is too viscous, it may be entangled in the weld, weakening it, and if too thin, it will not protect the metal; but it is a fact that electrodes of this type when properly used give a sounder weld than electrodes made of bare wire. With gas welding no organized attempt has been made to provide such a slag covering. Naturally with the lower temperature a thinner slag will be necessary, but there is also to counteract this the blast from the flame, which has a velocity of about 375 ft. per second at the exit from the tip, which tends to blow away the slag and to leave the metal exposed. It is rather curious that nickel steel welding rod seems to provide a very thin slag. It is entirely probable that before best results will be ob-

tained with gas welding it will be necessary to provide a properly coated welding wire. It might be mentioned incidentally that in the case of non-ferrous metals such as brass and bronze, much sounder welds are produced when the welding material contains slag-forming constituents and when flux is sparingly used than when other conditions prevail. This would naturally be expected, because of the well-known fact that a clean surface of melted metal permits the absorption of gases which are given out during solidification, causing porosity.

Welding rods are low in carbon (that for gas welding having about 0.06 per cent and that for electric welding about 0.15 per cent[1]), yet there is always a loss of carbon due to the heat, so that the weld made with



FIGS. 7 AND 8.

Fig. 7. Nitrogenized iron. Primary and secondary plates of iron nitride. The primary ones (large) appear to lie along Neumann directions, while the secondary ones (small) appear to be parallel to the intersection of an octohedron by a cube face in two grains, and in the third (upper left corner) along intersections of an octohedron with dodecahedral planes; the larger plates do not appear where the small ones are. Etched with picric acid. ×200.

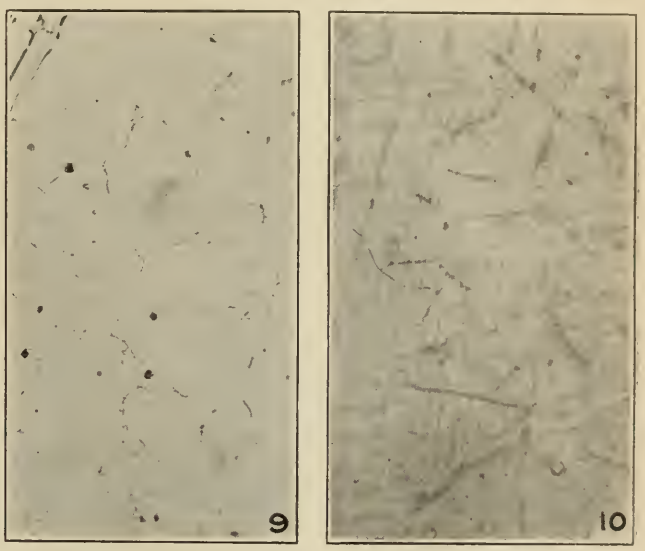
Fig. 8. Electric weld in ¾-in. plate. View in weld. Many iron nitride plates, small in size because of rapid cooling.

such materials does not contain over about 0.03 or 0.04 per cent of carbon. Manganese and silicon are also lost, but, as would be expected, the phosphorus and sulphur do not change. In the case of heavy welding the loss of the above elements is less near the V than in the center of the weld, as there is some interchange of the elements between the weld metal and base metal, so that in sampling a weld for chemical analysis care should be taken to keep away from the edge of the V, unless proper allowance is made.

While there is a loss of some elements, there is a gain in both oxygen and nitrogen. Nitrogen in both gas and electric welding comes from the air, while the oxygen probably also partly comes from the water vapor in the envelope flame in the case of gas welding. It is generally believed that molecular nitrogen has but small affinity for iron at even high temperatures, and this is doubtless true. On the other hand, iron ordinarily combines with nitrogen in the nascent condition at 1,400 deg. F., as has been proved by numerous tests.

There has been much discussion as to the effect of nitrogen on steel, some taking the position that it makes steel brittle and others that it has very little if any effect. The presence of nitrogen as nitride can be quite accurately determined by chemical analysis, but its existence in other forms, such as dissolved gas, cannot be proved in this way. It is usually believed that when it is present in sufficient quantity it combines with the iron, making an iron nitride having the formula Fe_4N. In this condition it may be seen as a constituent of the metal in the form of plates (Fig. 7) lying along the cleavage planes of the grains, and with larger quantities is present as a eutectoid of iron and iron nitride at the grain intersections.

Electric arc welds have the same structure as nitrogenized iron, except that the structure is much finer because of the rapid cooling. (Fig. 8.) Gas welds may also contain the plates when the metal has been overheated. Similar plates are also visible in samples of bessemer steel taken just after the blow and before recarburizing. (Fig. 9.) In all three cases the metal has been overheated, and it would seem to be quite possible for nitrogen to combine with iron as iron nitride at these very high temperatures. Of course there is as yet no chemical proof that the plates are iron nitride, as they have not been isolated. It is not worth while to discuss the matter here, except as to



FIGS. 9 AND 10.

Fig. 9. Blown steel from bessemer converter. Short lines at left are iron nitride. Cementite at grain boundaries at right. ×300.

Fig. 10. Electric weld strained. Slip bands frequently stop at iron nitride plates, but in no case do they follow along them, nor do the plates influence the slip bands. ×800.

whether nitrogen is responsible for the brittleness in electric welds made with bare wire. I have tested many welds by bending them and examining them under the microscope, and in no case has it been found that the nitride plates have any effect on the path of rupture. The slip bands in the grains never follow the plates (Fig. 10), but frequently stop at them when the two are at an angle to each other, and the rupture takes place either at defects in the weld, or at the grain boundaries, even where in the latter case no defects are visible, as they also sometimes do in the case of gas welds. This would indicate that as far as tensile stress is concerned nitrogen has no serious effect. In the case of alternating stress and shock tests, the results might be different, but no such tests have been made as far as I know. It seems to me that in view of all the facts the brittleness of welds is due to the presence of oxides, and I believe that in the future we shall be able to make much better welds by providing some effective but simple means for the protection of the melted metal from the air, or for removing from the weld the oxides as they are formed.

[1]While Armco iron does not come within the chemical limits given, the ratio of the strength of a weld made with Armco wire is to its plate strength about the same as that of a nickel steel weld to the plate specified. Also such non-metallic impurities as exist in Armco iron do not seem to impair its welding qualities. They are apparently of a different character.

Water-Power Resources of the World

THE water-power resources of the world and their present development form the subject of Part II of the World Atlas of Commercial Geology, by Herman Stabler, B. E. Jones, O. C. Merrill, N. C. Grower and a group of other co-workers of the United States Geological Survey.

The extreme ultimate development, with the greatest possible conservation of stream flow by storage, of the potential waterpower of the world may reach as high as 10 billion horsepower, but such a figure is purely speculative. The reasonable estimate, when the streams are at ordinary low water stage, is about 440 million horsepower, an amount equal to nearly four times the world's present total used power from all sources. Of this last estimated amount about 190 millions are in Africa, especially in the tropical zone; about 70 millions in Asia, China and India, having respectively 20 and 27 millions; about 62 millions in North America, the United States and Canada having respectively 28 and 20 millions; about 54 millions in South America, of which about half is in Brazil; Europe has about 45 millions, Norway leading with about 5.5 millions; Oceanica has about 17 millions, New Guinea leading with 5 millions. Only about 23 million horsepower—i.e., about 5 per cent of the total reasonable estimate—is now developed, the rank of developments by continents being: North America with about 12,210,000 horsepower, Europe 8,877,000, Asia 1,160,000, South America 424,000, Oceanica 147,000 and Africa 11,000.

Water Power in North America

In outlining the general conditions of the water power in the North American continent nineteen drainage areas are to be considered—namely:

1. *Middle Atlantic Area.* This area includes the basins of all the streams that flow into the Atlantic Ocean between the St. Lawrence River basin on the north and the James River basin on the south. The large demand for power in this most densely populated area of the Western Hemisphere has resulted in the utilization of a great percentage of all the fall sites.

Of the potential 400,000 hp. in New Brunswick, Nova Scotia and Prince Edward Island, about 54,000 hp. is already developed; a 12,000-hp. plant is now being built in Nova Scotia.

The New England water power has been extensively developed. Of the maximum potential 1,605,000 hp. available 1,381,000 is already developed, the principal users, besides public utilities, being pulp, paper, cotton and woolen mills.

Of the maximum potential 2,488,000 hp. in the Middle Atlantic States 1,735,000 is already developed, especially on the Hudson, Mohawk, Delaware, Susquehanna and Potomac rivers. There are also fairly large plants on the Lehigh, Schuylkill and Shenandoah rivers. Most of the developed power is used by public utility plants.

2. *South Atlantic and Eastern Gulf of Mexico Area.* This area includes the basins of all streams that flow into the Atlantic Ocean or the Gulf of Mexico between the Middle Atlantic area and the Mississippi River. Of the minimum 2,000,000 hp. about 1,500,000 is already developed. The greater part of this power is used mainly in cotton mills, although mines, iron and steel mills and miscellaneous manufacturing plants also are great users of water power.

3. *Ohio River Area.* This area includes the entire drainage basin of Ohio River. The potential power of this basin is about 1,500,000 hp., of which only about 400,000 has been developed. A large part of the power developed is for municipal purposes, but practically all the new power development now going on is for industrial use, largely for making cotton goods and aluminum.

4. *St. Lawrence River Area.* This area includes the drainage basin of the Great Lakes and St. Lawrence River to its mouth at Pointe des Monts. The plants near Niagara Falls form the largest water development in the world; their total capacity is 870,000 hp., of which 385,500 is on the United States side. If the total flow of the river were used the Falls would furnish, under favorable conditions, about 6 million horsepower. A plan whereby 60 per cent of the total flow of the river can be diverted for developing power is being considered. The developed power of the St. Lawrence drainage area aggregates more than 2.5 million horsepower, and the potential power is estimated at 10 million horsepower, on the assumption that only 60 per cent of the available flow at Niagara Falls may be diverted for this use. Most of the power developed is applied to municipal uses, but great amounts are also used in electrochemical industries, pulp and paper mills, mining and general industrial plants.

5. *Upper Mississippi River Area.* This area includes the part of the drainage basin of Mississippi River that lies north of the Ohio on the east and the Missouri on the west. The potential power of this area is estimated at about 1 million horsepower, of which 600,000 has already been developed. The power is used mainly for municipal purposes, but mills manufacturing paper, flour, wood products and other articles also use large amounts.

6. *Missouri River Area.* This area includes the entire drainage basin of the Missouri River. Of the total potential 4.4 million horsepower in this area (Montana, Wyoming, Colorado, South Dakota) only about 570,000 is developed. The power developed is utilized principally for mining, smelting, railway and municipal uses.

7. *Lower Mississippi River Area.* This area includes the parts of the Mississippi drainage basin that lie south of the Missouri and of the Ohio. There are only a few water plants in this area, all small.

8. *Western Gulf of Mexico Area.* This area includes the drainage basins of all streams that flow into the Gulf of Mexico between the Mississippi River and Cape Catoche in Yucatan. Only about 150,000 hp. is developed. There is about 50,000 additional potential horsepower on the Necaxa and about 200,000 on the Rio Blanco. Mines and municipal uses offer a market for a large amount of power in this country.

9. *Gulf of California Area.* This area includes the Colorado River drainage basin in the United States and extends to Capes San Lucas and Corrientes in Mexico. The potential power in this basin is estimated to be at least 2 million horsepower, of which less than 200,000 is developed.

10. *Great Basin Area.* This area includes the inland basin between the Rocky Mountains and the Sierra Nevadas. With proper storage the potential power in this area would amount to 500,000 hp. The plants now constructed have a capacity of 250,000 hp.

11. *Upper South Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean between the northern boundary of the Klamath River basin and the south end of Lower

SUMMARY OF POTENTIAL AND DEVELOPED WATER POWER IN 1920 IN HORSEPOWER

	Developed	Potential
North America		
Mexico	400,000	6,000,000
United States	9,243,000	28,000,000
Alaska	40,000	2,500,000
Newfoundland	60,000	400,000
Canada	2,418,000	20,000,000
Costa Rica	15,000	1,000,000
Guatemala	4,000	1,500,000
Honduras	3,000	1,000,000
Nicaragua	400	800,000
Salvador	2,700	200,000
Panama	13,300	500,000
West Indies	12,500	150,000
Approximate total	12,210,000	62,000,000
South America		
Argentina	25,000	5,000,000
Bolivia	12,000	2,500,000
Brazil	250,000	25,000,000
British Guiana	.....	2,500,000
Dutch Guiana	.....	800,000
French Guiana	.....	500,000
Chile	60,000	2,500,000
Colombia	25,000	4,000,000
Ecuador	2,500	1,000,000
Paraguay	200	2,000,000
Peru	36,500	4,500,000
Uruguay	.....	300,000
Venezuela	12,500	3,000,000
Approximate total	424,000	54,000 000
Europe		
Sweden	1,200,000	4,500,000
Norway	1,350,000	5,500,000
Finland	185,000	1,500,000
Russia	100,000	2,000,000
Esthonia, Latvia, Lithuania	20,000	200,000
Poland	80,000	200,000
Ukraine	40,000	425,000
Region of the Caucasus	5,000	5,000,000
Hungary	30,000	150,000
Czecho-Slovakia	50,000	420,000
Jugo-Slavia	125,000	2,600,000
Austria	205,000	3,000,000
Rumania	30,000	1,400,000
Bulgaria	8,000	1,200,000
Greece	6,000	250,000
Turkey	.....	Small
Albania	1,000	500,000
Italy	1,150,000	(a) 3,800,000
Switzerland	1,070,000	(b) 1,400,000
Germany	1,000,000	1,350,000
France	1,400,000	4,700,000
British Isles	210,000	585,000
Belgium	700	Small
Denmark	1,500	2,000
Netherlands	.....	.....
Spain	600,000	4,000,000
Portugal	10,000	300,000
Iceland	.....	500,000
Approximate total	8,877,000	45,000,000
Asia		
Chinese Republic	1,650	20,000,000
India	150,000	27,000,000
Asia Minor	500	500,000
Arabia	.....	.....
Persia	.....	200,000
Afghanistan	2,000	500,000
Siberia	.....	8,000,000
French Indo China	.....	4,000,000
Siam and Malay States	4,500	4,000,000
Chosen	2,620	500,000
Japan	1,000,000	(c) 6,000,000
Approximate total	1,160,000	71,000,000
Africa		
Tangier	.....	50,000
Morocco	.....	250,000
Algeria	130	200,000
Tunis	.....	30,000
Tripoli	.....	Small
Eritrea	.....	Small
British Somali	.....	Small
Italian Somali	.....	Small
Gold Coast and British mandate in Togo	.....	1,450,000
Liberia	.....	4,000,000
Sierra Leone	.....	1,700,000
Senegal	.....	250,000
Rio de Oro	.....	Small
Gambia	.....	Small
Portuguese Guinea	.....	Small
Union of South Africa	5,000	1,600,000
Angola	4,000	4,000,000
Southwest Africa (Union of South Africa mandate)	.....	150,000
Belgian Kongo and Belgian mandate	250	90,000,000
French Kongo	.....	35,000,000
French mandate in Kamerum	.....	13,000,000
Nigeria and British mandate in Kamerun	.....	9,000,000
Rhodesia	.....	2,500,000
Tanganyika (British mandate)	800	2,700,000
British Central Africa	.....	1,200,000
British East Africa	900	4,700,000
Portuguese East Africa	.....	3,700,000
Bechuanaland	.....	20,000
Abyssinia	.....	4,000,000
Egypt	.....	600,000
Ivory Coast, Dahomey, and French mandate in Togo	.....	2,850,000
French Guinea	.....	2,000,000
French Sudan	.....	1,000,000
Madagascar	100	5,000,000
Approximate total	11 000	190,000,000
Oceanica (d)		
Australia	.....	620,000
New Zealand	45,000	3,800,000
Philippine Islands	.....	1,500,000
Sumatra	(e) 11,600	2,000,000
Java	(e) 56,500	500,000
Borneo	.....	2,500,000
New Guinea	.....	5,000,000
Tasmania	34,500	400,000
Celebes	.....	1,000,000
Approximate total	147,000	17,000,000
Recapitulation		
North America	12,210,000	62,000,000
South America	424,000	54,000,000
Europe	8,877,000	45,000,000
Asia	1,160,000	71,000,000
Africa	11,000	190,000,000
Oceanica	147,000	17,000,000
Approximate grand total	23,000,000	439,000,000

(a) Ordinary flow. Ordinary low flow estimated at 2,700,000 hp.
(b) Ordinary low water 900,000. For 9 months, 1,374,000 hp., and for 6 months 2,504,000.
(c) Total power developed, under lea e and availabl · at low flow.
(d) All these estimates except those for the Philippines and New Guinea assume the use of storage.
(e) Installed or under construction, November, 1920.

California, at Cape San Lucas. The total developed power in this area in California is more than 800,000 hp., and at the present rate of increase will soon exceed 1 million. The potential power at low water is about 3 million horsepower, but this amount could probably be doubled by storage. The power is used mainly for irrigation, mining, electrochemical industries and public utilities.

12. *Lower North Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean between the Klamath River basin and the Canadian boundary. The potential power is about 11 million horsepower, of which only 750,000 is developed. The power is used mainly by public utilities.

13. *Middle North Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean from the U. S. boundary to and including Yakutat Bay, Alaska. The undeveloped power at known sites is between 2 and 3 million horsepower of which only 250,000 is developed. Probably many large sites of potential power are still unknown.

14. *Upper North Pacific Area.* This area includes the drainage basins of all streams that flow into the Pacific Ocean between Yakutat Bay and Cape Prince of Wales. The total developed power in this area is about 65,000 hp., which is used mostly in mining. The undeveloped power is unknown, but may amount to 2.5 million horsepower.

15. *Arctic Ocean Area.* This area includes the northern parts of Alaska, Canada and Greenland. Little is known of the undeveloped power resources of this area, but there seem to be no great concentrations of potential power.

16. *Hudson Bay Area.* This area includes the drainage basins of all streams tributary to Hudson Bay. The potential power is estimated at 5 million horsepower, of which about 225,000 is developed. This power is used for municipal purposes, in pulp and paper mills, in milling and general manufacturing.

17. *North Atlantic Area.* This area includes the drainage basins of all streams that flow into the Atlantic Ocean east of Hudson Bay and north of the St. Lawrence River and Cabot Strait. A 75,000-hp.

plant is said to be feasible on Bay d'Est River in Newfoundland. The only large power plants in this area are in Newfoundland, where 60,000 hp. is developed and used mainly in pulp and paper mills.

18. *Lower South Pacific Area.* This area includes a narrow belt between Cape Corrientes and the eastern boundary of Panama. Although power sites are plentiful and well distributed in most of this area, little power has been developed, because there is little manufacturing and no demand for power except for municipal use in the larger cities.

19. *Caribbean Sea and West Indies Area.* The largest plant in this area is that at Gatun, Panama Canal, of about 13,000 hp. Porto Rico has developed 8,000 hp. of a total potential 25,000 hp. Jamaica has one 1,300-hp. plant. Other small plants are scattered in Honduras, Nicaragua and Cuba.

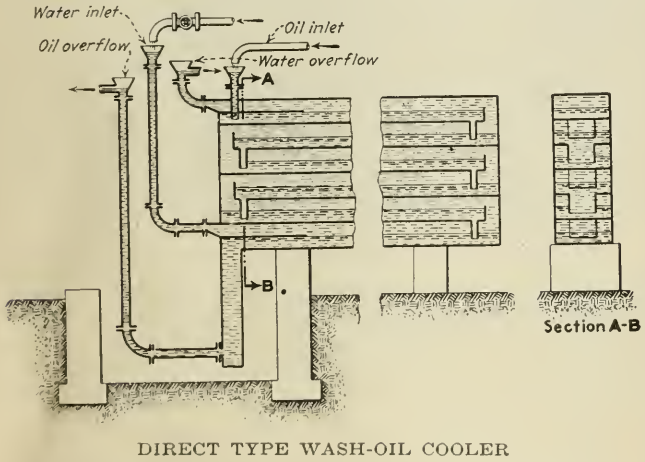
The accompanying tables give the summaries of the potential and developed water power in 1920 by continents and countries.

Direct Type Wash-Oil Cooler for Benzene Plants

By Arthur Kuhn

SEVERAL benzene plants in Germany have adopted what is known as the direct method of wash-oil cooling in which the hot debenzolized creosote oil is brought in direct contact with the cooling water, the effect being that the oil is cooled down almost to the temperature of the entering water.

This process, as well as that of the successful direct gas cooling based on similar principles, emanates from Dr. C. Still, and on account of the imperfection of the small testing apparatus a little initial trouble was experienced just prior to the war. The tests were eventually abandoned, as the cooling effect of a new type of a then inexpensive tubular oil cooler was most satisfactory.



DIRECT TYPE WASH-OIL COOLER

With the present high costs of arranging, cleaning and replacing tubes of the usual coolers, however, less expensive oil-cooling devices are desirable and so the direct cooling has again been taken up and carried through successfully by several coke-oven firms. Though this process is at present confined to European practice, in which heavy tar oil is used in benzene recovery, it will no doubt be of great interest to many coke-oven operators in this country.

Referring to the accompanying illustration, the new type of oil cooler consists of a number of baffle plates or trays combined in a rectangular box, so arranged that there is always a seal pipe dipping into the oil layer at the bottom of every baffle plate in order that the water may not be mixed with the oil.

The creosote oil, which is heavier than water, enters the cooler a little below the top, whereas the lighter cooling water enters near the bottom. In this way the downward-flowing oil is met by a current of water rising from below. With this constant contact of oil and water the oil is cooled to about the temperature of the entering water.

The separation of oil and water is most satisfactory, provided the water is clean and the oil kept in proper operating condition. Naturally, traces of phenols contained in the oil will be diluted and carried along by the water, but this is of little inconvenience, as the water is used for quenching coke.

The process described refers to the cooling of heavy oil only. It cannot be used for cooling straw oil in the same simple way, as no proper counter-current will be assured. The light straw oil would enter at the bottom and travel in an upward direction similar to the water in the former process, whereas the heavier water would be supplied from the top of the cooler. The result, of course, will be that the cooled oil tends to remain at the bottom owing to its increased specific gravity, while the warm water tends to remain at the top, where the cooled oil leaves the apparatus. Undoubtedly there can be no question that these difficulties can be overcome by an apparatus of different design in which the two liquids in question pass each other in one shallow layer.

Pittsburgh, Pa.

The Use of Nozzles in Measuring Pulsating Flow

NOZZLES are one of the most valuable pieces of equipment in measuring the flow of fluids. Their application in the measuring of steady flow is well known and needs no further mention here.

When nozzles and some sort of measuring device for differential pressure are used for pulsating flow, errors result, unless the flow curve is known as a function of time. This fact is easily illustrated by reference to Fig. 1, *A*, which represents flow of fluid plotted against time. In this special case it is assumed that the velocity of flow fluctuates periodically and abruptly between the values of 10 ft. per second and zero. Evidently, the average velocity must equal 5 ft. per second. If, however, the velocity is measured by an instrument such as a nozzle, or a Venturi meter, or a Pitot tube in conjunction with a differential pressure gage, the instrument will not measure the average velocity directly, but its readings will fluctuate between 10^2 and 0^2—i.e., the readings will fluctuate between 100 and 0. If now the gage be throttled down so that it can be read, then it will show the average between 100 and 0 or 50. However, the square root of 50 does not equal 5, but is a little more than 7, and the conclusion is that the instrument will show 7 ft. per second instead of the actual average velocity of 5 ft. per second. This in itself would do no harm if we knew beforehand how much the excess reading is, but, as before stated, to that end we must know the flow curve. Let the flow curve be as in Fig. 1, *B*, which again represents velocity of flow plotted against time, and let the velocity fluctuate now only between 6 ft. per second and 4 ft. per second, then the

readings of the instrument will fluctuate between 36 and 16, these being the squares of 6 and 4. The average between 36 and 16 equals 26 and the square root of 26 is but little more than 5, from which it can readily be seen that the error becomes quite small if the violence of the fluctuations of flow can be decreased or damped. Several means can be employed for accomplishing this result.

In the testing or in the regular supervision of the air delivery of reciprocating compressors it is quite possible to install a large tank between the compressor and the delivery line. This tank may well act as an aftercooler for removing the moisture from the air. If this

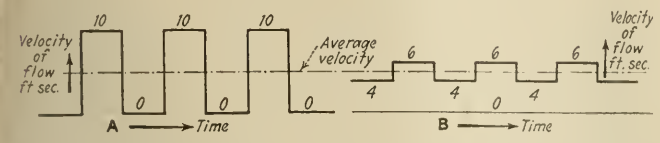


FIG. 1. FLOW CURVES WITH VELOCITY FLUCTUATING PERIODICALLY: *A*, OVER A WIDE RANGE; *B*, OVER A NARROW RANGE

tank be about three or four times the volume of the high-pressure cylinder, the flow fluctuations are greatly reduced, and if in addition a throttling flange be applied at the end of the tank—i.e., at the place where the tank joins the delivery pipe—then the flow in the delivery pipe will be made quite even and a nozzle or a similar instrument can be used with great accuracy. The larger the tank and the smaller the throttling flange the more uniform is the flow. The flange need not be so small as to produce any noticeable pressure drop.

The same method can also be used in the application of steam meters to measure the flow of steam for reciprocating engines. Every engine should be equipped with a large receiver separator, and can in addition be equipped with a throttle flange at the place where the steam main joins the receiver separator. The flow is made even enough to apply a steam meter and to accept its readings without any correction.

It has also been suggested that the flow in lines carrying variable velocity fluids can be made even for a distance by placing a fan in the line at either side of the nozzle or of the measuring instrument, the theory being that the fans have inertia and resist pulsating flow, thereby reducing the violence of the pulsations.

In the testing of air compressors and blowing engines, or of Roots blowers, the following methods for the ap-

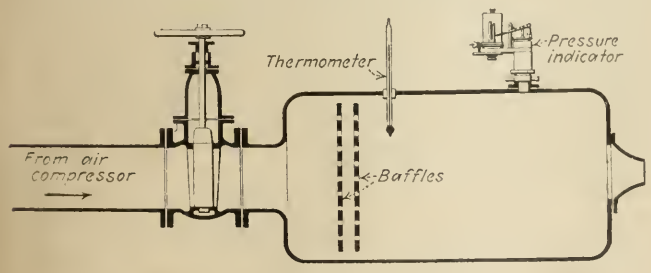


FIG. 2. USE OF NOZZLE IN DISCHARGE LINE OF COMPRESSOR

plication of nozzles have been found quite successful. As shown in Fig. 2, a valve may be placed in the discharge line from the air compressor or blowing engine, and a tank with the nozzle may be placed at the end of the line. The valve serves the purpose of varying the pressure against which the compressor discharges, and at the same time reduces the fluctuations of flow in the tank. The fluctuations proper can be measured by indicator which is mounted on the tank, and the drum of the gage is pulled as evenly as possible by hand. The indicator gives at once the average pressure in the tank and the fluctuations of pressure. The diameter of the nozzle and the pressure of the air in the tank, together with its temperature, immediately give the quantity of air flowing. Any corrections for variations in velocity can be made as indicated in Fig. 1. The baffles are necessary for eliminating the effects of velocity of approach upon the nozzle and should consist of perforated plates or strong wire mesh.

For the ordinary run of shop compressors, it is usually preferable to test the compressor while it is in operation. This can be done by using nozzles on the inlet side, provided, of course, that the piston rod packings are tight. In this case it is quite easy to obtain uniform flow by attaching to the compressor inlet a sheet-iron box which carries the nozzle or nozzles, and which in addition is equipped with a rubber diaphragm as shown

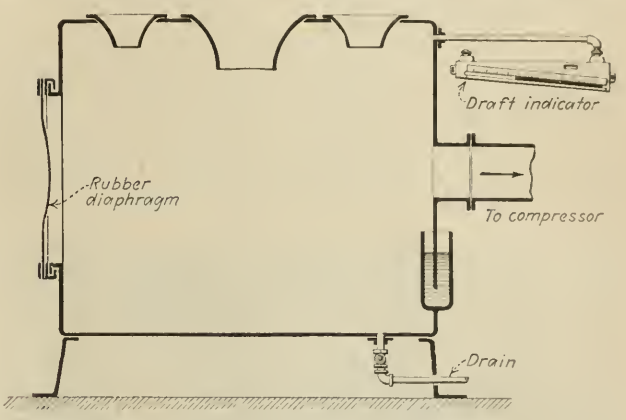


FIG. 3. USE OF NOZZLE ON INLET SIDE OF COMPRESSOR

in Fig. 3. The volume of the box acts as an equalizer and the rubber diaphragm which flops in and out helps materially to maintain an almost constant flow through the nozzles. A box of this sort is a very valuable adjunct to mechanical laboratories and especially in shops where air compressors are built or used, because it allows testing of the actual air compressor delivery with very little trouble. To this end, it is advisable to have several nozzles in the box and to plug up those which are not in use. It is very desirable to have a safety valve on the box to protect the rubber diaphragm from injury in case someone should close more nozzles than is good for the rubber.

Such a safety valve is indicated on the right hand side of the box in the shape of a U-tube full of water. The section of the U-tube must be large enough to prevent the formation of such a vacuum in the box as might break the rubber diaphragm. The pressure drop of the nozzles can be kept quite small, and can be measured by means of an inclined gage such as a draft gage. The pressure drop through the nozzles amounts to much less than the variations in barometric pressure and no fear need exist that the measuring box will in any way interfere with the air delivery of the compressor.

Nozzles have not been used for testing to the extent which they deserve, probably for the reason that it is troublesome and expensive, first, to lay out nozzles, and then to machine them. These obstacles, however, were removed some time ago by the Bacharach Industrial Instrument Co., of Pittsburgh, which has standard nozzles

for almost all purposes of testing. It may therefore be hoped that nozzles will be used more in the future for the testing of reciprocating machinery. It may also be stated that the discharge from positive blowers, such as the Roots or Connersville blowers, is likewise pulsating and needs some means to reduce the fluctuations.

Occasionally, it is practically impossible to damp the vibrations on account of the size of the equipment—for instance at the air inlet of blast furnace blowing engines. In that case the flow velocity curve can be determined occasionally by placing in the nozzle a very light flapper and by recording its motion on an indicator. In the use of such an instrument it is frequently found that, during very short intervals, the air actually blows back.

Welding Curved Pipe Coils of a Glucose Tank

As the result of an unforeseen circumstance a thermit pipe-welding job of unusual nature was recently performed on a helical 2½-in. standard pipe coil for the American Chicle Co., Long Island City, N. Y.

The coil in question was to be used to convey steam under pressure for heating a glucose tank and was first constructed in one piece measuring about 17 ft. in outside diameter and 14 in. from pipe center to pipe center of adjacent pipe turns. Because of the large size of the coil, however, it was impossible to transport the coil to the place where it was to be installed, so it

THERMIT WELDED CURVED PIPE COIL

was necessary to cut the coil with an oxyacetylene torch into two semi-circular segments by making nine cuts and later thermit welding these cuts together.

As the cutting torch had left ragged edges, the pipe ends first had to be backsawed. The surfaces to be welded were next faced smooth with a pipe-facing machine and the usual pipe-welding operations then followed. Immediately after each weld was made the section having one end just welded and the other end about to be welded was bent around to a shorter radius and into a proper position for the next weld, the red hot temperature of the weld just made enabling this bending to be made.

The results of the welding were entirely satisfactory in every way, continuous joints being obtained with no trace of leakage whatsoever during a preliminary test of the welded coils under 40-lb. steam pressure and later in service under a 5-lb. pressure intermittently for about 2 months up to the time of writing.

The work was undertaken for the American Chicle Co. by the Carrier Engineering Corp., Newark, N. J.

Synopsis of Recent Chemical & Metallurgical Literature

The Formation of Pearlite in Steel.—In a paper on this subject read before the Cleveland (England) Institution of Engineers, and abstracted in *Iron and Coal Trade Review*, Dec. 9, 1921, J. H. Whiteley showed that pearlite can grow directly from a solid solution of carbide of iron in gamma iron without the formation of any intermediate stages, and that the so-called transition stages, troostite and sorbite, should be regarded as alternative or side products of the transition. He gave evidences of "lag," showing that a certain degree of supersaturation is required before pearlite will form, and that growth never starts within the area, but at the boundary, apparently through inoculation by the adjacent ferrite or cementite, as the case may be. The average coarseness of the pearlite was not found to depend either upon the lenght of heating or maximum temperature, but simply upon the rate of cooling through Ar_1. This was explained as due to the greater opportunity allowed, in slow cooling, for solution and diffusion of the carbide to occur whereby the spacings are widened. The maximum width of ferrite laminæ yet seen is slowly cooled hypo-eutectoid steel is $\frac{1}{22,000}$ in. With a given rate of cooling, the presence of manganese and silicon in steel increases the fineness of the pearlite, and pearlite formed in the presence of free cementite is much coarser than that formed either in eutectoid or hypo-eutectoid steels. Apparently this effect is due to the manner of inoculation.

Standard and Tentative Methods of Sampling and Testing Highway Materials.*—This publication gives in full the methods recommended by the second conference of state highway testing engineers and chemists as adopted at their meeting in Washington early in 1920. Many of the methods are those of the A.S.T.M. Most of the others are those which have previously been recommended by the bulletins of the U. S. Department of Agriculture Bureau of Public Roads. The bulletin includes more than fifty methods of testing or analysis for both non-bituminous and bituminous road materials, including stone, sand, cement, brick, bituminous products, etc. Full recommendations are included of standard methods for sampling each of the important materials.

Production of Iron by Direct Electrothermic Reduction of the Ore. (Levoz Process).—Marcel Guedras in *Technique moderne*, vol. 13, p. 264, (1921) describes the Levoz process. Essentially it consists in the formation of ferro-alloys in a reaction mass, which later purify iron oxide. The process comprises three distinct stages as follows:

First, oxides of iron, manganese and other easily reducible metals are reduced by carbon. No details of the furnaces are given, but they are so designed that the aluminum silicates of the ore react with the iron oxides, in the presence of C, to give ferrosilicon and alumina, which later dissolves in the cryolite flux which is added to the charge.

Second, the Al_2O_3 dissolved in the flux prevents the volatilization of any reduced aluminum metal and also the oxidation of the iron in the crucible. The iron absorbs the aluminum reduced by the carbon in the bath, forming ferro-aluminum and eliminating at the same time any iron carbide which has formed. With the ferrosilicon formed in the first stage the Al forms an Fe:Si:Al alloy, which is a powerful reducer and which gives rise to strongly exothermic reactions. At the end of the second stage the mass consists of a layer of slag over this complex ferro-alloy dissolved in iron and manganese.

Third, the molten mass flows into an electric furnace containing a charge of the ore to be reduced. The strongly reducing, complex ferro-alloy reacts with the oxides in the

*Bulletin 949, Department of Agriculture.

ore with great evolution of heat, so that the greater part of the heat absorbed in the two stages above is recovered and the current consumption in the third stage is very small. The slag, consisting of double silicates and of cryolite, has a very low melting point and is easily separated from the metal. The silicon, manganese, aluminum and calcium in the complex alloy first produced carry the metallic oxides and sulphides completely from the ore into the slag with formation of very fluid silicates. There remains a pure iron which may be either drawn off as such or converted into steel. The cryolite reacts with the lime of the charge to form CaF_2 and $Al_2O_6Na_6$; but this does not interfere with the main reactions.

The first step of the process is carried out in a reduction furnace with an inclined hearth, emptying into a crucible for the second stage and an electric furnace for the third, the molten metal flowing from one to the next by gravity.

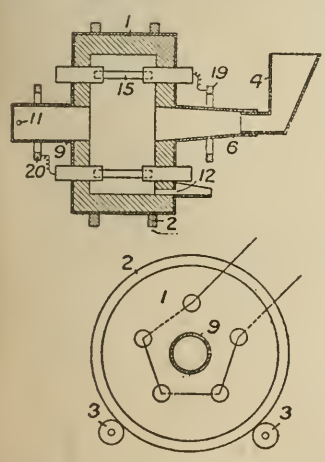
Advantages of the process are said to be: Any kind of ore can be treated. The cost of the plant is much less than that of a blast furnace, and the product obtained is pure iron or steel. There is an important saving in fuel. Reducing gases having a high caloric value are utilized. By suitable combination of furnaces, any grade of iron or steel can be obtained. The consumption of electric energy is reduced to a minumum owing to the strongly exothermic reactions of the aluminum alloys in the third stage. Finally, cost of labor is low.

Recent Chemical & Metallurgical Patents

British Patents

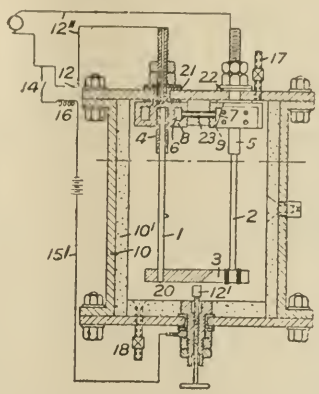
For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Electric Furnace for Continuous Conversion of Zinc Dust Into Molten Zinc. An electric furnace for the continuous conversion of zinc dust into molten zinc comprises a cylindrical casing 1 surrounded by rings 2 which run on rotating rollers 3 whereby the furnace is given a rotary motion. A coned inlet tube 6 is fitted axially in one end of the furnace and zinc dust is fed into this tube from a hopper 4. A tube 9 is similarly fitted axially at the other end of the furnace and is provided with a number of adjustable openings 11 through which the residue escapes and by which the working of the furnace may be controlled. The molten zinc may be tapped off through an opening 12 in the furnace casing. The resistance members 15 are arranged concentrically round the axis of the furnace and are coupled up, as shown, and fed with current from contact rings 19, 20. (Br. Pat. 168,018. C. E. Cornelius, Stockholm. Oct. 12, 1921.)



Purifying Gases. A process for the removal of sulphur compounds from coal or like gas consists in washing the gas with both a volatile oil such as benzene and a stripping oil such as creosote of which not less than 500 gal. are used per million cubic feet of gas. These oils may be mixed or used separately. Paraffin oil may be used instead of creosote, particularly if finely divided alumina or charcoal be suspended in it, and the stripping oil free from benzene may be introduced into the washer and benzene vapor added to the gas entering the washer. Thiophene may be removed by treatment with sulphuric acid and the benzene and creosote used again in a cyclic process. (Br. Pat. 168,482. South Metropolitan Gas Co., E. V. Evans, H. Hollings and H. Stainer, London. Oct. 26, 1921.)

Refining Tungsten.—A process for the manufacture of ductile rods from high-fusing metals such as tungsten, molybdenum, etc., or alloys of the same consists in heating rods made of the said substances hung vertically in a vessel containing neutral or reducing gas at high pressure by the passage of an electric current or by an electric furnace, bringing them to a nearly molten state and then using the elongation of the rods to stop automatically the heating current supplied to the rods or furnace. Two rods of tungsten 1 and 2 are placed vertically in a vessel 10 lined with refractory material 10′ having openings 17 and 18 provided with cocks for the inlet and outlet of the inert gas, the lower ends 20 of the rods 1, 2 being connected by a horizontal tungsten rod 3. The upper ends of the rods fit into two electrodes 4, 5 which are fixed to two other electrodes 8, 9 having water jackets 6, 7 joined by a pipe 23 of insulating material, these electrodes 8, 9 being insulated from one another and the vessel 10 by insulating-pieces 21, 22. The heating current is supplied to these electrodes 8, 9 through lines 12″ of low resistance upon closing a switch 12, and the elongation of the rods 1 and 2 causes contact between the rod 3 and an adjustable insulated electrode 12′ which allows the current to pass through a local circuit comprising a low-resistance line 15″, a switch 14 normally closed, and a trip coil 16 which then opens the main switch 12. When the rods are heated by an electric furnace, the elongation of the rods make contact as before to close a local circuit which may operate means to cut off the main heating current. If the material of the rods contains impurities, the rods may be heated initially under a reduced pressure to eliminate the impurities by vaporization and later the high pressure applied. (Br. Pat. 168,697. E. Aoyagi, Kyoto, Japan. Oct. 26, 1921.)



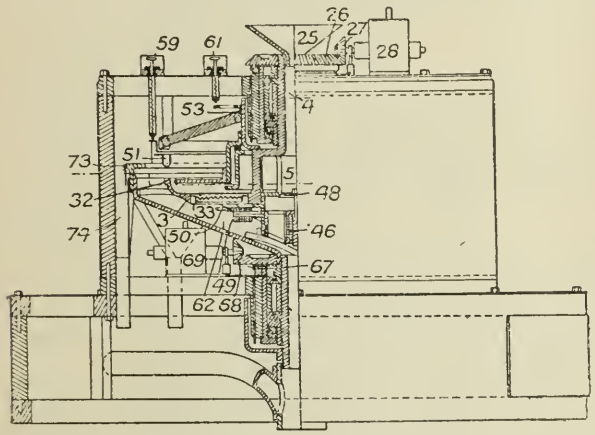
Froth-Flotation Process for the Concentration of Oxidized Ores. In a froth-flotation process for the concentration of oxidized ores such as cassiterite, or oxidized ores of tungsten, lead, zinc, or copper, carbon dioxide or a gas containing it is introduced into the pulp as a gangue-modifying agent. A mineral-frothing agent may be used consisting of or containing a fatty acid or a fatty-acid compound such as soap. The carbon dioxide or gas containing it may constitute both the gangue-modifying agent and the flotation agent. (Br. Pat. 168,098. L. A. Wood and Minerals Separation, Ltd., London, Oct. 12, 1921.)

Glycerine.—In a process for treating waste liquors of alcoholic fermentation for the extraction of glycerine, the liquors are neutralized with lime or chalk, filtered and boiled with ferric chloride, preferably under pressure, until the liquor no longer reacts with Fehling's solution. The iron is precipitated by lime, and then the lime by carbonic acid or sodium carbonate. The resulting liquor is filtered, concentrated and distilled. In a modification, ferric sulphate is used instead of ferric chloride, the iron being then precipitated by baryta instead of lime. (Br. Pat. 168,833 Barbet et Fils et Cie., Paris. Nov. 2, 1921.)

Purifying Tannins.—Tannins, preferably those extracted from the raw materials with the aid of acids, are purified by conversion, by the action of bases or basic compounds, into insoluble or difficultly soluble salts which are freed from impurities by washing with water or organic solvents and then decomposed by acids or in some cases by salts; the tannin solution is finally evaporated. As basic compounds may be used magnesium oxide, hydroxide or carbonate, or the corresponding barium, strontium or calcium compounds and two or more bases may be used successively or conjointly. For the decomposition of the tannin compounds, acids or salts which will give insoluble compounds

with the base or bases employed are preferably used. The crude tannins may be previously treated with reducing agents, such as sulphurous acid, hydrosulphurous acid or "other acids of sulphur," but preferably with volatile reducing acids. (Br. Pat. 169,722; not yet accepted. Byk-Guldenwerke Chemische Fabrik Akt. Ges., Berlin. Nov. 16, 1921.)

Electrostatic Separators. In the electrostatic separation of finely divided material such as metal-bearing ores, the material is dried by heating elements while being spread centrifugally in a rotating pan, from which it is discharged into an electrostatic field wherein the susceptible particles are sustained against gravity so as to become separated from the less susceptible particles, which fall to a different



point of discharge. Apparatus for effecting such a separation comprises a pan 3 the rim 32 of which forms one electrode, a second annular electrode 51 being situated above the rim of the pan and the whole being rotated along with the hollow shaft 4 by a motor 28 through gearing 26, 27. The material to be separated passes down the hollow shaft 4 from the hopper 25 into the pan 3 through a chamber 5 and is dried by heating elements 33 in the bottom of the pan. The particles are cast centrifugally against the rim electrode 32 and the susceptible particles are carried upwards in their centrifugal travel through the electrostatic field over the edge of a dividing-ring 73 and into hoppers 74. The less susceptible particles falling on the inside of the ring 73 into the hopper 62, which may be given an opposite rotation through gearing 67, 68, pass down the shaft 4 to waste or, if a further separation is desired, to the next pan of a series. In the hopper 69, a transformer 49 may be provided to supply a spark at gaps 50 for preventing the dispersion of dust, and a bypass valve 48 operated by a solenoid 46 may be provided in the shaft for cutting-out steps in the separation where a series of separators are used. Low-tension current is conducted to the heating elements 33, transformer 49 and solenoid 46 through a brush 61 and ring 53, and the high-tension supply to the annular electrode 51 is through a brush 59. (Br. Pat. 168,479. G. R. Brown, Bondi, near Sydney, New South Wales. Oct. 19, 1921.)

Hardening Oils.—Unsaturated oils are catalytically hydrogenated by treatment with a material which is capable both of giving off hydrogen and of acting as a catalyst. This material is prepared by melting together certain metals, such as iron, manganese, ferromanganese, copper, tin, zinc, lead, aluminum, antimony, nickel, cobalt and bismuth, to form an alloy which is stated to evolve hydrogen when added to the oil alone or to oil containing water. The particular alloy mentioned as an example is composed of ferromanganese, aluminum, antimony, nickel and lead in stated proportions. (Br. Pat. 169,147; not yet accepted. W. P. Heskett, Waiotahi Creek, Thames, New Zealand. Nov. 2, 1921.)

Synthetic Resins.—Phenol or its homologs when condensed with acetaldehyde or its polymers produces a resin which is soluble and does not harden on heating. Formaldehyde or its polymers may be added at any stage of the process to render the product less soluble or insoluble or to make it harden. Acids, bases and salts may be used as accelerators, the following being mentioned as suitable: sulphuric acid ammonia, caustic alkali, oxalic acid and phenyl hydrazine hydrochloride. (Br. Pat. 169,347. H. V. Potter and W. F. Fleet, Birmingham, and Dainard Lacquer Co., Ltd., Westminster. Nov. 9, 1921.)

Treating Hides and Skins.—Comprises a process for depilating hides and skins in which extrinsic bacteriological or saprophytic enzymes are inactivated while the action of thrombase (thrombin) which is stated to be found in the skins, especially at the roots of the hairs, is encouraged or activated. The extrinsic enzyme system, to which the term "saproprotease" is applied, is inactivated by the use of end products of proteoclastic enzyme action such as ammonia or compounds producing ammonia, amino acids, skatol and indol. The intrinsic enzyme, thrombase, is activated by the addition of easily dissociated calcium salts or compounds such as the lactate or polysulphides thereof. The activator and inactivator are mixed together in the form of a solution, the inactivator preferably comprising a 1 per cent solution of ammonium hydrate. The action of the intrinsic enzyme may be assisted by the addition of trypsin or other proteolytic enzymes which will work in an alkaline medium. The depilation is stated to be effected without destroying the epidermis, so that comparatively large sections thereof with the hair attached can be removed. Subsequent bating is unnecessary. In preparing dressing leathers, the solutions are heated, while for sole leathers cold liquids are employed, these allowing imhibition or plumping to take place to a greater extent. The process may be employed in the treatment of diseases, but no claim is made for this application of the invention. The provisional specification describes also the use, to assist the depilatory action, of pepsase and in certain circumstances of the saprophytic extrinsic enzyme which is therein termed "saprophase." (Br. Pat. 169,730. H. C. Ross and Walker & Sons, Ltd., Bolton. Nov. 23, 1921.)

Methylamine.—Gases or vapors are minutely subdivided in passing through a series of porous diaphragms and layers of liquid thereon in order to effect their maximum contact with liquids. The process may be applied to the treatment of gases from petroleum stills, coke ovens and gas producers, with liquids which may contain substances in suspension. The gases and vapors from the still 1 pass through the compressor 3 to the bottom of one of a series of diffusers shown in section in Fig. 2, comprising

FIG.2.

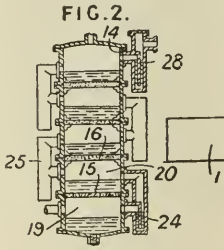
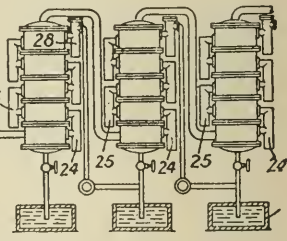


FIG.1.



a shell 14 containing gas-porous diaphragms 15, 16 . . . which form compartments 19, 20 . . . connected in series by ducts 24, 25 . . . having liquid seals. The gases penetrate upward through the successive diaphragms and the liquid borne thereon, which enters at the inlet 28 and to the extent limited by the height of the duct inlets flows in counter current. The gases are led to the bottom of the next diffuser, from which liquid may be pumped to the previous one, or the liquid may be discharged from each diffuser into separate tanks. (Br. Pat. 169,605. Canadian American Finance & Trading Co., Ltd., Victoria, B. C., Canada. Nov. 16, 1921.)

Wood and Like Cellulose Pulp and Fibers.—In the preparation of light-colored strong fibrous material for the paper trade from wood or other substance containing cellulose, in logs or billets, the material is saturated, softened or boiled with water in vacuum or under mechanically produced water, air or steam pressure. Either a high temperature

of 105 to 120 deg. C., or a low temperature of about 80 deg. C. and a high pressure of from 5 to 10 atmospheres or a low pressure of about 350 mm. of mercury may be employed. Neutral, acid or alkali reagents may be added to the water. A flowing movement of the liquid used is maintained in the direction parallel to the direction of the fibers of the wood. When treating under vacuum, an air pump is used during the whole operation, lasting 6 to 8 hours, the drop in temperature being made up by indirect heating. (Br. Pat. 169,802. L. Enge, Niederschreiberau, Silesia, Nov. 23, 1921.)

Book Reviews

THE MANHOOD OF HUMANITY. THE SCIENCE AND ART OF HUMAN ENGINEERING. By *Alfred Korzybski*. Pp. 264. New York: E. P. Dutton & Co. Price $3.

Here is a book which we believe would have delighted the heart of the late William James. It is easy to read, and no one need fear that he will go to sleep over it. It isn't dull, or involved, or even subtle. If a reader tries to be subtle in reading he will miss its bigness.

Early in the work the question is asked, What is man? The answer given is full of illumination. We know life, the author says, in three phases, as plant, as animal, and as man. The plant is a chemical phenomenon. The animal is also a chemical phenomenon, but it has another dimension. It controls, or "binds," as Count Korzybski says, space. The author means space on or about the earth, space of three linear dimensions; the space in the fields, in the woods, among houses and along the road; space without any cosmic complexities. The animal goes or walks or flies whither it will, which the plant does not do. If your metaphysical conscience urges you to protest against the postulate of will in animals, then substitute desire or any other word that will indicate the quality that we know does exist. The plant is a chemical phenomenon. The animal is a chemical phenomenon, but it also binds space. Man has both these attributes; he is a chemical phenomenon, he binds space, but to him is added a third dimension which makes him a different being from animals. He has control over and "binds," as the author says, time. Man binds time. No plant or animal does this. By time we mean that which is ticked off by the clock, and is measured by seconds and minutes and hours and years and centuries. Please do not try to get off the earth in regard to time or space, even in imagination, when you read this book.

The difference between an animal and man as timebinder is immense. The beaver, for instance, builds his dam according to his instinct and in the same way that beaver dams have been built for hundreds of thousands of years. Each generation builds for itself, and does not learn from the past. When man builds a house he uses not only his instinct for protection against the weather; he avails himself also of the experience, the work and the inventions of the dead, adding to this his own inventions, and thus makes a house different from that of former generations. He has the capacity to improve on earlier houses. Plumbing, elevators, electric annunciators and the like are incidents of invention added originally by living men to the inventions of men who were dead.

Let us cite a couple of examples in which the time-binding faculties of man have been actively employed, and observe what progress follows. In the past 125 years great advances have been made in the mechanic arts. They have been no less than amazing. The reason for this is that through patent records and by the increased means of communication which inventions have brought about man has been informed of the experiences of previous generations, has learned the particulars of the work of the dead, and has added his own inventions to these. A similar curve of progress has taken place in the natural sciences during the past 60 or 75 years. Discovery leads to discovery. In no other walk of life is there so complete a historical perspective available as in the natural sciences and in the mechanic arts. This progress has been due to the fact that when he so wills, man—and man alone—can make of the past, the present and the future one continuous *now*.

Consider the progress in other respects and we find no such curves. The reason is that we have tried to organize continuance by tradition without the aid of experience on the one hand, or we have become so offended by tradition that we have vainly tried to organize methods of human behavior out of our own puny, ignorant, narrow, unenlightened imagination. We have blundered about as we do, for instance, in matters of government, like little children with no one to guide them.

Let's say that man as a time-binding creature is old as we count a lifetime, but young on earth. He has grown some, but how much has he grown as an intelligent being, say since the days of Babylon? The sandy desert which is Babylon today is scarcely an improvement over the city of hanging gardens that was. We get ahead in one respect and go back in another. The lusty artisan of Renaissance days, singing as he worked, making things of a quality of beauty that we cannot reach, surely had a more abundant life than the factory hand of today, whether he could read and write or not. He had the joy of artistic creation, which is a delectable state, unknown to most of us.

We have, by means of engineering, been diligent in conserving materials to the best uses, and in avoiding wastes of them, but we have been neglectful in conserving humanity. We look after man's health somewhat as we look after the health of animals, but we have not looked after man as a time-binder. And he is that. Not one of us can loosen himself from this line of time. We can't get rid of our participation in it. Then let's follow the author again and note again what we can do in this respect.

Time proceeds in arithmetical progression as it is ticked off by the clock, or is measured by the years. Man as a time-binder can progress according to a different ratio. The first of a series of generations, for instance, has its experiences, meets its difficulties and solves its problems by invention. The second has the advantage of the experience and work of the first, and to it adds its own experience. The third adds to this, and so on, so that the line of progress of time-binding man may be geometric rather than arithmetical. The lofty heights of understanding, of intelligence, of welfare in the arts of living, to which humanity may attain, are stupendous. It is a problem, as Mr. Korzybski puts it, of engineering. He has worked out a mathematical formula which is the first step in showing the available rate of progress, and this is a practical rule. As soon as we begin to compute human progress by means of mathematics we shall begin to know our shortcomings. We need to integrate our work in relation to the general welfare. The book is full of hints in this direction.

Here's another point of attack. No man ever "makes" a fortune. He collects it. Thousands and thousands of dead have contributed to it. The wealth of the world is in the main a great treasury left by the dead. Our business is to carry it on. Anyone who destroys such results by misuse of it is not living the life of a human being; he is living the life of a ghoul. He is preying upon the dead, and neither legalistic title nor documentary ownership alters the fact. Everyone is a time-binder. Everyone is passing on the work of the past to the future. What are we doing with it?

We have claimed that man is a highly developed animal. He has many of the organs and the space-binding qualities of an animal, but he is not any more an animal than a cube is a plane because it has planes as parts of its structure. Then we have said that man is part animal and part something supernatural. That means that he is part something that we can understand and part something that we cannot understand. It is dodging the question and does not lead to progress. It is a lazy thought and irreverent to whatever Greater Intelligence there may be beyond our senses. Our business in life is living, and we should make the best of it. ELLWOOD HENDRICK.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Proposed Merger of Fertilizer Companies Expected to Materialize Next Spring

Consolidation plans are under way among about thirty-five independent companies manufacturing commercial fertilizers for a merger of interests. A meeting will be held early in January, it is stated, to perfect details of the proposal, and it is expected that definite plans will be developed to bring about the change in the spring. The move is being made on the basis of business economy, with idea of concentrating operations at certain plants, operating under full capacity, and shutting down other works until conditions in the industry warrant resumption. Among the companies interested in the movement are the Davison Chemical Co., Piedmont-Mt. Airy Guano Co. and G. Ober & Sons Co., all of which operate plants in the Baltimore, Md., district.

Registration of Professional Engineers in West Virginia

Pursuant to Chapter 106, acts of the Legislature of 1921, it will be unlawful to use the title of "Registered Professional Engineer" in West Virginia unless actually registered with the State Board of Registration for Engineers, Charleston, W. Va. The official roster will include civil, structural, mechanical, electrical, mining, metallurgical and chemical engineers.

Registration is not compulsory except for those desiring to use the title. The initial fee is $20 and the yearly renewal fee $10. Application blanks may be obtained from George E. Taylor, Secretary, 504 Coyle & Richardson Building, Charleston, W. Va.

Fertilizer Manufacturers Want Pyrites and Crude Oil Kept on Free List

Formal requests have been made of the Senate Finance Committee by the National Fertilizer Association that pyrites and crude oil be left on the free list. The committee's attention has been called particularly to the conclusion of the United States Tariff Commission that the serious competition which domestic pyrites producers face comes from American sulphur rather than from imported pyrites.

In this connection it is pointed out to the committee that prior to the war approximately a million tons of foreign pyrites was imported annually for use in sulphuric acid manufacture. During the war foreign pyrites was supplanted largely by domestic sulphur as the raw material for sulphuric acid. As a result of the war there has been a large increase in sulphur production. The price of sulphur has declined to the point where foreign pyrites no longer can compete with it, it was argued, except at points highly favored in the matter of transportation, such as Atlantic ports. It is claimed that even under the stimulus of war prices the production of domestic pyrites remains small. A tariff on pyrites would have the effect of prohibiting further importations, but it is contended that sulphur and not domestic pyrites would be substituted unless sulphur producers, because of the tariff, greatly advanced their prices. With sulphur at its present price, it is pointed out, the consumption of foreign pyrites has fallen to less than a quarter of the pre-war tonnage.

The point is also made that a tariff on pyrites would be a standing invitation and a constant temptation to the sulphur producers to add the amount of the duty to the price of their products. That the domestic sulphur industry needs no protection is apparent, it is pointed out, by the fact that it has displaced the Sicilian product in the important Scandinavian markets and is being sold extensively in England, France, Germany and Africa.

With regard to fuel oil, C. H. MacDowell, president of the National Fertilizer Association, in a statement submitted to the committee, among other things says:

> The National Fertilizer Association regards with apprehension the announced purpose of representatives of certain oil-producing companies to urge a tariff duty on imports of crude oil. We had believed that question was settled definitely some months ago when the House of Representatives, in response to the overwhelming sentiment of the country, as affirmed in a letter from the President, rejected the recommendation of the Ways and Means Committee for a duty and voted to retain oil on the free list. To learn now that efforts for a duty will be renewed and to hear that such efforts are receiving some support in the Finance Committee is very disquieting.
>
> The fertilizer industry, struggling out of a period of unparalleled depression, is in no position to bear the burden of a tariff on oil. The losses of the past season, due to a decline of about 50 per cent in the use of fertilizer, were not confined to fertilizer manufacturers. There followed reduced yields of field crops, causing tremendous losses to farmers and business generally. C. R. Capps, vice-president of the Seaboard Air Line Railway, testifield at the hearing before the Interstate Commerce Commission Dec. 16 that the loss of fertilizer tonnage to the railroads of the South this year amounted to more than 2,000,000 tons. To that primary loss must be added the potential crop tonnage which such a quantity of fertilizer develops.

Many of the large fertilizer plants on the Atlantic seaboard use Mexican crude for fuel. In addition practically all the power used in the mining of phosphate rock is produced from plants using Mexican crude oil for fuel. It is contended that a tariff on crude oil would increase greatly the cost of fertilizer without bringing any corresponding benefits to domestic oil producers.

Shipment of Steel by Barges on Inland Waterways System

Considerable interest is being taken by communities along the Ohio and Mississippi rivers in the possibility of using the inland waterways system of the country for handling steel trade in quantities. This has been greatly quickened by the success of the Jones & Laughlin Steel Co., of Pittsburgh, which has already sent two large fleets of barges carrying approximately 400 carloads of steel products south on the Ohio and Mississippi from its works in the Pittsburgh district, and is preparing to continue the service as a regular factor in its distribution system.

The first tow, carrying about 100 freight carloads, left the Pittsburgh harbor the last week in October, and distributed its cargo to Huntington, Louisville, Evansville and St. Louis. The second tow, three times as large as the first, carrying 300 freight carloads of steel products, started down the river the first of December, proceeding as far as Memphis, unloading parts of its cargo at several intermediate points.

Not only is the steel company planning an increase in use of the inland waterways system, but has advised some of its customers in Memphis and other points that it is looking into the possibility of the use of seagoing steel barges for delivery of steel products to such points and, in time, to the ports on the Pacific Coast by way of the Panama Canal.

F. E. Hackett, general manager of sales of the Jones & Laughlin Co., is responsible for the inauguration of this new service.

More Plants in Many Lines of Industry Increasing Operations

Paper—The French Paper Co., Niles, Mich., is operating its local mills at full capacity. A number of improvements are being made at the plant.

The American Writing Paper Co., Manchester, Conn., has resumed production at its local Oakland mill, following a shutdown for about a year past. All former operatives have been engaged and full-time production schedule has been adopted.

The Consolidated Paper Co., Milwaukee, Wis., has resumed full-time operations at its Wisconsin Rapids and Biron mills. The plants have been running on part time for some months past.

Ceramics — The H. E. Buck Manufacturing Co., Lake Charles, La., will take possession of its local plant, effective Jan. 1, heretofore operated under lease by other interests. It is proposed to resume full operations at once for the manufacture of building brick.

Potteries devoted to the manufacture of dinnerware in the eastern Ohio district are now operating in excess of 80 per cent capacity. Production is greater than at any time during the past year. Electrical porcelain potteries are producing under a full-time schedule at capacity output.

Glass — The Sneath Glass Co., Hartford City, Ind., is maintaining active production at its plant, and has distributed a bonus of $10,000 among its employees.

Oil—The Standard Oil Co. has resumed operations at its Bayway refinery, Elizabeth, N. J., after a curtailment for about 8 months past. Employment will be given to about 500 operatives. Effective Jan. 1, the 4,000 employees at the Bayonne refinery went on full time, as compared with 5 and 5½ days previously.

Rubber—The General Tire & Rubber Co. is increasing production at its plant at Akron, Ohio. Plans are being considered for doubling the present capacity during 1922.

Effective Jan. 1, the Mason Tire & Rubber Co., Kent, Ohio, has increased production from 2,300 casings a day to 4,500 casings. The plant is working on three shifts and giving employment to about 1,000 persons. This number will be increased by approximately 700 additional operatives at an early date.

Copper—The Utah Copper Co., Bingham, near Salt Lake City, Utah, is planning for the resumption of operations at its plant at an early date, probably in February, giving employment to more than 2,500 men.

Metals—The silver and lead producers in Utah and Idaho are increasing operations. During the last week in December three additional silver-lead furnaces were blown in, and others will start up at an early date.

Iron and Steel—The Lackawanna Steel Co., Buffalo, N. Y., is maintaining a production about 50 per cent of normal, and is said to be planning for an early increase.

The Bethlehem Steel Co. has continued the operation of its coke ovens and blast furnaces at the Steelton, Pa., works throughout the holiday period. Departments closed down during this time to permit repairs and improvements to machinery will resume production at once.

The Colorado Fuel & Iron Co. has arranged for the immediate resumption of operations at its steel mills at Pueblo, Col., on a 50 per cent basis, giving employment to about 2,000 men. The company recently reopened its iron mines on a 40 per cent production schedule.

The Carnegie Steel Co. is operating two blast furnaces at its Mingo Junction plant, near Steubenville, Ohio, with blooming, bar and other mills recently placed in service. A large number of men are being employed who have been idle for many months past.

Magnesia—The Keasbey & Mattison Co., Ambler, Pa., is arranging for the early resumption of operations at its local plant, closed for some time past. Initial production will be on a 5-day, full-time, day-and-night-shift basis.

Kelp Plant May Be Sold

The Bureau of Soils has informed the appropriations committees that negotiations are pending for the sale of its kelp plant at Summerland, Ca. While the sale has not been consummated, the opinion is expressed that the plant will be disposed of during the current fiscal year.

Vulcanization of Rubber Discussed at Meeting of Delaware Section, A.C.S.

Dr. H. L. Fisher, chemical director of the B. F. Goodrich Co., addressed the Delaware Section of the American Chemical Society on Wednesday evening, Dec. 21. His subject was "Rubber Chemistry, Particularly Vulcanization and Its Acceleration," and the lecture was illustrated with slides and experiments. The sources of crude rubber were described and statistics as to the production and consumption of rubber were presented, showing that, of the world's total production, 76 per cent goes into tires and tubes; 67 per cent is imported into the United States and 50 per cent goes to Akron, Ohio.

The work on the structure of the rubber molecule was reviewed briefly and the speaker stated that the consensus at present favors the structure $(—CH_2—C(CH_3)=CH—CH_2—)_x$. It is believed that an indeterminate number of these chains are polymerized to form complex rings, with one double bond for every five carbon atoms.

The process of vulcanization is essentially the addition of sulphur to the rubber molecule, but the mechanics of the reaction are not thoroughly understood. In the hot process, sulphur is mixed with the rubber and heated to a temperature of 135 to 150 deg. C. In the cold process, the rubber is treated with a dilute solution of sulphur monochloride in some organic solvent, such as benzene. In the recent Peachey process, the rubber is treated with a mixture of sulphur dioxide and hydrogen sulphide at the ordinary temperature. In any case the amount of sulphur added is determined by the use to which the product is to be put. It is possible to add as much as 32 per cent of sulphur, corresponding to one atom of sulphur for each double bond in the rubber molecule. Ordinarily not more than 6 to 7 per cent of sulphur is added. The vulcanization process is still controlled by rule-of-thumb methods.

It has been known for many years that the use of such inorganic materials as litharge, magnesia, slaked lime and certain iodides would hasten the reaction between sulphur and rubber. In 1906 A. H. Marks used aniline and thiocarbanilide in vulcanization, and since 1910 many other organic accelerators have been introduced. One reason for this has been the development of synthetic rubber, which is much more difficult to vulcanize than the natural product. Among the many accelerators used may be mentioned pyridine, hexamethylenetetramine, p-nitrosodimethylaniline, dithiocarbamates, zinc xanthate and other basic compounds. Any acidity, even that of phenols, is harmful. The action of these accelerators is not well understood. They apparently act as sulphur carriers, and as such they may be considered as catalysts.

Sugar Refining Studied by Chemistry Students of University of Texas

Students of the senior class of the chemistry department of the University of Texas, Austin, are giving concerted attention to sugar refinery operations as found in regular plant practice. Weekly visits are being made to the plant of the Imperial Sugar Co., Sugarland, Tex., for investigation work, and reports are made after each trip covering the situation as found. Two students make the trip each week and expenses are defrayed by the state; in this way practically the entire class will be enabled to gain the practical experience thus afforded. Special experiments are being made to determine the best methods for saving sugar cane from early fermentation, and to elminate damage from the cane borer. The sugar is analyzed carefully and the various properties are studied by the students, and the industry is considered, as well, from other standpoints. Reports on the findings are made to the state.

Census of Coal-Tar Chemicals Extended to Include Other Organic Chemicals

The United States Tariff Commission has extended its census of coal-tar products to other organic chemicals, including the aliphatic group. The Synthetic Organic Chemical Manufacturers Association was instrumental in convincing the commission that the compilation of production figures of other organic chemicals would be particularly serviceable at this time.

Portland Cement Production Rate Decreases During November

The production of portland cement continued on a large scale during November, approximately 8,921,000 bbl. of finished cement having been manufactured. This quantity represents a decrease of 1,585,000 bbl. as compared with the record production of October, 1921, but is larger than that for any other month of this year up to May and is about 17 per cent greater than the average for November, 1917-1921. The total production for the 11 months ended Nov. 30, or 91,734,000 bbl., was about 99.5 per cent of the record quantity made during the corresponding period of 1920 and was 11 per cent greater than the average for the first 11 months of the years 1917-1921. Favorable operating conditions are indicated by this large production, the decrease having been due mainly to the slowing up of orders during the month.

The statistics shown in the following table, prepared under the direction of Ernest F. Burchard, of the United States Geological Survey, are based mainly on reports from producers of portland cement and in part on estimates. They indicate that even though the output for December should not quite equal that for November, the totals for 1921 would come very close to those for 1920 and thus constitute one of the highest outputs on record.

PORTLAND CEMENT STATISTICS, FIRST 11 MONTHS, 1921

Month	Production Bbl.	Shipments Bbl.	Stocks at End of Month Bbl.
January	4,098,000	2,539,000	10,300,000
February	4,379,000	3,331,000	11,400,000
March	6,763,000	6,221,000	12,000,000
April	8,651,000	7,919,000	12,660,000
May	9,281,000	9,488,000	12,450,000
June	9,296,000	10,577,000	11,150,000
July	9,568,000	10,301,000	10,414,000
August	10,244,000	12,340,000	8,280,000
September	10,027,000	11,329,000	6,953,000
October	10,506,000	12,114,000	5,348,000
November	8,921,000	5,195,000	9,091,000
	91,734,000	91,354,000	.....

Forest Products Laboratory Requires Increased Appropriation

For more than 10 years the Forest Products Laboratory at Madison, Wis., has been studying wood, always with the object of developing its most efficient and economical use. During that period it has amassed a great deal of scientific information of the most practicable application. Considerable credit is conceded the laboratory for its research accomplishments, but in the final analysis the value of its work must be measured by the extent to which the results of its work are made known and effectively applied by the wood-manufacturing industries. It is believed that this phase of the work is not being developed to an extent which its research results and industrial needs justify.

It is well recognized that those in charge have been endeavoring to remedy this situation, as evidenced by the information disseminated currently through trade and technical publications, by direct distribution of technical notes, by instructional courses in box construction and kiln drying, and in the facilities offered for direct co-operation in applying its information to specific manufacturing problems. In order to develop its dissemination work even to this extent, it has been necessary in certain cases to require co-operators to bear the cost of dissemination. This of necessity limits the broad usefulness of the laboratory and tends to restrict its information and services to the relatively few individuals and companies which are conversant with its work and the value of its results.

This is a situation which ought not to exist. It is one easily remedied, and the remedy lies in a specific appropriation by Congress for the dissemination and application of the results commensurate with its research activities and accomplishments.

The application of research is largely a matter of education, and when research is conducted as a governmental activity, adequate facilities must be provided for carrying the results through to their commercial application. This seems so thoroughly established as to forego argument. In its agricultural research and development the Department of Agriculture has solved the problem in a highly satisfactory and profitable way by placing county agents in every state in the Union, whose duties are to advise and educate the farmers in better methods of farming.

There is at Madison a great deal of information which it has never been possible to supply to the industries, because the finances are not available to put this information in usable shape for the business man. There should be an adequate force to prepare all data of practical application in a form which the business man can readily grasp and apply. In addition, men are needed whose whole time may be devoted to field work. The duties of these men should be to carry the information, now available and being made use of by the relatively few, to the men in the sawmill, or in the lumber yard, or in the wood-using plant. Personal contact is an effective means of disseminating practical, scientific information.

As concrete examples of some of the ways by which the dissemination of this knowledge should be developed, the following may be mentioned: expansion of instructional work in kiln drying, box construction, and special co-operative tests under a plan by which the expense is at least shared equally by the government and the co-operator; the assignment of field representatives to disseminate results in such fields as the preservation of mine timbers, the kiln drying of lumber, the proper working values of wood in building codes, the protection of wood pulp and pulpwood from decay in storage; and the demonstration of improved processes on a commercial scale, such as the cooking and bleaching of Southern pine for magazine and book paper, increasing the yield of methanol in destructive distillation, the utilization of sawdust and mill waste for cattle feed, and the de-inking of old magazines and newspapers.

The current annual appropriation for forest products research amounts to $325,000. This is equivalent to less than 25c. for every $1,000 of raw manufactured value for the total annual cut of wood. On the other hand, the Department of Agriculture is spending for agriculaural research and development $1.50 for every $1,000 of value of all agricultural and animal products.

The service above outlined requires a $100,000 increase in the appropriation. The Secretary of Agriculture and the director of the budget have approved $340,000 for the research work of the laboratory for the fiscal year beginning July 1, 1922. These estimates will be presented to Congress. They are contained in the estimates for the Forest Service, U. S. Department of Agriculture, and will be considered first by the sub-committee on agriculture of the House Committee on Appropriations and later by the Senate Committee on Agriculture. Sidney Anderson of Minnesota is chairman of the House sub-committee.

Slight Decrease in Unemployment in New York

The New York Committee on Unemployment Statistics reports that on Dec. 15 there were 331,000 unemployed persons in that city. This is about 13 per cent of number of persons reported by the federal census to have been gainfully employed on Jan. 1, 1920. On Oct. 17 the committee had reported 343,000 persons out of work, or 13.5 per cent of the total with gainful occupation.

The number of persons so employed in New York City on Oct. 17 and Dec. 15, as classified by groups, follows:

Group:	With Gainful Occupation January, 1920 Number	Per Cent	Approximate Unemployment as of Oct. 17, 1921 Number	Per Cent	Dec. 15, 1921 Number	Per Cent
Manufacturing and mechanical industries	951,889	37.6	143,071	15	173,840	18
Clerical occupations and trades	793,966	31.4	72,996	9	39,309	5
Domestic and personal service	306,069	12.1	26,940	9	23,900	8
Transportation	242,447	9.6	63,000	26	58,900	24
Professional service	168,375	6.7	26,940	16	24,774	15
Public service	61,084	2.4	9,163	15	9,163	15
All other occupations	7,919	3	1,029	13	1,029	13
	2,531,747	100	342,860	13.5	330,915	13

The greatest increase in unemployment has occurred in the building trades, which include about 125,000 workers, listed under "manufacturing nd mechanical industries." This has resulted from seasonal conditions.

Contractor Interested in Muscle Shoals

C. C. Tinker, president of the Construction Company of North America, the contracting concern constructing the Hetch Hetchy tunnel in California, has an appointment with the Secretary of War on Jan. 5 to discuss Muscle Shoals. While considerable publicity has been given to the statement that Mr. Tinker has hopes of submitting a more attractive offer than that of Henry Ford, the details of his plan have not been announced. It is stated that the government is to be relied upon for at least a portion of the financing.

To Discuss Fertilizer Matters in Conference at Department of Agriculture

Research and educational problems in the fertilizer industry are to be discussed on Jan. 6 at a conference at the Department of Agriculture. At that time the soil improvement committee of the National Fertilizer Association will meet with the department's officials who are interested in fertilizers for a general discussion of the present situation. It is the first meeting of the kind with the federal department, although the soil improvement committee has arranged similar conferences on several occasions at state agricultural colleges and at state experiment stations.

British Industries Fair to Be Held in London and Birmingham

Since its inception in 1915 the British Industries Fair has grown until it is today the most import national trade fair in the world. For the 1922 fair, to be held Feb. 27 to March 10, it has been possible to obtain enough additional accommodation both in London and Birmingham not only to provide for the annual growth of the fair but also to find room for the great industries which have hitherto exhibited at Glasgow. Textiles will, however, not be included in the 1922 fair.

The function of this fair, which is organized by the Department of Overseas Trade, is to bring buyer and seller together and to facilitate business between them by every legitimate means. Participation is confined to manufacturers and admittance is restricted to trade buyers, so that business is not impeded by crowds of sightseers.

The London section of the fair will, as in 1921, be housed in the White City, an enormous range of exposition buildings within a few minutes of the center of London, while the Birmingham section will again be in the great buildings of the Castle Bromwich Aërodome, within easy reach of the center of the city. Further imformation can be obtained from the Trade Department of the British Consulate-General at New York.

Imports of Chemicals Decrease in November, but Exports Increase Slightly

Further decreases in the imports of chemicals were registered in November, it is shown by the figures just compiled by the Bureau of Foreign and Domestic Commerce. The decrease applies to chemicals on the free list as well as those on the dutiable list. The aggregate value of the free-list chemicals imported during November was $3,983,567. This compares with $4,342,505 in October and $10,914,341 in November of 1920. The value of the dutiable chemicals imported in November is given as $2,085,144. This compares with $2,785,348 in October, and $4,639,186 in November of 1920.

The value of all chemicals exported in November was $4,938,494. This is a slight increase over October, when the value of exports totaled $4,671,310. It is a great decrease, however, from November, 1920, when exports totaled $12,894,772. A comparison of some of the items which make up these totals is as follows:

	Nov., 1920	Nov., 1921
Dyes and dyestuffs	$2,310,751	$500,918
Acids	506,379	76,744
Extracts for tanning	165,389	99,445
Total sodas	1,961,519	708,364

The imports of coal-tar products dropped from $2,107,682 in November, 1920, to $509,550, in November of this year. The value of the gums imported in November of this year was $1,756,868. This compares with $3,252,296 in November of 1920. That a part of this decrease is represented by shrinkage of value is shown by the fact that there was 7,294,528 lb. of the various gums imported in November of this year, whereas 9,228,269 lb. was valued at the much higher figure in 1920. An indication of the trend of color imports may be had from the following table:

	Nov., 1920	Nov., 1921
Germany, lb.	353,099	47,758
Switzerland, lb.	109,421	131,872
United Kingdom, lb	44,705	15,384
Other countries, lb.	55,411	4,473

Personal

WILLIAM J. BURGESS, formerly associated with the National Aniline & Chemical Co. in its production of resorcinol, has assumed the duties of chemical supervisor of the resorcinol plant of the Pennsylvania Coal Products Co., at Petrolia, Pa.

ROBERT E. DEVINE, formerly with the Joslin Smith Co., Cincinnati, Ohio, and more recently doing independent consulting work, has become associated with the Armour Soap Works in Chicago, where he is carrying on special investigation work on plant processes.

Dr. H. L. FISHER, chemical director of the B. F. Goodrich Co., Akron, Ohio, addressed the members of the Delaware Section of the American Chemical Society, Dec. 21, on "Rubber Chemistry."

F. G. JACKSON has been added to the chemical staff at the Bureau of Mines ceramic station at Columbus, Ohio. Mr. Jackson has been working as a physical chemist at the submarine base at New London, Conn.

Dr. FRANK E. E. GERMAN, of the University of Colorado, read an instructive paper on Nov. 28 on "Thermal Analysis as a Method of Discovering New Compounds" before the Colorado Section of the American Chemical Society. Dr. German spoke particularly of the hydroxides of uranium.

Prof. R. G. GUSTAVSON, of the University of Denver, read a paper Dec. 13 before the Teknik Club of Denver on "Colloids."

ERNEST LERICHE, formerly with the Newport Chemical Co. at Milwaukee, has become associated with Schaar & Co., Chicago.

JAMES H. POST has been elected president of the Cuban-American Sugar Co., New York, N. Y., succeeding Robert B. Rawley, deceased.

A. E. SCHAAR, of Schaar & Co., Chicago, will sail for Holland Jan. 4. He expects to visit the principal cities of Europe.

R. B. STRINGFIELD, who has been chemical engineer for the Los Angeles plant of the Goodyear Tire & Rubber Co., has been transferred to the parent plant at Akron, Ohio, in connection with chemical engineering development there.

A. P. VANGELDER announces that in January he will retire from the active ranks of the organization of the Hercules Powder Co., where he has been general superintendent.

Obituary

JOHN C. PENNIE, senior member of the firm of Pennie, Davis, Marvin & Edmonds, patent attorneys, died in New York City on Dec. 23, 1921. A more extended notice will appear in a subsequent issue of this magazine.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

What We Hope to Accomplish in Our Market Pages

Reference has already been made in the editorial columns of this issue to the magazine's plans for extending the scope of its usefulness and thus increasing the service it is able to render to its readers. It is believed that one of the ways in which this purpose can be served is through the market pages, since they represent already established contact with commercial factors in the chemical and allied industries. By broadening the conception of these pages to include the discussion of market conditions and of those economic and business problems that have important bearing on trade and commerce in chemicals, it is hoped to present information of value to the chemical engineer and technical executive as well as to the man engaged in the actual buying and selling of chemical products.

The weekly price quotations which have become one of the features of CHEM. & MET.'S service to the industries are to be continued, and no effort will be spared in making them accurate, trustworthy indexes of business in the chemical and allied industrial markets. The market letters from New York and other centers of trade and commerce are to be written from this broader viewpoint in order to reflect national as well as local conditions in these markets. From time to time these columns will contain brief reviews of business, commerce and finance and of the relation to the chemical industry of such important factors as the tariff, taxation, foreign exchange and international trade. It is hoped that space can be given occasionally to pertinent industrial notes and reports from individual firms whose activities influence or have a marked effect upon conditions in the chemical market. In a word, then, it is our intention to make these pages a source of interesting and reliable commercial information, and to this end it is hoped that we may have the co-operation of all who are interested in advancing the best interests of the chemical, metallurgical and related industries.

Some High Spots in Business During 1921

The outstanding characteristic of business during the year just past has been the reaction toward certain economic tendencies and developments. Prominent among these has been the world-wide process of deflation and the gradual return to a mythical state of normalcy. Although the process has not yet been completed and further readjustment appears to be inevitable, the chemical industry has at least kept pace with the general trend of liquidation. Price indexes of the government and other agencies place chemicals on a level only slightly higher than the average for all commodities. Indeed, many basic chemicals are being offered at prices which are less than pre-war costs.

Falling prices, both in this country and abroad, have had a demoralizing effect on business. International trade has been seriously affected by this element of uncertainty, although it is believed that in some cases the apparent decreases may have been caused by lower unit costs. This point is well illustrated by a comparison of our present export trade with that of the pre-war period and of 1920. A quantity survey recently completed by the U. S. Chamber of Commerce shows that "of the twenty exports that are of the greatest tonnage, fifteen registered increases in poundage ranging from 43 to 5,210 per cent for the first 9 months of 1921, as compared with the 9 months average for the pre-war period, 1910 to 1913. Losses on the five other commodities were from 5 to 32 per cent." Furthermore, over half of these commodities have been exported in larger tonnages during 1921 than during the corresponding period of the preceding year.

An equally important factor in shaping the year's business has been the fluctuations in foreign exchange. In a subsequent issue it is our intention to present a detailed study of the trend of the principal currencies of the world, but for the purpose of the present review it is perhaps sufficient to direct attention to two outstanding examples. The German mark, which 6 months ago was worth 1.5c., fell to 0.35c. during November. On the other hand, there is the phenomenal recovery of the pound sterling from $3.53 in January, 1921, to $4.24 early in December.

POLITICAL DEVELOPMENTS—TAXATION AND THE TARIFF

Political developments of the year have been disappointing on the whole, although in a few instances they appear to have taken a somewhat favorable turn. The Disarmament Conference may not accomplish all that might be desired, but it must be admitted that it has effected savings which will ultimately benefit industry. The new revenue law has also been the source of some disappointment. Instead of offering a new and constructive solution for our tax problems, the old war revenue act has been patched up and overhauled for additional service. Some consolation, however, is gathered from the repeal of the excess profits tax which is effective Jan. 1, 1922, in the reduction of the levy on capital gains and in the repeal of the transportation and other of the so-called "nuisance" taxes.

The tariff, although figuring prominently in the political developments of the year, can scarcely be said have had a beneficial influence on industry. In fact the year witnessed a rather general change in the attitude of many manufacturers toward the tariff. There appeared to be a growing feeling that the time was inappropriate for tariff framing and that little practical assistance could be obtained from such legislation. The inorganic chemical industry has had to meet a great deal of foreign competition, which in a number of instances has proved disastrous to the domestic producers. The dye and organic chemical industries, on the other hand, have been less affected, largely because of the continued control of imports provided by the dye and chemical section of the emergency tariff act.

The important lesson taught by the year, however, has been to emphasize the absolute necessity for increasing plant efficiencies and thus lower production costs. The period of retrenchment and careful, competent management must continue despite the few signs of encouragement that are gradually making their appearance. Inventories, both of raw materials and finished products, must be reduced, costs brought down and every preparation made for a severe, competitive fight for business. It is in this direction that future advance must be made. Economies of production, rather than expanded volume, promise greatest profits for business during 1922.

Growing Demand for Zinc Compounds

The increased production of rubber tires, with corresponding greater consumption of zinc oxide, has resulted in a growing demand for chemical derivatives of zinc. At the present time about 50 per cent of the zinc production is being used by the chemical trades, while the other 50 per cent is divided among the brass, galvanizing, sheet zinc and affiliated industries. This compares with averages of 25 and 75 per cent, respectively, in former years.

A Review of the Chemical Market During 1921

During the closing months of 1920 there was a widely prevalent feeling that the chemical and allied industrial markets would show evidence of marked improvement durthe first 3 months of 1921. Unfortunately this revival was not effected. Liquidation continued throughout the entire year and business reversals were more common in the chemical industry than ever before. Our newly developed export trade in chemicals practically disappeared during the early part of the year as foreign exchange sank to depths at which competition was impossible. Only recently, however, Japan and certain South American countries have turned their attention to the American market and have placed orders for large tonnages of phenol and various other general chemicals. During the later months of 1921 Italy has also been a frequent buyer and domestic manufacturers of caustic soda have reported business to this country in as large as 1,000-ton lots.

COMPARATIVE PRICES OF 45 IMPORTANT CHEMICALS, JANUARY, 1921–JANUARY, 1922

Article	Unit	Jan., 1921	April	June	Oct.	Jan., 1922
Acetic acid, glacial	Lb.	$0.10½	$0.09½	$0.09¾	$0.10	$0.10
Muriatic acid, 20 deg.	Lb.	.01¾	.01½	.01¼	.01½	.01½
Nitric acid, 40 deg.	Lb.	.07	.06½	.06½	.06¼	.06¼
Oxalic acid	Lb.	.18½	.17	.18	.15½	.14½
Sulphuric acid, 66 deg.	Ton	21.00	19.00	18.00	17.00	17.00
Acetate of lead	Lb.	.13⅜	.11⅝	.11⅝	.10⅝	.10⅝
Ammonia alum, lump	Lb.	.04½	.04	.03½	.03½	.03½
Aluminum sulphate, iron free	Lb.	.03½	.03½	.03	.02½	.02½
Salammoniac, white, gran.	Lb.	.10½	.06½	.06½	.06	.07
Ammonium sulphate	Lb.	.03½	.02¾	.02⅝	.02¾	.02⅝
Amyl acetate	Gal.	4.50	4.00	4.00	3.25	2.40
Arsenic, white, powder	Lb.	.11½	.07¾	.06½	.05¾	.06
Barium chloride	Ton	75.00	60.00	59.00	47.00	52.00
Bleaching powder	100 lb.	3.25	2.55	2.15	2.50	2.50
Calcium acetate	100 lb.	2.00	1.75	2.00	2.00	1.75
Camphor	Lb.	.90	.63	.75	.80	.91
Copperas	100 lb.	1.50	.75	.85	.80	.75
Copper sulphate, crystals	100 lb.	6.50	5.50	5.75	5.00	5.65
Epsom salt, U.S.P.	100 lb.	3.00	2.75	2.40	2.50	2.65
Formaldehyde, 40 per cent.	Lb.	.18½	.14	.13½	.11½	.10¾
Fusel oil, refined	Gal.	3.50	3.25	3.00	3.00	2.50
Glaubers salt	100 lb.	1.75	1.50	1.50	1.50	1.30
Glycerine, cp	Lb.	.20	.16½	.16	.14	.16
Methanol, 95 per cent	Gal.	1.50	.75	.78	.66	.62
Nickel salt, single	Lb.	.13	.14	.15	.14	.14
Phosphorus, red	Lb.	.40	.45	.45	.40	.45
Potassium bichromate	Lb.	.17½	.12	.11⅞	.10	.10½
Potassium bromide, gran.	Lb.	.35	.20	.16	.14	.15
Carbonate of potash, 80-85 per cent	Lb.	.11½	.06½	.05	.04½	.04½
Chlorate of potash, crystals	Lb.	.12	.08	.08½	.08	.06
Caustic potash, 88-92 per cent	Lb.	.14	.07	.05	.05¼	.05½
Permanganate of potash, U.S.P.	Lb.	.60	.35	.31	.18	.16
Prussiate of potash, yellow	Lb.	.33	.26	.24½	.20	.23
Salt cake, bulk	Ton	45.00	33.00	30.00	20.00	18.00
Soda ash, light	100 lb.	1.85	2.10	2.15	2.05	1.80
Bichromate of soda	Lb.	.09½	.07¾	.06	.07¼	.07¼
Fluoride of soda	Lb.	.17	.12	.11½	.10½	.11
Cyanide of soda	Lb.	.23	.19	.19½	.25	.27
Caustic soda, solid	100 lb.	3.75	3.65	4.15	4.05	3.75
Nitrate of soda	100 lb.	2.50	2.60	2.90	2.35	2.30
Prussiate of soda	Lb.	.17½	.11½	.12¼	.14½	.16½
Sulphide of soda, 60 per cent	Lb.	.06¼	.05½	.05½	.04½	.04¼
Sulphur, crude	Ton	16.00	20.00	20.00	18.00	18.00
Zinc chloride, gran.	Lb.	.12	.11	.11	.09½	.09
Zinc oxide, XX	Lb.	.10	.08½	.09	.07½	.07½

The import business for the first 6 months of 1921 progressed exceptionally in the face of many adverse conditions. German interests, aided by the low mark, shipped goods into the American market at prices lower than domestic costs. The latter part of the year has been different to some extent. Imports of chemicals have shrunk noticeably. In October, 1921, the value of arrivals was $7,127,853, as compared with the corresponding month of 1920, which was $19,192,039. This represented a drop of over 60 per cent. The value of September, 1921, imports was much less—$6,506,192. The past year showed some rather striking advances in imports and as many exceptional decreases. Naphthalene and coal-tar intermediates dropped over 60 per cent. Fusel oil, crude camphor and potassium cyanide lost over 70 per cent. Carbonate of potash fell from 16,313 tons to 2,898 tons; sodium nitrate from 581 to 174 long tons. Miscellaneous coal-tar crudes dropped over 90 per cent.

Some of the advances were equally marked. Calcium salts advanced over 10 per cent; sodium cyanide, 25 per cent, miscellaneous potassium salts, 60 per cent. Caustic potash rose from 778 to 3,908 tons, bleaching powder from 495 to 4,581 tons, benzene from 104 to 820 tons. To counterbalance the last two items, we exported 6,408 tons of bleach and 32,280 tons of benzene.

In general, the American chemical industry has undoubtedly just passed its most trying crisis. The industry has been severely dealt with and the new year will put it to a further test. Although there were many setbacks during the 12 months of depression, the results have not been disastrous. The encouraging feature of our industry is that everybody in the trade is hopeful and optimistic. The future is not without hope and everyone in trade circles is determined to fight hard to overcome the business depression that has proved so disastrous to some of the domestic producers.

Mathieson Alkali Works Reports Encouraging Business Conditions

E. M. Allen, president of the Mathieson Alkali Works, in a letter to the stockholders states that while general business is still unstable, that of the company shows material improvement during the last 3 months and appears to justify a hopeful outlook for the future. The output of the Niagara plant has gradually been increased until it is now approximately 80 per cent of capacity. During the recent inactivity, arrangements were made to increase materially the output of certain profitable products to replace others whose manufacture and sale have proved less profitable. The Saltville works of the company are operating at only about half capacity, but, as pointed out in Mr. Allen's letter, "because of improved physical and management conditions, the production substantially equals the average output of the entire plant during the past 9 years."

Regarding trade conditions in the alkali industry, Mr. Allen points out that "although competition has been unusually keen and average selling prices have gradually decreased, the company's position is believed to be fairly secure because of many new contracts made for 1922 delivery and a considerable tonnage which will be carried over under 1921 contracts, and it is believed that lower cost of production will keep pace with decreased selling prices."

The New York Market

NEW YORK, Dec. 30, 1921.

There were but few developments in the chemical market during the past week, owing to the holidays and the slow season of the year. However, those close to the heart of industry believe that the latter part of January will see a marked revival in the general list, with prices more stabilized. An important announcement by the domestic manufacturers of *sodium cyanide* that a reduction of 4c. per lb. would become effective Jan. 1 came as a considerable surprise to the trade, since foreign material has been held firm by a majority of the resale trade.

Another outstanding feature of the industry is the continued rise of *yellow prussiate of soda*. Some believe the advance of foreign exchange has had a strengthening influence on this commodity, while others contend that the natural working of the law of supply and demand has made prices firm. Prices opened at 16c. per lb. and closed with the majority of dealers asking up to 17¾c. per lb. Still another item that commanded attention was *caustic potash*, 88-92 per cent, on which spot prices advanced noticeably, even though large tonnages of imported material have already been docked. These lots, in most cases, had been previously consigned to various domestic consumers. The present market ranges from 6@6¼c. per lb., ex-store New York. Solid *caustic soda* has not attracted new consumers, and business in this commodity will be dull until the latter part of January. Leading producers report a large part of their output already sold on contract over 1922 at $2.75 per 100 lb., f.o.b. works, basis 60 per cent. Spot prices range from $3.80@$4 per 100 lb., f.o.b. or f.a.s. New York. Small-lot trading has featured the market on *bichromate of soda* and sales were made at 7⅞c. per lb. In some quarters it was intimated that round-lot business would shade prices down to 7¾c. per lb. Demand has not been active, but supplies in resale quarters are not abundant and prices seem

to be well in line with manufacturing costs. *Yellow prussiate of potash* advanced in sympathy with prussiate of soda. Although the demand cannot be termed active, spot supplies are rather scarce and prices are quoted firmer at 24@25c. per lb., according to quantity. The red prussiate has also been advanced, and prices range from 30@30½c. per lb. *Light soda ash* has been in moderate demand during the week and prices were slightly firmer. Imported material was quoted around $1.80 per 100 lb., ex-dock. Domestic material in single bags ranged from $2@$2.10 per 100 lb.

The Chicago Market

CHICAGO, Dec. 30, 1921.

Trading in industrial chemicals during the past 2 weeks has been slow. No one expects a revival of even fair business until after the first of the year. With reference to prices there was little of real importance done over this period and most factors are holding to the idea that business could not have done during these last weeks of the year at any reasonable scale of prices. The only reports of shading came from weak holders and these offers failed to disturb the market to any great extent. All factors are generally optimistic over the prospects for next year and in some quarters are preparing for a considerable increase in both inquiries and actual business.

The alkali market is very quiet at the present and prices are slightly easier. *Caustic soda* was offered today at $4 per 100 lb. for the solid 76 per cent and the ground at $4.65@$4.70 in ton lots. There is little material moving, as deliveries on 1922 contracts will soon start and then low prices are predicted for the coming year. *Caustic potash* is quiet and unchanged at 6½c. per lb. for the 88-92 per cent material. Soda ash lacks quotable change in first hands and is moving only in small parcels at $2.60 per 100 lb. basis cooperage.

Supplies of *potash alum* are rather light and 6c. per lb. for the lump and 6½c. for the powdered were the best offers noted. *Aluminum sulphate* is quiet at $3.25 per 100 lb. for the iron free. *White arsenic* was reported to be moving in a fair way at 6¾@7c. per lb. *Bleach* is quiet at 3@3¼c. per lb. for large drums. Another advance on *glycerine* was announced by refiners, which brings the c.p. material to 16c. per lb. drum basis. This item is one of the very few which is apparently enjoying a good demand. Single *nickel salts* is also in good demand and the price is firm at 12@13c. per lb.

Potassium bichromate is still slow, with supplies plentiful at 13@13½c. per lb. *Bichromate of soda* has assumed a firmer position and it was impossible to do better than 9¼c. for material of standard brand. *Chlorate of potash* is scarce on spot and 8½@9c. were the prevailing quotations for the powdered. Spot stocks of the crystals could not be located and 10c. was the best offer on material for shipment from the East. The *prussiates of potash* are both firm and scarce. The red crystals are held for 30c. per lb. in small lots and the yellow at 25c. *Salammoniac* is firm with supplies none too plentiful. Holders are asking 8@8½c. for the white granular in large casks and are said to be doing a fair volume of business. The condition of the acid market remains unchanged and may be characterized as very dull.

The Iron and Steel Market

PITTSBURGH, Dec. 30, 1921.

The year now ending has been the smallest for steel production since 1905, production of steel ingots being not over about 20,000,000 gross tons, so that the industry had, in a sense, a setback of 16 years, which is a new record. The setback in point of tonnage was also a new record, about 55 per cent from the record tonnage, made in 1917, 43,619,200 tons.

The year 1921 opened with steel ingot production at the rate of about 30,000,000 tons, although a rate of about 42,000,000 tons had been maintained during the first 9 months of 1920, before the tapering off began. Production decreased almost continuously until at the middle of July the rate was barely over 10,000,000 tons a year. Then improvement began, carrying the rate up to about 25,000,000 tons at the beginning of November. To the end of the year there was some falling off, but the rate even now, despite holiday dullness, is probably above 20,000,000 tons, and a return to a rate of 25,000,000 tons within a few weeks, or 2 months at the outside, is far from improbable.

STEEL CONSUMPTION

Almost invariably when the steel appears scarce and prices are high it is remarked in the trade that there are no stocks of consequence and that liquidation will therefore be easy, but in every instance the event has proved that the stocks existed. Even 1920, with an apparent scarcity indicated by the fanciest prices in the whole history of the industry, has proved no exception. At the beginning of 1921 there were stocks of steel in the hands of buyers, both jobbers and manufacturing consumers, and there were stocks of manufactured wares, including agricultural implements, machinery, hardware, tools, etc., in the hands of manufacturers and distributers. All these stocks had to be liquidated, and it was chiefly the process of liquidation that caused steel production to fall to its extremely low level in July. An incident was that in the early months of the year customers of the United States Steel Corporation took larger tonnages of steel than they currently needed.

PRICES DURING 1921

The last day of 1920 had seen the disappearance of the last extra price on the part of independents. All independents had advanced prices above the Steel Corporation level in 1920, the corporation alone adhering to the Industrial Board schedule, promulgated March 21, 1919. Late in the year independent prices began to drop to the corporation level, pipe being the last. During January there was a steady market. Early in February independents got on the other side from the one they occupied in 1920, and began cutting the Steel Corporation's prices. In April the corporation reduced and from that time on there was only one market, quite an irregular one. On the whole the Steel Corporation, on account of the good will acquired by its price policy in 1920, was able to obtain slightly higher prices, on an average, than the independents, but the difference was only a dollar or two a ton, while in 1920 the difference the other way was frequently $10 or $20.

Two-thirds of the total decline in steel prices in 1921 occurred in the 6 months from Feb. 1 to Aug. 1, when the market experienced a succession of falls. Afterward there was only a gentle sagging now and then, with attempts, rarely successful, at recovery. A weighted average of all the important finished steel products showed 3.25c. at the beginning of the year and 2.16c. at the end, a decline of about $22 per net ton, or just one-third, and putting prices at a level 26 per cent above the average of 1913 and 52 per cent above the low level of December 31, 1914.

THE MARKET FOR THE WEEK

The steel market has been extremely quiet in the past week, reflecting the usual holiday or pre-inventory dullness. The quietness has given no concern to producers or buyers, being regarded as altogether natural. The market really lost most of its snap about the middle of October, the remarkable thing being that production held up so well notwithstanding the dullness of the market.

As noted in our last report the Steel Corporation reduced its prices on wire products $5 a ton, this following a reduction a week earlier in tubular goods, each reduction having been made on account of price cutting by independents. In the past week nothing has occurred as to steel prices, which are fairly steady. The liquidation has been quite thorough and no further changes of any consequence are to be expected for some time to come. The next change worth mentioning may come by buyers being ready to make purchases for forward deliveries, in which case some slight extra concessions may be brought out.

Four contracts for Connellsville furnace coke for the first quarter of the new year have been made, at prices ranging from $3.25 to $3.50, the variation being probably due chiefly to quality. The spot market is very soft, with $3 scarcely even an asking price.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 40 – $0 45
Acetone	lb.	$0 12½ – $0 12¾	13 – 13½
Acid, acetic, 28 per cent	100 lbs.	2 75 – 3 00	3 25 – 3 50
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		10 00 – 10 50	10 75 – 11 00
Boric, crystals	lb.	12½ – 12¾	.13 – .13½
Boric, powder	lb.	.13 – .13½	.14 – .14½
Citric	lb.	..... –	.44 – .46
Hydrochloric	100 lb.	1 25 – 1 50	1.60 – 1 75
Hydrofluoric, 52 per cent	lb.	12 – 12½	.12½ – .13
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	04 – 04¼	.04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)	....	..... –	..... – .....
Nitric, 40 deg	lb.	.06½ – 06½	.06¾ – 07
Nitric, 42 deg	lb.	.06¾ – .07	.07¼ – 07½
Oxalic, crystals	lb.	.14½ – .15	.15½ – .16
Phosphoric, 50 per cent solution	lb.	.13 – .13½	.14 – .18
Picric	lb.	.20 – .25	.27 – 35
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	..... –	11 00 – 12 00
Sulphuric, 60 deg., drums	ton	..... –	13 00 – 15 00
Sulphuric, 66 deg., tank cars	ton	17 00 – 18 00	..... – .....
Sulphuric, 66 deg., drums	ton	21 00 – 22 00	22.50 – 23 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21 00 – 22 00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23 00 – 23 50	24.00 – 24 50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	..... –	.75 – .85
Tannic (tech.)	lb.	.55 – .60	.61 – .65
Tartaric, imported crystals	lb.	..... –	.26½ – .27
Tartaric acid, imported, powdered	lb.	..... –	.27 – .28
Tartaric acid, domestic	lb.	..... –	..... – .32
Tungstic, per lb. of WO	lb.	..... –	1.10 – 1.20
Alcohol, ethyl	gal.	..... –	4.65 – 5.00
Alcohol, methyl (see methanol)	....	..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.42 – .43
Alcohol, denatured, 190 proof	gal.	..... –	.43 – .44
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03½ – .04	.04½ – .04½
Alum, chrome lump	lb.	.08 – .08¼	.08½ – .09
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02½ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.07 – .07¼	.07½ – .07¾
Ammonium chloride, granular (gray salammoniac)	lb.	.07 – .07½	.07½ – .07¾
Ammonium nitrate	lb.	.07¼ – .07½	.07¾ – .08½
Amylacetate tech	gal.	..... –	2 40 – 2 50
Arsenic oxide, (white arsenic) powdered	lb.	.06 – .06½	.06½ – .07
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	52.00 – 53.00	54 00 – 55 00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.06¾ – .07	.07½ – .08
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .05
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder (see calc. hypochlorite)		..... –	..... – .....
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax (see sodium borate)		..... –	..... – .....
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.23 – .24	.25 – .28
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – 05½
Calcium chloride, fused, lump	ton	23 00 – 24 00	24.50 – 28 00
Calcium chloride, granulated	lb.	01½ – .02	.02½ – .02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2 50 – 2.60	2 65 – 3 25
Calcium peroxide	lb.	..... –	1 40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.90 – .95
Carbon bisulphide	lb.	.06½ – .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10¼	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – ....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04 – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .04	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	..... –	.38 – .40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas (see iron sulphate)		..... –	..... – .....
Copper carbonate, green precipitate	lb.	.20 – .20½	.21 – .21½
Copper cyanide	lb.	..... –	.50 – .62
Copper sulphate, crystals	100 lb.	5.65 – 5.70	5.75 – 6 25
Cream of tartar (see potassium bitartrate)		..... –	..... – .....
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.70 – .80
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.95 – .....
Formaldehyde, 40 per cent	lb.	10½ – .11	.11½ – .12
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth—imported powdered—net	ton	22.00 – 24.00	..... – .....
Fusel oil, ref	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.50 – 1.75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16 – .16½
Iodine, resublimed	lb.	..... –	3 80 – 3.90
Iron oxide, red	lb.	..... –	.12 – .18
Iron sulphate (copperas)	ton	15.00 – 16.00	17.00 – 20 00
Lead acetate	lb.	..... –	.10½ – .12½
Lead arsenate, powd	lb.	.15 – .15½	.15½ – .16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.08 – .08½	.08½ – .09
Magnesium carbonate, technical	lb.	.07½ – .07¾	.08 – .09
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2.75 – 3.00
Magnesium sulphate, technical	100 lb.	..... –	1.10 – 1 75
Methanol, 95%	gal.	..... –	.62 – .63
Methanol, 97%	gal.	$ – $	$0 64 – $0.65
Nickel salt, double	lb.	–	12 – 12½
Nickel salt, single	lb.	–	.14 – 14
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – 50
Phosphorus, yellow	lb.	..... –	.32 – 35
Potassium bichromate	lb.	.10½ – .11	.11¼ – .11½
Potassium bitartrate (cream of tartar)	lb.	..... –	.25 – .27
Potassium bromide, granular	lb.	..... –	.15 – .20
Potassium carbonate, U. S. P.	lb.	.15 – .16	.17 – .20
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.06 – .06¼	.06½ – .12
Potassium cyanide	lb.	..... –	.43 – .45
Potassium hydroxide (caustic potash)	lb.	.06 – .06¼	.06½ – .06¾
Potassium iodide	lb.	..... –	2.90 – 3.00
Potassium nitrate	lb.	.07½ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .16	.16½ – .22
Potassium prussiate, red	lb.	.30 – .30½	.31 – .31½
Potassium prussiate, yellow	lb.	.24 – .24½	.25 – .25½
Rochelle salts (see sodium potas tartrate)	....	....	..... – .....
Salammoniac (see ammonium chloride)	....	....	..... – .....
Sal soda (see sodium carbonate)	....	..... –	..... – .....
Salt cake (bulk)	ton	..... –	18.00 – 21.00
Soda ash, light	100 lb.	1.80 – 2.10	2.15 – 2.50
Soda ash, dense	100 lb.	2.15 – 2.20	2.25 – 2.50
Sodium acetate	lb.	.04 – .04¼	.04½ – .05
Sodium bicarbonate	100 lb.	2.30 – 2.35	2.40 – 2 75
Sodium bichromate	lb.	.07½ – .08	.08½ – .08½
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .05	.05½ – .06
Sodium borate (borax)	lb.	.05½ – .06	.06½ – 07
Sodium carbonate (sal soda)	100 lb.	1.80 – 1.90	1.95 – 2.15
Sodium chlorate	lb.	.06½ – .07	.07½ – .08
Sodium chloride	long ton	12 00 – 13.00	..... – .....
Sodium cyanide	lb.	.26 – .26½	.26½ – .27
Sodium fluoride	lb.	.11 – .12	.12½ – .14
Sodium hydroxide (caustic soda)	100 lb.	3.75 – 3.80	3.85 – 4.25
Sodium hyposulphite	lb.	..... –	.03½ – .03½
Sodium nitrite	lb.	.06⅝ – .06¾	.07 – .07½
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½ – .04½	.04½ – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.19 – .21
Sodium prussiate, yellow	lb.	.17 – .17½	.17½ – .18
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.05	1.10 – 1.30
Sodium silicate, solution (60 deg.)	100 lb.	2.30 – 2.40	2.45 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.30 – 1.50	1.60 – 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04½ – .04¾	.04½ – .05
Sodium sulphite, crystals	lb.	.03⅜ – .03¼	.04 – .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11¼ – .15
Sulphur chloride, red	lb.	.05½ – .06	.06½ – .06½
Sulphur, crude	ton	18.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 – 40.00	..... – .....
Talc—domestic powdered	ton	18.00 – 25.00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.15 – .16
Zinc chloride, gran	lb.	.09 – .09¼	.09½ – .10
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11½ – .11½	.11¾ – .12½
Zinc oxide, XX	lb.	.07½ – .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.30 — .32
Aniline oil, drums extra	lb.	.17½ — .19
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.35 — 1 45
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.30 — .34
Beta-naphthyla mine, sublimed	lb.	1.65 — 1.75
Cresol, U. S. P., in drums (100 lb.)	lb.	.15 — .16
Ortho-cresol, in drums (100 lb.)	lb.	.24 — .26
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.95 — 1.10
Dimethylaniline	lb.	.40 — .45
Dinitrobenzene	lb.	.23 — .27
Dinitroclorbenzene	lb.	.20 — .25
Dinitronaphthalene	lb.	.30 — .35
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.30 — .35
Dipnenylamine	lb.	.60 — .70
H-acid	lb.	1.00 — 1.10
Meta-phenylenediamine	lb.	1.10 — 1.15
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.65 — 1 70
Naphthalene crushed, in bbls.	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — .08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	3.00 — 3 10
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.77 — 80
Ortho-nitro-toluene	lb.	.15 — .20

Ortho-toluidine	lb.	.20 —	.25
Para-amidophenol, base	lb.	1.40 —	1.45
Para-amidophenol, HCl	lb.	1.70 —	1.80
Para-dichlorbenzene	lb.	.12 —	.15
Paranitroaniline	lb.	.77 —	.80
Para-nitrotoluene	lb.	.80 —	.85
Para-phenylenediamine	lb.	1.70 —	1.75
Para-toluidine	lb.	1.25 —	1.40
Phthalic anhydride	lb.	.37 —	.40
Phenol, U. S. P., drums	lb.	.11½ —	.15
Pyridine	gal.	2.00 —	3.50
Resorcinol, technical	lb.	1.50 —	1.60
Resorcinol, pure	lb.	2.00 —	2.25
Salicylic acid, tech., in bbls	lb.	.20 —	.21
Salicylic acid, U. S. P	lb.	.22 —	.23
Salol	lb.	.70 —	.72
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.16
Sulphanilic acid, crude	lb.	.27 —	.30
Tolidine	lb.	1.30 —	1.35
Toluidine, mixed	lb.	.43 —	.45
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.28 —	.31
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices are quotably unchanged for the entire list.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.30 —	5.35
Rosin E-I	280 lb.	5.40 —	5.50
Rosin K-N	280 lb.	6.05 —	6.75
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	81½ —	.....
Wood turpentine, steam dist	gal.	.79 —	.....
Wood turpentine, dest. dist	gal.	.78 —	.....
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.50
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.39 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	$2.30 —	2.90
Blood, dried, f.o.b., N. Y	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.30 —	2.35
Tankage, high grade, f.o.b. Chicago	unit	2.75 —	3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	4.50 —	6.50
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	35.00
Potassium sulphate	unit	.90 —	1.00

Crude Rubber

Quotations have remained unchanged since our previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10¾ —	$0.10¾
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13¼ —	.13½
Coconut oil, Ceylon grade, in bbls	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls	lb.	.10 —	.10¼
Corn oil, crude, in bbls	lb.	.08⅝ —	.08¾
Cottonseed oil, crude (f. o. b. mill)	lb.	.07 —	.07¼
Cottonseed oil, summer yellow	lb.	.08¼ —	.09
Cottonseed oil, winter yellow	lb.	.09¼ —	.09¾
Linseed oil, raw, car lots (domestic)	gal.	.67 —	68
Linseed oil, raw, tank cars (domestic)	gal.	.62 —	.63
Linseed oil, in 5-bbl lots (domestic)	gal.	.70 —	.71
Olive oil, denatured	gal.	$1.15 —	$1.20
Palm, Lagos	lb.	.07½ —	.07¾
Palm, Niger	lb.	.06¼ —	.06¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08 —	.08¼
Peanut oil, refined, in bbls	lb.	.11 —	.11¼
Rapeseed oil, refined in bbls	gal.	.82 —	.83
Rapeseed oil, blown, in bbls	gal.	.88 —	.90
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08¼ —	...
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07¼ —	....

FISH

Light pressed menhaden	gal.	$0.43 —	....
Yellow bleached menhaden	gal.	.44 —	....
White bleached menhaden	gal.	.46 —	....
Blown menhaden	gal.	.48 —	....

Miscellaneous Materials

Prices remain unchanged throughout the list.

Refractories

All prices remain the same as figures appearing in our Dec. 28 issue.

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.12 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.13 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00 —	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport	gross ton	54.00 —	58.35
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	.....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	57.00 —	59.00
Ferrosilicon, 75%	gross ton	120.00 —	125.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	.....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00 —	23.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	22.00 —	23.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24 —	.25
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.45 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13¼

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	33.125
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375
Zinc, spot, New York	5.25@5.30
Zinc, spot, E. St. Louis	4.80@4.85

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	80.00–84.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00–60.00
Mercury	75 lb.	49.00–50.00

FINISHED METAL PRODUCTS AND OLD METALS

Quotations have remained unchanged since our previous report.

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named

	New York	Cleveland	Chicago
Structural shapes	$2.78	$2.88	$2.78
Soft steel bars	2.68	2.78	2.68
Soft steel bar shapes	2.68	2.78	2.68
Soft steel bands	3.28	3.48	3.28
Plates, ¼ to 1 in. thick	2.78	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

FORT SMITH—The Page Milling & Smelting Co. has leased property in Benton County, totaling over 500 acres of copper land, and plans for the construction of a new refining plant on a portion of the site. The initial installation will comprise a 150-ton concentrating plant and auxiliary buildings.

California

ANAHEIM—The Anaheim Sugar Co. is considering preliminary plans for the erection of a new mill, estimated to cost about $250,000, including machinery. D. Jessurun is president.

SAN FRANCISCO—The Pacific Sanitary Mfg. Co., 67 North Montgomery St., manufacturer of sanitary earthenware, is planning for extensions in its plant at Richmond, Cal., to cost about $60,000.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. is perfecting plans for the immediate erection of the first building at its new local plant at South Wilmington, to be followed by the construction of seven other plant buildings. The entire plant is estimated to cost close to $1,000,000.

Florida

ARCHER—The Maddox Foundry & Machine Co. is considering tentative plans for the erection of a 40 x 50-ft. addition to its foundry. H. Maddox is general manager.

Illinois

CHICAGO—The Oxweld Acetylene Co. has purchased the property it has been occupying under lease, at Jasper Place, near 37th St. The plant was acquired at an indicated $173,500.

Indiana

BLOOMINGTON — The Bloomington Brick & Tile Co., with headquarters at Indianapolis, is considering plans for the erection of a new brick, tile and other burned clay products manufacturing plant at Bloomington, estimated to cost about $200,000, including machinery. Work will be commenced in the spring. A. W. Beecher is president.

INDIANAPOLIS—The Piel Bros. Starch Co., 831 State Life Bldg., has awarded a contract to Latham & Walters, State Life Bldg., for a 1-story top addition at its plant, 200 x 200 ft., with improvements in the present factory, estimated to cost about $50,000. William F. Piel is president.

Iowa

DUBUQUE—The Globe Portland Cement Co., 416 McKnight Bldg., Minneapolis, Minn., has preliminary plans in preparation for the erection of a new cement-manufacturing plant at Dubuque, estimated to cost about $1,5000,000 for initial mills. The building contract has been awarded without competition to H. C. Stuchen, Dakota Bldg., St. Paul, Minn. The C. L. Pillsbury Co., 1200 Second Ave., South Minneapolis, Minn., is engineer.

Louisiana

BATON ROUGE—The Standard Oil Co. of Louisiana is planning to increase the capacity of its local refinery, including extensive storage facilities, comprising about 20 tanks, each with capacity of 55,000 bbl. The company is said to have purchased the plant of the Export Oil Corp., at Avondale, La., for a consideration of about $950,000, and will continue the operation of the refinery. Fire recently damaged a portion of the company's distributing plant on South Claiborne Ave., New Orleans, with loss reported at about $30,000.

Maryland

BALTIMORE—The United States Industrial Alcohol Co., Curtis Bay, has tentative plans under consideration for the erection of a new 1-story plant in the Stonehouse Cove section, 50 x 180 ft. It is said that work will be started in the spring.

Massachusetts

SPRINGFIELD—Fire recently destroyed a portion of the plant of the Fiberloid Co. No official estimate of loss has been made.

BOSTON—The Eastern Metal & Refining Co., 121 Beverly St., has taken out a permit to rebuild the portion of its foundry recently damaged by fire.

Michigan

KALAMAZOO—The Sanitary Mfg. Co., manufacturer of sanitary earthenware products, will build a new addition to its plant, 112 x 400 ft., estimated to cost about $200,000, including equipment. It is expected to have the extension ready for occupancy in the late spring, adding about 125 men to the working force for operation.

DETROIT—The Solvay Process Co. has completed plans for the erection of a 1-story addition to its local building, 22 x 50 ft., estimated to cost about $15,000. Maurice H. Finkel, 333 Majestic Bldg., is architect.

New Jersey

LINDEN—The Warner-Quinlan Co., 79 Wall St., New York, has plans under way for the erection of the second section of its new oil refinery and asphalt plant at Linden, estimated to cost about $1,000,000. The entire plant will cost about double this amount and will replace a works recently destroyed by fire. The Gifford, Huntze, Baker Engineering Corp., 40 Rector St., is engineer. Bids will be asked at an early date.

BELLEVILLE—Fire, Dec. 16, destroyed a portion of the plant of the Federal Leather Co., River Road, with loss reported at about $12,000.

JERSEY CITY—Colgate & Co., 105 Hudson St., manufacturers of soaps, etc., have construction under way on a new 3-story plant addition, 100 x 125 ft., with cost estimated at about $140,000. The Turner Construction Co., 244 Madison Ave., New York, has the erection contract.

New York

NEW YORK—The Goodyear Tire & Rubber Co., 123 West 64th St., with plant at Akron, O., is concluding negotiations with the Brazilian Government for permanent rights on certain state property, heretofore held under limited concessions, with site to be used for the erection of a large rubber-manufacturing plant. The project was planned a number of years ago, but has been held in abeyance owing to industrial conditions.

Oklahoma

PONCA CITY—The Chamber of Commerce is perfecting plans for the establishment of a local brick-manufacturing plant. A new company will be formed, it is said, to construct and operate the property.

HENRYETTA — The Henryetta Glass Mfg. Co. has acquired local buildings and plant site for the establishment of a new factory for the manufacture of glass specialties. Machinery will be installed and operations commenced at an early date.

TULSA—The Oklahoma Tanning & Mfg. Co. has acquired the plant heretofore occupied by the Pawpaw Refining Co., for the establishment of a new tannery. Machinery and equipment will be installed to provide for a daily output of about 250 tanned hides.

GRANITE—The Town Council is considering preliminary plans for the erection of a new municipal gas plant and distributing system. A bond issue will be arranged to cover the cost of the improvement.

Pennsylvania

POTTSTOWN—The Vulcweld Rubber Co. has acquired property, 300 x 392 ft., on West High St., to be used as a site for the erection of a new 2-story plant for the manufacture of automobile tires and other rubber products. It will be 60 x 260 ft., supplemented with a 1-story building for general operations and storage service.

PHILADELPHIA—Horace T. Potts & Co., 316-20 North Third St., manufacturers of iron and steel castings and other metal products, are perfecting details for the erection of their proposed new foundry buildings at Erie Ave. and D St., and will break ground for the structures early in the spring. The new plant is estimated to cost in excess of $150,000. The William Steele & Sons Co., 1600 Arch St., is the contractor. H. T. Potts is head.

PHILADELPHIA — The Pennsylvania Sugar Co., North Delaware Ave., has acquired additional property in the vicinity of its local refinery, 83 x 146 ft., adjoining other land lately acquired, to be used for proposed future expansion. The last purchase was acquired for a consideration of about $18,000.

CHESWICK—The Stonecrete Corp., 6023 Penn Ave., has commenced the erection of its proposed new plant at Cheswick, to be equipped for the manufacture of cement products. Charles B. Lawton heads the company.

Tennessee

CHATTANOOGA—The Crane Enamelware Co., occupying the former plant of the Mutual Enamelware Co., is arranging for a state charter with capitalization of $2,000,000, for the manufacture of enamelware products of all kinds. Increased production will be arranged in the line of sanitary ware, supplementing the present output of plumbing fixtures, etc. The company is headed by Hugh W. Powell and Frank H. Caldwell.

CHATTANOOGA—The Southern Cotton & Paper Co. has been organized by Mercer Reynolds and associates, Chattanooga, with capital of $200,000, for the erection of a new plant at Nashville, Tenn. A site has been acquired at that place and construction will be commenced at an early date. The plant will specialize in the manufacture of bond and kraft papers from cotton linters.

MEMPHIS—The Memphis Varnish Co., owned by the De Soto Paint Co., has let contract for the erection of a 2-story building to be used for a varnish plant at East Railroad Ave. and South Somerville St. The plant and the equipment represent an initial investment of about $50,000. New storage tanks will be installed to take care of between 250,000 and 300,000 gal. of liquid.

Texas

WORTHAM—The Wortham Refining Co., recently organized, has perfected plans for the immediate erection of a new oil-refining plant in the northern section of the borough. It is proposed to have the refinery ready for operation in from 60 to 90 days, with initial output of about 400 bbl. per day. The plant will be of one-unit type, and will be increased at a later date. H. G. Lemendes is president; and Roger Seeley, secretary and treasurer.

SANTA ANA—The Industrial Department of the Santa Fe Railway Co. is developing plans for the establishment of a local plant for the manufacture of glass products. The project will be carried out in conjunction with a new company to be organized, headed by F. E. Brazelton, Santa Ana.

EL PASO—The American Smelting & Refining Co., 120 Broadway, New York, is considering the erection of a large metallurgical experimental plant on local site for testing ores from its properties at Monterey, Mex.

MINERVA—The Owens Refining Co., First National Bank Bldg., Cameron, Tex., will construct its proposed new oil refinery in this section on a site acquired at Minerva. It will have an initial daily output of about 1,200 bbl. W. A. Jones is construction engineer for the company. John S. Owens is president and manager.

GAINESVILLE—The Lone Star Co. has commenced the erection of a new condensing plant with number of other buildings for a new works to produce gasoline from natural gas. It is planned to have the plant ready for operation early in 1922. It will cost about $75,000.

AMARILLO—The Panhandle Brick & Tile Co. has commenced operations at its new local plant, and will develop production in the line both of brick and tile from clays secured in this section. The plant has a rated capacity of 100,000 bricks per day.

Virginia

GRAHAM—The Columbia Chemical Co., Roanoke, Va., is perfecting plans for extensions and improvements in its plant at Graham. Work will be commenced at an early date.

West Virginia

WHEELING—The Wheeling Mold Foundry Co. has construction under way on a 1-story addition to its plant, 60 x 285 ft., estimated to cost about $50,000. It will be equipped as a roll shop.

Capital Increases, Etc.

THE WHITE TAR CO., 56 Vesey St., New York, N. Y., with plant at Kearny, N. J., has filed notice of increase in capital from $100,000 to $300,000.

THE HOOD RUBBER CO., East Watertown, Mass., has arranged for a note issue of $6,000,000, to be used for general operations, financing, etc.

THE MONARCH CHEMICAL CO., Saginaw, Mich., has filed notice of dissolution under state laws.

THE HEAT UNIT TILE CO., 616 Fidelity Bldg., Tacoma, Wash., has filed notice of increase in capital from $100,000 to $300,000. Frederick H. Murray heads the company.

Upon petition by stockholders, a temporary receiver has been appointed for the NEW MEXICO FIREBRICK CO., Gallup, N. M.

THE W. S. VICK CHEMICAL CO., Knoxville, Tenn., has filed notice of change of name to the Gilbert Chemical Co., at the same time increasing its capital from $100,000 to $250,000.

THE DETROIT INDEPENDENT OIL CO., Detroit, Mich., has filed notice of increase in capital from $25,000 to $150,000.

THE AJAX RUBBER CO., Trenton, N. J., has arranged for a bond issue of $3,000,000, the proceeds to be used for financing, general operations, etc.

C. BISCHOFF & CO., 451 Washington St., New York, N. Y., has filed notice of change of name to the Carbic Color & Chemical Co.

THE CONDENSED BLUING CO., 66 East South Water St., Chicago, Ill., has filed notice of increase in capital from $50,000 to $100,000.

THE STANDARD OIL CO. OF INDIANA, Indianapolis, has been granted permission by the Indiana Securities Commission to issue common stock for $40,000,000.

New Companies

THE IMPERIAL REFINING CO., Lock Haven, Pa., has been incorporated with a capital of $100,000, to manufacture refined oil products. S. H. Fredericks, Lock Haven, is treasurer.

ALBACH & STUEHLER, INC., Elizabeth, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are Carl H. Stuehler, Morris M and Maxwell M. Albach, 210 Broad St., Elizabeth.

THE RIVERSIDE BRONZE & ALUMINUM CO., River and Lloyd Sts., New Haven, Conn., has been organized to manufacture bronze, brass, aluminum and other metal products. T. E. Hyde is president, and H. S. Brown, treasurer.

THE NORTHWESTERN RUBBER CO., Seattle, Wash., has been incorporated with a capital of $100,000, to manufacture rubber products of various kinds. The company is headed by C. E. Elliott, and is represented by Van Dyke & Thompson, 812 Lowman Bldg., Seattle.

THE SHULBERG CO., INC., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture paper products. The incorporators are L. and S. Shulberg, and I. Gettinger. The company is represented by Gettinger & Weiman, 63 Park Row, New York.

THE POLY CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of $70,000, to manufacture chemicals and chemical byproducts. The incorporators are F. Haber, L. Rothstein and V. Blancheri. The company is represented by Charles Firestone, 299 Broadway, New York.

THE STANDARD FOUNDRY PRODUCTS CO., 661 East Lafayette St., Detroit, Mich., has been incorporated with a capital of $15,000, to manufacture iron and other metal castings. The incorporators are Karl D. Stellwagon, Anthony J. Detlaff and Joseph F. Racine, 647 East Lafayette St., Detroit.

THE LYNCHBURG PAINT & COLOR CORP., Lynchburg, Va., has been incorporated with a capital of $25,000, to manufacture paints, varnish, colors, etc. A. T. Quick, Jr., is president, and H. B. Hughes, secretary, both of Lynchburg.

THE RICH STEEL PRODUCTS CO., Vernon, Cal., has been incorporated with a capital of $3,500,000, to manufacture iron and steel products. The incorporators are Richard L. North, L. L. Otis, H. F. Prince and S. M. Haskins. The company is represented by Gibson, Dunn & Crutcher, 1111 Merchants' National Bank Bldg., Los Angeles, Cal.

THE REX MCDILL CO., Haines City, Fla., has been incorporated with a capital of $200,000, to manufacture chemicals and chemical byproducts. Rex D. McDill is president and general manager, and Fred J. Hampton, secretary, both of Tampa, Fla.

THE BAINTSVILLE OIL & REFINING CO., Wilmington, Del., has been incorporated under state laws with a capital of $5,100,000, to manufacture petroleum products. The company is represented by the Corporation Service Co., Wilmington.

THE PENN LEATHER PRESERVING CO., Pittsburgh, Pa., has been incorporated with a capital of $10,000, to manufacture leather preservatives and kindred compounds. N. B. Trumbo, McKees Rocks, Pa., is treasurer.

THE CURTIS PROCESS REFINING CO., Indianapolis, Ind., has been incorporated with a capital of $100,000, to manufacture refined oil products. The incorporators are F. A. Curtis, C. B. Cox and B. W. Templeton, all of Indianapolis.

THE GOLD SEAL CO., Bloomfield, N. J., has been incorporated with a capital of $125,000, to manufacture fiber products and affiliated specialties. The incorporators are George M. Browning, Robert W. Nicholls and William P. Baerenrodt, 251 Spruce St., Bloomfield.

THE KLEAN-O PRODUCTS CORP., 1307 North Clark St., Chicago, Ill., has been incorporated with a capital of $5,000, to manufacture chemical compounds and preparations. The incorporators are N. M. Strebel, H. W. Bjernson and Sexton Bruce.

THE AMBER OIL CO., Bowling Green, Ky., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are J. E. Waldron, A. H. Malaney and B. J. White, all of Bowling Green.

THE WATER VALLEY FOUNDRY CO., Buffalo, N. Y., has been incorporated with a capital of $20,000, to manufacture iron and other metal castings. The incorporators are M. A. and C. A. Fries, and J. L. Babinger. The company is represented by Harding & Harding, attorneys, Buffalo.

THE UNITCO POTTERY CO., Trenton, N. J., has been incorporated with a capital of $125,000, to manufacture sanitary earthenware and other pottery products. The incorporators are John Morgan, William G. Amisson, Sr. and Jr., 77 Frazier St., Trenton.

THE CLINCH RIVER ZINC CO., Memphis, Tenn., has been incorporated with a capital of $500,000, to operate zinc properties and manufacture zinc products. The incorporators are John Cunningham, Arlington, Tenn.; and P. R. Cary and B. D. Bird, both of Memphis.

THE BRITE-LITE POLISH CO., Tulsa, Okla., has been incorporated with a capital of $25,000, to manufacture polishes and kindred products. The incorporators are P. G. Heffelfinger and S. S. Bassett, both of Tulsa.

THE SEARCHLIGHT PAINT SUPPLY CO., 5-7 Commerce St., Baltimore, Md., has been incorporated with a capital of $25,000, to manufacture paints, oils, etc. The incorporators are William H. and Charles I. Jamieson, and Bernard J. Flynn.

BRUCKNER, LIPPMAN & JACOBS, INC., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture leather products. The incorporators are M. Bruckner, I Lippman and D. S. Jacobs. The company is represented by Joseph Kohler, 280 Broadway, New York.

THE AMERICAN CONCRETE TILE & PRODUCTS CO., 426 New Amsterdam Bldg., Baltimore Md., has been incorporated with a capital of $250,000, to manufacture cement roofing tile and kindred products. The incorporators are John W. Ritter, John E. Springer and John T. Davis.

THE WINDSOR LOCKS PAPER MILLS CO., Windsor Locks, Conn., recently incorporated, has been organized with H. H. Turner as president; H. E. Platt, Jr., treasurer; and J. R. Kedley, secretary, Windsor Locks, to manufacture paper products.

THE RUBBER PROCESS CORP., Detroit, Mich., has been incorporated with a capital of $50,000, to manufacture rubber products under a special process. The incorporators are A Frank Bigger, Leo and Eugene Siegel, 1060 Fort St., W., Detroit.

THE OXAGINE CHEMICAL MFG. CO., Wilmington, Del., has been incorporated under state laws with a capital of $1,000,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Service Co., Wilmington.

THE ARISTO PRODUCTS CO., New York, N. Y., has been incorporated with a capital of 10,000, to manufacture polishes and kindred compound products. The incorporators are I. L. Hopkins, P. Berman and M. A. Karp. The company is represented by Goldstein & Phillips, 217 Broadway, New York.

THE ELIBI PRODUCTS CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are W. H. Haack, J. C. Williams and R. S. Kristeller. The company is represented by Watson, Kristeller & Swift, 68 William St., New York.

Manufacturers' Catalogs

THE HAMILTON COPPER & BRASS WORKS, Hamilton, O., has issued Bulletin 52 describing and illustrating Hamilton copper steam-jacketed kettles for the chemical and related industries. These kettles are furnished with or without agitators; one model is particularly designed for thick or lumpy materials. Capacities 25 to 250 gal. are carried in stock.

THE SULLIVAN MACHINERY CO., Chicago, Ill., has issued three new illustrated bulletins. Bull. 71-F is on the Sullivan Displacement Pump for Elevating Acid by Compressed Air; Bull. 70-W. on Sullivan Rotators and Bull. 71-G on the Sullivan Air Lift Pumping System, giving methods and apparatus.

THE CHICAGO PNEUMATIC TOOL CO., New York, has issued a special bulletin which should be of value to users of pneumatic tools, because it gives specifications which can be used as a reference when ordering tools. Bull 70, on vacuum pumps, which is the first of its kind to be issued by this company, contains information on dry vacuum pumps, steam, belt or motor driven.

THE CHAPMAN ENGINEERING CO. Mt. Vernon, O., has issued a booklet on Erecting and Operating Instructions. It contains detailed instructions for successfully operating a bituminous gas producer.

THE HAUSER-STANDER TANK CO., Cincinnati, O., announces a new publication entitled "Wooden Tanks for Every Purpose." The construction of wooden tanks for general use is shown, as well as specially constructed and irregular shaped tanks for special purposes. Especial attention is called to a study of the action of various chemicals upon different woods used for chemical tanks.

THE MINE SAFETY APPLIANCES CO., Pittsburgh, Pa., calls attention to Bulletin 72, on Burrell Gas Masks, for use in carbon monoxide and for all service.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

PERKIN MEDAL will be presented to William M. Burton by the Society of Chemical Industry at its meeting Jan. 13 at the Chemists' Club, New York.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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"Prohibiting" Chemical Warfare

THE accomplishments of the Disarmament Conference have been of an epoch-making character and the high principles that have guided its work have received universal acceptance and approval. It is, therefore, with no small measure of temerity that we raise our voice to question its recent stand on chemical warfare. As an expression of humane purpose and magnanimous intent the resolution may be worth while, but as a means of actually prohibiting the use of gas in warfare we are inclined to doubt its efficacy. Some way or other we cannot help but feel that it was a mistake to disregard the recommendations of the committee of experts and to accept the views of the non-technical advisers, even though they included officers high in the councils of the Army and Navy Departments.

It will be recalled that the committee of experts consisted of Professor EDGAR F. SMITH, chairman, and Brigadier-General AMOS A. FRIES for the United States, Colonel BARTHOLOMEW for Great Britain, Professors MOUREU and MAYER for France, Colonel PENTINALLI for Italy, and Major-General HARAGUCHI for Japan. This committee had presented a logical, convincing report supported by incontrovertible evidence from the late war. They proved that it was not feasible for the Conference to attempt to prohibit gas warfare, and that manufacture of poison gas as a military agency could not be controlled. On the other hand, the reports of those who opposed this form of warfare were noticeably weak, in our opinion, and inclined to deal in the sort of generalities that appeal to our broader sympathies, even though they do not always influence our better judgment. They state that chemical warfare is "a cruel, unfair and improper use of science," but for that matter so is all of warfare. Furthermore, it is quite contrary to the fact to claim that the use of gas inevitably results in its application to non-combatant as well as combatant. An unscrupulous enemy might so apply it, but there is no more reason why he must than there is that he should bomb a defenseless city with high explosive or sink an unprotected hospital ship with his torpedoes. The choice is his.

But let us turn to the resolution for a minute to find out, if we can, something of its real significance. It reads as follows:

> The use in war of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices having been justly condemned by the general opinion of the civilized world and a prohibition of such use having been declared in treaties to which a majority of the civilized powers are parties;
>
> Now to the end that this prohibition shall be universally accepted as a part of international law binding alike the conscience and practice of nations, the signatory powers declare their assent to such prohibition, agree to be bound thereby between themselves and invite all other civilized nations to adhere thereto.

Is chemical warfare to be forgotten as a nightmare of the past or does this resolution mean, as one diplomat is quoted as saying, "that in the next war each of us promises to wait until the other fellow uses gas before we do?" The mere restating of an international law which has already failed to withstand the actual test of war can scarcely be regarded as a lasting solution of this problem. Under these circumstances preparation for chemical warfare must go on, for no nation can afford to be unprepared against a treacherous nation which may refuse to be governed by the law of nations. There are no penalties attached as was the case with the submarines, which, by the way, were limited as to use and not abolished. The only punishment awaiting the user of poison gases is the moral condemnation of other nations, and this, to be effective, depends upon the support given it by the public opinion of the world.

The attitude of the other powers toward the Conference resolution is a matter of considerable interest. Great Britain appeared somewhat skeptical of its efficacy. The French delegates seemed considerably more enthusiastic in according their approval to the resolution, while in the case of the Italians and Japanese the proposition was met with joyous acclaim. Apparently the sentiment against chemical warfare varies inversely with the size and development of a nation's organic chemical industry.

The importance of peace-time chemical plants for dyes and medicines is still evident. Governments bound by international agreement to prohibit gas warfare will continue to make gas masks and other defensive equipment, but they cannot, in good faith, erect and operate chemical arsenals for the production of poison gases. Should the world again be faced by a conscienceless enemy, the only safe preparedness lies in the organic chemical industry, with its plants and chemically trained personnel.

All Is Vanity And Vexation of Spirit

BY WHAT curious twist of the ego does a man who has achieved reputation and eminence in his chosen calling betray himself into attempting to speak with authority on other matters of which he knows little or nothing? What is it that apparently leads a man to believe that because his opinion would be accepted on a certain subject, his voice will be equally effective if lifted up in the wilderness of his ignorance? Recently we seem to have had an epidemic of this kind of public pronouncement by prominent men on topics quite outside their knowledge.

First, Mr. EDISON and Mr. FORD inspected the great nitrate plant at Muscle Shoals and we were informed that the former was so pleased with the place that "he would like to wander through it all night." We admit it is a fascinating plant, and we are only sorry that the process used at No. 1 was a failure. But Mr.

EDISON was more than fascinated, and we can take heart because he "offered several suggestions for making the process a success, but as the plant is not running they cannot be tried out now." This is truly unfortunate. Mr. EDISON should have visited the plant several years ago.

And after Mr. FORD had been to Muscle Shoals he delivered himself of a profound opinion on money and methods of financing which consist simply in "displacing gold as the basis of currency and substitute in its place the world's imperishable natural wealth." Thus we would put an end to war because "the cause of all wars is gold." He would substitute energy units for the precious metal and issue currency thereon—a sort of horsepower dollar.

But at the same time that Mr. FORD was condemning gold, Professor IRVING FISHER, economist of Yale University, was upsetting all our industrial calculations by holding out the possibility of Germany paying her reparations by means of synthetic gold. Addressing the London School of Economics, Professor FISHER is reported as saying that he has "been credibly informed that a German chemist has already succeeded in a laboratory in making synthetic gold out of baser metals by means of an electric vacuum furnace." Note the vacuum. Let the process become cheap enough and the Germans could "flood the world with chemically manufactured gold and so make it worthless." This should satisfy Mr. FORD.

We repeat the question with which we opened our discourse, and leave the reader to answer. When Mr. EDISON talks on electricity, Mr. FORD on automotive industry and Professor FISHER on economics we listen with rapt attention, but somehow when they respectively deliver sober opinions on nitrogen fixation, economics and synthetic gold, we grow restless and perhaps a bit disrespectful. We wish they wouldn't do it, because we like to hold them in the highest esteem.

Salaries for Government Professional Men

ON DECEMBER 15 the House of Representatives passed a bill (H.R. 8,928) for the classification of civilian positions in the government which establishes grades for the professional workers in the federal service. In order that uniformity of practice may prevail in the several technical bureaus and proper attention be given to salary scales of all, it is a distinct step forward to have this bill receive favorable action.

The salaries provided for beginners (college graduates) in professional work will be from $1,620 to $1,980. The next grade will be $2,100 to $2,640, and so on until finally the highest compensation recognized is for those in the chief professional grade, which "shall include all classes of positions in this service the duties of which are to act as the technical and administrative head of a major professional or scientific bureau," for which the compensation is to be $5,400 to $6,600 unless a higher rate is specifically authorized by law. No one will claim that these salaries are wholly adequate, especially in the higher grades. But apparently they represent a slight increase for the professional workers and as such should be welcomed.

The legislation is, however, seriously defective in two particulars. It provides that all vacant or new positions must be filled at the *minimum* rate of the appropriate grade. Thus apparently if a man is not qualified for $2,100 as an assistant chemist, the maximum which could be paid him would be $1,620. In other words an $1,800 man outside the service could not be recognized as such even though an $1,800 vacancy might exist; such vacancy would have to be filled by promotion. Also it would appear that the bill contemplates more or less automatic promotion for professional workers "not more than once a year." This places the professional workers as cogs in a mechanical personnel scheme of the most vicious sort. It applies the rule of seniority almost without regard to merit or efficiency.

Industries interested in chemical classification and compensation of professional workers will be glad to study and may profit by considering the proposed rates of compensation and the rather loose but significant classification of the positions. However, it is certainly to be hoped that they will not follow either a rigid scheme of salary fixing or any idea of automatic promotions. Either of such practices is vicious in the extreme when applied to scientific or professional workers.

Co-operation to Promote Our Foreign Trade in Chemicals

THE Bureau of Foreign and Domestic Commerce has made an unquestioned success of its effort in the commodity divisions already organized for the furtherance of foreign trade by investigation and report on domestic and foreign problems of production, distribution and marketing. One of the very first divisions contemplated last year, when this work was being planned by Secretary HOOVER and his assistants, was a division of chemicals. However, that division of the work has never been organized, largely if not wholly because the industries for which the service was designed showed a very obvious unwillingness to co-operate in the work. Apparently the difficulty arose from a confused idea in the minds of some prominent members of the heavy-chemicals industries that this work in promotion of export was interlocked with some statistical work regarding the domestic industries in the Bureau of the Census to which these industrial leaders found objection.

For the fiscal year beginning July 1, 1922, it is proposed in the national budget that additional commodity divisions be organized. Thus far there have been more than a dozen such divisions, including those on iron and steel, rubber goods, textiles, fuels, leather, etc. It is now proposed that divisions be added to deal with vegetable oils and breadstuffs, dyes and drugs, heavy chemicals, paints, varnishes and tanning materials, paper, non-ferrous metals, glass and earthern ware, petroleum and others not so directly of chemical interest. And the need for these is clear.

Stabilization of many chemically controlled industries demands that at least a small percentage of the products of these industries be exported. The federal government's effort to stimulate and stabilize such export business is, therefore, of great importance. It is to be hoped that the requested appropriations for the extension of the work will be granted.

It is even more to be hoped that the chemical industries will not again make the mistake of seeming to be unwilling to co-operate with the Department of Commerce. That department can do much good for the industries, and if co-operation on the proper basis is assured there is no likelihood of objectionable practice within the department. The organic chemical industries of the country recognize these facts. May the other branches of chemical business appreciate them also.

Soft Lead And Soft Soap

A SERIES of four articles by JEROME ALEXANDER, discussing the colloid state in metals and alloys, commences in this issue. It is of a nature which should and probably will interest many readers, both metallurgists and chemists, as the title attempts to indicate. Again, its perusal should build an excellent background for Dr. BANCROFT'S forthcoming lecture before the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers on "Colloid Chemistry and Metallurgy," even though it may be expected that these two gentlemen will view the subject in different perspective. Rather than infer the ultimate constitution of alloys from information gained when studying viscous colloids, BANCROFT would probably reverse the process, and argue from the "simple" alloy structure to the "complex" jelly.

The principles of colloid chemistry undoubtedly have intimate bearing upon that most practical problem of metallurgy: hardening. It has long been accepted that at high temperatures, carbon (the iron-hardener) is in solution or atomic dispersion in the hot solid metal, whereas after slow cooling it accumulates into visible crystals of carbide. Somewhere early in the range between these two extremes, which are both soft, occurs a certain arrangement of submicroscopic (and doubtless colloidal) particles of carbide which is associated with extreme hardness. Such facts as these led ALEXANDER, as early as 1908, to assume that maximum hardness in metal corresponds to "zones of maximum colloidality," where the system exhibits surface phenomena to the highest extent.

At that time steel was about the only metal which could be usefully hardened. In more recent years duralumin has been shown to be another such, and Dr. MERICA led fellow investigators in defining the conditions of its behavior, thus: "There is a certain size of particle of $CuAl_2$ [insoluble in the aluminum] for which the hardness of the material is a maximum." Dr. JEFFRIES later dubbed this condition a "critical dispersion." Recently he has given a highly useful view on the actual mechanism of hardening action in his paper on "Slip Interference Theory of the Hardening of Metals," appearing in these columns a few months ago —a contribution, by the way, which many chemists could read with advantage, despite its metalliferous title.

It may only be invidious to discuss priority in these ideas, and doubtless agreement could never be reached among colloid chemists and physical metallurgists, because of a fundamental difference in mental processes. The chemist fixes his attention upon surface forces, and without requiring any working model of their action, readily agrees with ALEXANDER that there is a certain fine subdivision of phases which possesses the maximum amount of internal energy and hence greatest hardness. The metallurgist requires a more, shall we say, mechanistic demonstration of the problem. He has been used to working with solid and relatively rigid masses of crystalline metal; he associates the idea of hardness with certain tests he has made on the metal; he observes certain microscopic changes to accompany permanent deformation; and naturally an explanation of hardness which appeals to him must use his terms and explain his facts. This Dr. JEFFRIES and Mr. ARCHER have done in a most skillful way.

Perhaps both are right!

Byproduct Coking For the Public

IN ONE SENSE we have been doing exactly the wrong thing with byproduct coke ovens, for most of those we have built have been located adjacent to blast furnaces. Of course the word "we" is used to represent society collectively. It may be asked how a better location for a plant can be found than next door to the largest consumer of the product involved. It is true the blast furnaces have been using 75 or 80 per cent of all the coke the country has been producing, but the coke produced represents only about 10 per cent of all the bituminous coal produced. Speaking for national economy, a great many of those who are consuming bituminous coal should be using byproduct coke.

Most of the byproduct ovens built have been located at blast furnaces because the steel industry had the capital and was willing to invest it. The record of 1921, with production of both pig iron and steel ingots at 37 or 38 per cent of the productive capacity, shows that the blast furnace is not a steady consumer of coke. Households and public utilities are much steadier consumers, and as a byproduct coking plant is one that involves a very heavy investment, it should be predicated on as steady an operation as can be compassed.

The wide variation in blast-furnace coke requirements from time to time has occasioned much less economic loss than would be the case if byproduct ovens were depended on solely at the time of maximum load. Speaking approximately, the coking capacity of the country is divided one-half beehive and one-half byproduct. Last July, when blast-furnace operations were at their minimum, coke production was aligned one-eighth beehive and seven-eighths byproduct, and thus in a measure the remaining beehive coke ovens of the country exist to carry the peak of the load.

It might be argued that the blast furnace and steel plant can provide itself with a full complement of byproduct coke ovens, and then sell to the public when its own requirements are light, as is so frequently the case. One difficulty is that rail freight rates are high even for very short coke hauls, while a greater difficulty is that the gas cannot be freighted at all. The byproduct coking plant located near a municipality can truck its coke and pipe its gas and count on a much steadier demand than is furnished by blast furnaces and steel mills.

It is established that the iron and steel industry can well afford to carry byproduct coke-oven investment even though the employment of the facilities is quite irregular. Much more, then, can the investment be carried when the arrangement is such that there is a relatively steady demand for the coke and gas. A recent transaction involving approximately 100,000 tons of byproduct coke indicated that the producer had a leeway of about a dollar a ton in underselling the actual cost of producing and transporting Connellsville coke. The computation was complicated, involving cost of coal and coal freights, value of byproducts, etc., but the net result was approximately as stated. The byproduct coke producer does not, however, retain the money, since nearly all of it goes to the railroad that transports the coke. If the ovens could be moved to the point of coke consumption for the life of the contract, this would be saved, as the assembly cost of the coal would not be increased. Thus it is advantageous to locate the plant so that there will be no freight on the coke. There is no milling-in-transit arrangement for coal and coke.

Readers' Views and Comments

Seriums and Anta Toxines

To the Editor of Chemical & Metallurgical Engineering

SIR:—My friend ——, well, now, never mind what his name is. He is a little shy about seeing it in print, but I shall ask you to take it from me that he is a real chemist and would be one even in New Jersey, where they are tagging them. He has been receiving letters in reference to a chemical venture in Kansas City from the treasurer of the prospective concern, and on reading them they seemed so interesting to me that I begged him to let me offer at least one of them to you for publication. This reads:

> Dear Sir, I am writeing you at the suggestion of Mr. —— of ——. He tells me you are a practical Chemist, now at this time we are Organizing a large plant for Kans City Mo. we have enough Stock sold and promiced at the present time to put it over in a smaller way than we wanted to start with; but we are not tiard of well doing so are going to add some more to what we now have, we expect to Manufacture a full and compleet line of Chemicals and specilize in Seriums Anta Toxines, Glanular Extracts, and in fact other lines not mentioned, we thought perhaps you would like to connect yourself with a concern like this, in a Financial way at the present time, and in the future you wished to employ yourself in this capasity in this part of the U S, the writer believes it would be a fine thing for you to associate yourself with this young Factory before the present issue of stock is raised in price above par we are issueing Stock at par value of $10.00 per share would like to hear from you if interested will mail you a compleet prospectus of the whole situation. Respt Yours J. D. HENDERSON, Treas.

There is another one from the same erudite gentleman setting forth the advantage of getting in on the ground floor so that my friend may participate in "the groth" of the company. It tells him that, he being a chemist, "there is no use to dwell on the profeit end of the business" and "hense" he will understand it.

The officers of the company are respectively Messrs. Thompson, president; Henson, secretary, and Henderson, treasurer—all sons, you observe. The correspondence makes me want to urge old Mr. Thomp, Mr. Hen and Mr. Hender to send the boys to school for a while before they begin to produce their "seriums."

There is nothing to hinder these promising gentlemen from engaging in pharmaceutical industry, but I can't help wondering how the scholarly gentlemen of the Kansas City Section of the A.C.S. will greet their new colleagues. MARTIN SEYT.

Various Methods for Hardening High-Speed Steel

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest Mr. d'Arcambal's paper on "Various Methods for Hardening High-Speed Steel," which is published in the Dec. 21, 1921, issue of CHEMICAL & METALLURGICAL ENGINEERING. Mr. d'Arcambal, in speaking of blisters and pitting of high-grade steel when heated in barium chloride, lays this trouble to the graphite crucible.

Several years ago I had occasion to experiment with barium chloride as a heating bath for high-speed steel. The furnace first used was an oil-fired crucible furnace, the container was a graphite crucible. The work hardened from this bath when new, showed no sign of blister or pitting, but after a day or so of use the steel would blister. In form the appearance of these blisters was that of oyster shells. Examination at that time led us to believe that the trouble came about by the surface of the steel flowing from one spot and building up at another spot. In other words, pits and blisters existed together. It was found that this trouble could be eliminated by a renewal of the barium chloride until that in turn became unfit for use. It was also found that an accumulation of molten metal took place at the bottom of the crucible. This was found accidentally by dropping the tool being hardened to the bottom and on its removal a considerable quantity of this metal had adhered to it, rendering it quite useless. At first it was thought the tongs and poker used in holding the work had melted sufficiently to cause this accumulation. Some of this metal was saved and although never analyzed, it was undoubtedly due mainly to successive drippings from the high-speed tool.

Brearley, in his "Heat-Treatment of Tool Steel," shows several pictures relating to the above findings. He also analyzed the metal found at the bottom of the crucible as follows: Carbon 2.56 per cent, manganese nil, chromium 1.13, tungsten 8.48.

It is a question whether this action of barium chloride on steel is in any way related to the action of borax in carburizing and adding of new metal, as claimed under British patent 125,666, by Samuel Whyte, May 1, 1919.

Hardening of high-speed steel in barium chloride contained in a firebrick crucible did not cause the trouble referred to in the graphite crucible.

Hartford, Conn. S. P. ROCKWELL.

Hydrochloric Acid as an Etching Reagent

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your journal of Nov. 23 we noted an article on the use of concentrated hydrochloric acid as an etching reagent for nickel, written by Henry S. Rawdon and Marjorie C. Lorentz. This proved doubly interesting to us, as we had accidentally discovered the value of hydrochloric acid in this connection.

A short time ago, while using nickel shot as a reducing agent in a rough analysis of a solution of tin in concentrated hydrochloric acid, we noted that very shortly after boiling commenced, the nickel appeared to be etched. Subsequently, a specimen of the same nickel was properly prepared and polished, and the etching value of boiling concentrated hydrochloric acid tried. The results were highly satisfactory. In from 2 to 5 minutes etching was completed, the crystal being as clearly defined and contrasted as those shown in Fig. 1*b*, of the above article, which represents a section of a sample which had had 1 hour's etching with cold concentrated acid.

We have since on different occasions used boiling concentrated hydrochloric as a metallographic etching reagent for nickel, and uniformly excellent results have been obtained. W. G. ROBERTSON,

Faculty of Applied Science, University of Toronto. A. H. MELLISH.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Dec. 17, 1921.

PROBABLY the chief topics for discussion during the past month have been the santonine and gas mantle cases, which have just been dealt with by Cyril Atkinson, K.C., the referee appointed under the safeguarding of industries act. While British chemical industry as a whole has been deeply concerned as to the outcome of these test cases and the technical journals have given considerable prominence to the very conflicting evidence presented by the "experts," the daily press, including the *Times*, has scarcely referred to what are certainly far-reaching decisions of great importance to industry.

When Is a Chemical Not a Chemical?

In some respect the chemical evidence and the judicial mind may be said to have been trying to answer conundrums rather than taking a broad common sense view. Santonine is a medicinal chemical extracted from flowers grown in south Russia, and its supply is at present under the control of German and Russian interests, which have raised the price by about 800 per cent over the pre-war level. The raw material could also be collected within the British Empire and santonine is apparently a crystalline substance of definite composition, which might conceivably be synthesized and thus ultimately come under the act as a synthetic organic chemical. Yet on the balance of the evidence it has been held that it is not a "fine" chemical, and so the game goes on. The primary purpose of the act is to safeguard industries actually carried on or likely to be carried on in this country, and in excluding santonine from its operation the general opinion seems to be that the decision interprets the spirit of the act and the intentions of the legislature. Next week it is the turn of calcium carbide on the motion of the British Cellulose & Chemical Manufacturing Co., of airplane dope fame, which installed at the request of the government a 30,000-ton carbide plant during the war, and although this manufacture may not be economically sound, it is thought to be a key industry requiring protection. If, on the evidence, carbide is deemed to be an organic chemical, an import duty of 33 per cent would be imposed, and speculation is rife as to what would then happen in the case of putative organic compounds such as the carbonates, carbon bisulphide, solid carbon dioxide, dissolved acetylene and kindred substances containing carbon. The third case to be heard will be that of cream of tartar, and it is confidently predicted that by then our legal luminaries will be in hospital suffering from brain fever.

Rare Earths in Gas Mantles to Pay Duty

The gas mantle case turned on the conundrum, "When is a compound not a compound?" some of the experts suggesting that a chemical compound was necessarily referred to in the act and that a mixture was not included. The common sense view prevailed in this case and the cerium and thorium contents of the mantle are now subject to duty, but not the gas mantle as a whole. Probably further protection under the dumping clauses will now be sought by the manufacturers, as unless the whole mantle is taxed, the amount of the duty imposed would be insufficient to enable continental competition to be met successfully. Both in the santonine and gas mantle cases the awards have not yet been signed and the Board of Trade appears to be unjustifiably endeavoring to have the decisions modified —probably without success.

Sir Arthur Duckham Announces Probable Solution of Peat-Drying Problem

In stating last month that one or two important inventions were on the point of fruition, the new drier and evaporators for the treatment of peat developed by Peco, Ltd., which has carried on the work of Wet Carbonising, Ltd., and Testrup, were among others in your correspondent's mind. It is understood that 1 ton of fuel in these apparatus will be capable of removing about 20 tons of moisture from peat, and an experimental plant is now being erected with a capacity of about 40 tons a day. Sir Arthur Duckham is at the head of Peco, Ltd., and is very sanguine as to the future of the invention, which should be of great importance to Canada, Italy and Great Britain among others. Plauson's colloid mill, regarding which propaganda has recently been made, is perhaps in a different category, because it has been very diffcult to obtain trustworthy information or to get down to business. Briefly, Plauson claims to grind in water as a disperse medium rubber and many other materials to a fineness of between 1 μ and 10 $\mu\mu$—i.e., 0.001 mm. and 0.00001 mm.—and that in this "colloidal" condition with or without the addition of certain substances acting as protective colloids an entirely new field is opened in soap manufacture, fat hardening, colloidal wood, graphite, etc. Plauson and his financial agent in London have protected the invention with a cloud of patents, but so far no one seems to have seen the mill in satisfactory operation or has learned anything regarding its efficiency, output or the power required to drive it.

General Notes

There is quite a vogue in rustless irons and steels at the moment and in addition to Vickers' and Krupp's steels referred to in my last month's notes, the rustless iron made by J. J. Saville & Co., Ltd., is worthy of notice. It differs from the others in not requiring hardening and in that it is ductile with a tensile strength of 40 tons and an elongation of 25 per cent with a reduction of area of 60 per cent. These properties enable it to be pressed, spun, stamped or cold-worked into the most intricate shapes without requiring subsequent heat-treatment, and in the soft condition, when polished, will not tarnish or rust and will probably also find a limited application in the chemical industry. Very little progress has been made in electrolytic iron and the new material seems to be a good substitute. West's paper on the Claude process [see p. 58 of this issue] has failed to draw any reply or information from the Brunner Mond group and meanwhile there is a tendency to reconsider the merits of the Häusser explosion process for direct production of nitric acid from coke-oven gas, which would be a very useful adjunct to ammonia synthesis, particularly as the oxygen obtained as a byproduct could be used to increase the yield from the explosion process. The recent cinematograph evening organized by the Society of Chemical Industry was the first of its kind in this country and it is generally thought that the use of motion pictures so prevalent in America will be extended and that films shown in the future will be of a standard more comparable with those usual in America.

Colloidal State in Metals and Alloys. I—Molten Metal

Just Prior to Solidification, Metal and Glass Show Many Similarities—Pure Molten Metals Are Doubtless Isocolloids—Ultramicroscopic Researches on Glass Are Quoted to Indicate Expected Results When Such Studies May Be Extended to Metal

BY JEROME ALEXANDER*

THE object of this paper[1] is to show that many of the important phenomena of metals and alloys are due to the facts that at a certain stage of their existence they or some of their constituents are in a colloidal state of subdivision, and that notwithstanding the generally brief duration of this stage and the powerful crystallization tendency of metals, a portion of the metal or alloy tends to remain in the colloidal state and exert a powerful influence upon the physical properties of the final solid magma. Incidentally it will become evident that the so-called amorphous phase in pure metals is an isocolloid, consisting of colloidal groups of metal molecules which may be dispersed in still more finely subdivided metal; that these colloidal particles are not truly amorphous, but may consist in part, if not entirely, of ultramicroscopic crystals; and that the expressions "amorphous phase" and "amorphous theory" might with justice be replaced by the expressions "colloidal phase" and "colloidal theory."

Nature of Colloidal Particles

To avoid misunderstanding, allow me to recall that any substance is in colloidal state when the constituent particles consist of molecular or atomic groups, whose size varies approximately from about 100 $\mu\mu$ down to about 1 $\mu\mu$—that is, from just below the limit of microscopic resolvability down to the dimensions commonly ascribed to the larger molecules. It should be particularly noted that colloidality involves no assumption as to the shape, internal structure or orientation of the colloidal particles, size alone being the critical factor. A colloidal system may therefore contain crystalline groups, or amorphous groups (non-crystalline, random or haphazard clusters), or a mixture of the two. Thus the recent observations of Scheerer[2] with the X-ray spectroscope show that in certain gold and silver hydrosols the metal particles, including even those below the limit of ultramicroscopic visibility, consist of regularly oriented molecular groups—i.e., of tiny crystals, which show the same space lattice as macroscopic gold crystals. On the other hand, old specimens of silicic acid and stannic acid gels exhibit well-marked interference figures in addition to the characteristics of amorphous substances, and probably represent substances which are on the verge of crystallizing. Typical organic colloids, such as albumen, gelatin, casein, cellulose or starch appear to be truly amorphous.

Besides illustrating the point that a colloidal system may consist of crystalline or of non-crystalline groups, or of a mixture of the two, the results are of especial interest as showing the slow transformation, in the case of the silicic acid and stannic acid gels, of irregularly oriented into regularly oriented or crystalline groups, which indicates that the colloidal may be precursor of the crystalline condition.

Isocolloids

All colloids consist of at least two phases—the subdivided substance, or "dispersed phase," and the substance into which this is subdivided, the "dispersion medium." It should be particularly remembered that it is not even necessary that there be any chemical difference between the dispersed phase and the dispersion medium. For example, there is here given[3] in tabular form (Table I) a list of eight different "isocolloids" of water, where water forms both the phases.

TABLE I. WATER ISOCOLLOIDS

	Dispersion Medium	Dispersed Phase	Example
(1)	Solid ice....	Water vapor bubbles.....	Milk ice—turbid or milky white ice produced in refrigerating machines.
(2)	Solid ice....	Liquid droplets of colloidal size.....	G. Quincke (Drude's *Ann. Phys.*, vol. 18, p. 11, (1905), regards this as the usual structure of solid, "amorphous" ice.
(3)	Solid ice....	Solid ice in a colloidal degree of dispersion .	For proof of the existence of such systems, see G. Tammann, *Z. phys. Chem.*, vol. 69, p. 569 (1910); *Z. anorg. Chem.*, vol. 63, p. 283 (1909). According to Quincke (1) and (2) may be converted into (3) by reduction of temperature.
(4)	Fluid water	Water vapor bubbles of colloidal dimensions.....	Water, like other chemically homogeneous fluids near their critical vaporization temperature, shows turbidity, opalescence, varying density, etc.
(5)	Fluid water	Fluid water droplets of colloidal dimensions.....	Ordinary water is supposed to consist of a mixture of associated group (polyhydrol) and unassociated groups. See H. Schade, *Kol. Zeit*, vol. 7, p. 26 (1910) *Trans.*, Faraday Soc., vol. 6, pp. 71-129 (1910).
(6)	Fluid water	Colloidally dispersed ice....	This dispersion is unstable and exists only as a transition form. "Snow-water" is a similar coarser dispersion. See P. P. von Weimarn and Wo. Ostwald, *Koll. Zeit.*, vol. 6, p. 181 (1910). Colloidal ice is readily produced in chloroform or ether (von Weimarn; *loc. cit.*) or in ice cream. (J. Alexander, *Koll. Zeit.*, vol. 4, p. 106 (1909).
(7)	Water vapor	Colloidally dispersed water droplets.....	Fog, mist, clouds and (when coagulated) rain.
8)	Water vapor	Colloidally dispersed ice....	Fine snow or frozen fog, which in the upper atmosphere frequently produced a halo around the moon.

In addition to the ordinary ice referred to in Table I, there have been proved to exist at least four other kinds of ice, each heavier than water and stable only under the very high pressures at which they are formed.[4] Since cooling and contracting metals exert a powerful

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The present series of papers was written mainly in the fall of 1919. Reduced to about half their original form, they were read before the Columbus meeting of the American Institute of Mining and Metallurgical Engineers, October, 1920, and will so appear in vol. 64 of its *Proceedings*. They are now given in full, together with some recent additions which are indicated by enclosure within square brackets [ ].

*President, Uniform Adhesive Co., Brooklyn, N. Y. Member, Committee on the Chemistry of Colloids, National Research Council.

[1] See also J. Alexander, "Metals and Alloys From a Colloidal-Chemical Viewpoint" and discussion. *Trans. Am. Inst. Min. Eng.*, 1919.

[2] *Nachr. Ges. Wiss. Gottingen*, vol. 96, p. 100 (1918). *Chem. Abs.*, vol. 13, p. 2624.

[3] Adapted from Wolfgang Ostwald's "Handbook of Colloid Chemistry," p. 107, translated by M. H. Fischer (P. Blakiston & Sons Co., 1918). See also for example, W. E. S. Turner, "Molecular Association" (Longmans, Green & Co.), and H. Schade, *Koll. Zeit.*, vol. 7, p. 26 (1910).

[4] See P. W. Bridgman, *J. Frank. Inst.*, March, 1915, p. 315.

pressure upon their interior molecules, the question arises as to what extent this may influence their crystalline grouping. The fact that under uniform conditions one kind of ice formed in glass bulbs, whereas another variety formed in steel bulbs, seems to me to throw some light upon the effect of impurities in metals, for glass is slightly soluble in water at high pressure.[5] This relation is borne out by the fact that the presence of a few splinters of glass in the steel bulb, caused the appearance of ice *V*, the glass bulb variety. Bridgman's experiments also show that at 20,000 atmospheres pressure (about 300,000 lb. per sq.in.) paraffin and rubber actually become harder than is steel at the same pressure; further, that the expansive force exerted when water freezes into ordinary ice is about 30,000 lb. per sq.in. Water near the boiling point may be frozen by the application of a pressure of 20,000 kg. per sq.cm. As molecular forces are extremely powerful, we need not be surprised to find marked changes in the physical properties of metals to result from their application; and it is doubtful whether metal in the interior, especially of large masses, possesses the same properties as that on or near the surface, which alone is open to inspection.

Allotropy of Elements

Isocolloids may consist of a single element, in which case the dispersed and the dispersing phases are usually regarded as different allotropic forms of the element in question. Wo. Ostwald has proposed the term "allocolloids" for such systems, of which sulphur, selenium and phosphorus are typical examples. The relation to alpha, beta and gamma iron will at once occur to metallographists.

In describing the theory of dynamic allotropy W. E. S. Turner[6] says: "The fact that molecules of different kinds can co-exist in any liquid, the proportion of each depending on the temperature and other factors, has paved the way for a new view of allotropic modifications, according to which both forms can be present in a state of equilibrium. This theory has arisen more particularly as a result of the study of liquid sulphur, the abnormal behavior of which has been demonstrated to be due to a mixture of a mobile, yellow liquid called $S\lambda$, which predominates in amount, and a viscous brown liquid $S\mu$, the proportion of which increases with rise of temperature and attains a proportion of 40 per cent at the boiling point, 455 deg. The two forms are further distinguished and rendered separable, and therefore capable of determination, by the fact that $S\lambda$ is soluble, while $S\mu$ is insoluble in carbon bisulphide; indeed, corresponds in the quasi-solid form to the well-known amorphous sulphur. Certain reagents have the effect of stimulating the rate at which the equilibrium between the two forms is attained at a given temperature, other reagents retard the rate. Ammonia is such a stimulant, sulphur dioxide a retarder,[7] and by the addition of the latter, the mixture can be cooled and afterward analyzed without the equilibrium set up at the higher temperature being disturbed. Sudden cooling by plunging into cold water will also retard the change and preserve the equilibrium proportions."

By pouring a thin stream of liquid sulphur heated to 400 deg. into liquid air, von Weimarn[8] obtained a perfectly transparent and exceedingly elastic sulphur. In this case the extreme speed of the chilling with the accompanying rapid increase in viscosity inhibits both the allotropic molecular rearrangement and also the colloidal aggregation, the resulting allocolloid being a very finely dispersed sulphur sulphogel or solid sulphosol. Of interest also as showing the influence of surface conditions is the fact that sulphur crystallizes from hot oil of turpentine in the form of monoclinic prismatic crystals (sp.gr. 1.98), which are unstable and transform into octahedral rhombic crystals (sp.gr. 2.05) with the evolution of heat, the transformation being facilitated by scratching or vibration, or by immersion in CS_2 in which the latter form is soluble, and from solutions of which it is deposited on slow evaporation of the solvent.

Phosphorus shows a variety of allotropic forms (or mixtures of a few); and from the evidence discussed by P. W. Bridgman,[9] it seems obvious that ordinary red phosphorus consists of one allotropic form dispersed in another, the relative percentages depending upon the conditions of formation. In this paper Bridgman also describes a new black form of phosphorus (produced by pressure of 11,000 to 12,000 kg. per sq.cm. at 200 deg.), which is a fair conductor of electricity and has a sp.gr. of 2.691. White phosphorus has a sp.gr. of 1.83, red phosphorus a sp.gr. of 2.05 to 2.34 depending upon the method of its preparation; and both are perfect insulators. Thus, heating under high pressure results in an aggregation of some kind and gives phosphorus conductivity, a true metallic characteristic. In metals, a similar aggregation seems to occur because of the enormous cohesion or molecular attractive forces of the metal molecules themselves—a property made use of in shrinking on collars and the like and even in straightening the bulging walls of buildings by the shrinking of heated iron rods.

Mechanism of Solidification

When a metal is heated to fusion, the thermal agitation of its molecules is sufficient to overbalance, at least to some extent, the mutual attraction of its molecules; but this does not mean that the strong aggregation tendency of its molecules is without effect. On the contrary, in the state of kinetic equilibrium which exists, there must be a certain number of molecular groups, whose size and number tend to increase as the solidification point is approached—that is, as the thermal agitation diminishes. The higher the temperature to which the metal is heated and the quicker it traverses the zone of intense thermal agitation to the comparative quiet of solidification the smaller and more numerous will be the molecular groups. The general tendency seems to be for atoms or simple molecules to form crystals, whereas complicated molecules—especially those with several foci of attraction, like gelatine—tend to remain in random or colloidal clusters. Although Traube's experiments[10] indicate that liquid zinc, cadmium and mercury are monatomic, it is probable that investigation will show that all metals near their freezing points, and especially metals of high melting points, exhibit molecular association or else allotropism.

It would appear then that just prior to solidification and crystallization all pure metals are isocolloids—that

[5] The indications are that in volcanic depths, where high pressures and high temperatures exist, water and silicates exist as a jelly-like solid, which explodes into colloidal fragments upon sudden release, as at the eruption of Mt. Pelée at Martinique.

[6] "Molecular Association," p. 92. Longmans, Green & Co., 1915.

[7] Note the analogy to the effect of Mn in steel.

[8] *Koll. Zeit.*, vol. 6, p. 250 (1910).

[9] *J. Am. Chem. Soc.*, vol. 36, pp. 1344-1363 (1914).

[10] *Ber.*, vol. 31, p. 1562 (1898). W. E. S. Turner, citation (6), p. 53.

is, they consist of colloidal sized groups of metal molecules distributed in a more completely dispersed magma. But the dense concentration and proximity of their molecules, their powerful molecular attractive forces (their cohesion, to which they owe their strength and strong crystallization tendency) act so rapidly that, as a general rule, the major portion of the metal forms macroscopic or microscopic crystals, which are embedded in an intercrystalline network consisting mainly of colloidally dispersed metal having different physical properties from the crystals, of whose creation it constitutes a remaining vestige. While a fluid metal may contain a percentage of isolated molecules, it does not seem possible that many of these remain in the solidified metal, which consists mainly of macro- and microcrystals, and of oriented and unoriented groups of colloidal dimensions. Thus not even the most rapid chilling prevents non-magnetic γ iron from becoming magnetic, although at the temperature of transformation the metal is no longer fluid.

Effect of Grain Size

The more rapidly the fused metal is chilled the less opportunity there is for the growth of crystals beyond the colloidal stage—it is well known that quick cooling yields fine structure. The effect of quick chilling on the hardness and specific gravity of metals is illustrated by the following results, kindly worked out by W. A. Cowan of the National Lead Co.'s research laboratory. The chill castings were made in a water-jacketed cylindrical mold and measured 2 in. in diameter by 1 in. high. The slowly cooled specimens were of the same size and shape, but were cast in a hot mold, taking 12 minutes to solidify after casting from a moderate temperature. Small vertical sections, weighing about 20 g., were cut radially from the ingots, and the specific gravity of these was determined by immersion in distilled water, with weighings before and after. Before making the hardness tests, both sides of the ingots were machined flat, $\frac{1}{16}$ in. being removed from the bottom for testing surfaces. The results follow:

	Sp.Gr.	Brinell Hardness Numbers
Straits tin, chill cast	7.309	8.8
Straits tin, slowly cooled	7.301	7.7
Corroding lead, chill cast	11.367	5.2
Corroding lead, slowly cooled	11.354	4.4

As the differences between the melting and chilling temperatures in these experiments is, for metals, rather narrow, further tests are being made using liquid air as a chilling medium.

The results of quick chilling are analogous to those of cold hammering, which shatters the large grains and increases the percentage of colloidal metal present. Thus Zay Jeffries[11] reports the following results:

	Brinell Hardness Numbers
Cast tin, large grain	9.12
Cold-hammered tin	11.32
Cast lead, large grain	5.44
Cold-hammered lead	6.54

Much regarding the minute structure of metals may be determined by metallography, which involves the microscopic examination of suitably polished and etched metallic surfaces. Metallography has been most fruitful of results, and much of our present knowledge of metals and alloys has been attained with its aid, particularly knowledge of the crystalline phase or "grain." Of the so-called amorphous or colloidal phase, however, metallography can tell us but little outside of its occurrence and distribution. Owing to the great opacity of solid metals, it has thus far been impossible to subject the colloidal phase to successful ultramicroscopic examination, and such examinations of thin films along the lines laid out by Beilby present difficulties and cannot apply to the mass, although they may be of interest.

Similarities Between Hot Glass and Hot Metal

But glass may be readily examined ultramicroscopically, and a consideration of the phenomena observed in glasses will serve for the present to give some insight into what occurs in metals and alloys.[12]

Among glass technologists a molten batch of glass is termed "metal," a term remarkably well chosen, for, strange as it may appear, there are numerous analogies between glasses and most metals. Both are produced or fused at high temperatures, and as they issue from the furnaces are, for the most part, heavy viscous liquids[13] prone to set and crystallize. Both exhibit the phenomena of supercooling to a marked degree if quickly chilled. Both may be cast, molded, pressed, drawn and annealed or tempered—they are in fact thermoplastic and their physical properties are largely dependent upon their thermal and mechanical histories. There are, of course, many enormous differences between glasses and metals, and very marked differences exist even in their analogous properties. Thus with metals the crystallization tendency is powerful and quick acting, whereas with glasses the composition is generally chosen so as to prevent crystallization under operating conditions, some of the constituents of glass apparently serving as protectors or inhibitors of crystallization toward the others. Furthermore, metals tend to cool much more rapidly than glasses because of their greater thermal conductivity; but their rapid crystallization usually outstrips their chilling, notwithstanding the fact that the latter is often facilitated by quenching.

Behavior of Supercooled Melts

As Tammann has shown,[14] there are three main factors which control the behavior of supercooled melts: (1) The specific crystallization capacity (which is measured by the number of centers of crystallization formed in a unit mass in a unit time); (2) the speed of crystallization; (3) the variation in viscosity. In the case of the various mixtures of fused silicates composing molten glasses, the viscosity increases so rapidly upon cooling that the crystallization forces are unable to establish themselves before the melt becomes too rigid to permit molecular orientation. The result is the amorphous, or colloidal, mass we call glass. In very quickly cooled glass—i.e., Prince Rupert bubbles—the internal strains are so great that the glass is actually explosive; and in the ordinary process of manufacture glass has to be annealed to render it less brittle. This is accomplished by cooling the glass very slowly, keeping it at a low heat for a long time so that there may be a partial adjustment of the aggregation tendencies of its particles. Gelatin jellies act similarly, but, because of their softness, anneal spontaneously at room tempera-

[11] *J. Am. Inst. Metals*, vol. 11, p. 318.

[12] For results of ultramicroscopic examination of quickly and slowly chilled soaps, see J. Alexander, *Trans. Am. Inst. Min. Eng.*, 1919; *J. Soc. Chem. Ind.*, 1909; *Trans. Am. Inst. Chem. Eng.*, vol. 2, pp. 210-228 (1909).

[13] [Truly liquid metals have a low viscosity. See abstract of Prof. T. Turner, *J. Soc. Chem. Ind.*, vol. 40, p. 190R (1921).]

[14] *Z. Elektrochim.*, vol. 10, p. 502 (1904).

ture.[15] Thus F. Stoffel[16] has shown that quickly cooled gelatin jellies permit the more rapid diffusion of electrolytes than slowly cooled jellies; but the difference equalizes itself after several days. Incidentally this shows the higher dispersion of the particles in the quickly cooled jelly and the greater total area of diffusion paths.

If the composition or heat-treatment of the glass is such that crystallization occurs, we call the phenomenon devitrification—the glass becomes cloudy or opaque. The inherent tendency toward crystallization exists even in clear glasses, and may be realized after a very long lapse of time. [The composition of opaque glasses is so chosen that under usual conditions a turbidity is produced, a fine precipitate which renders the glass opaque. Recently James Gillinder, of Port Jervis, N. Y., was kind enough to make for me some Prince Rupert drops from a batch of opal glass. The exterior rind of the drops was clear or showed a faint turbidity, whereas the interior, which was of course more slowly cooled, was milky and opaque. At the surface the chilling was from about 1,200 deg. down to 15 or 20 deg.] Thus ancient Egyptian and Roman glasses are frequently found to be devitrified. On the other hand, although old leaden roofs consist of metal showing coarse crystals, ancient iron shows practically the same structure as modern iron. We must remember that iron as a rule consists mainly of the crystalline phase, which is stable, not of the colloidal phase, which is metastable and can undergo slow hysteresis; besides, iron does not undergo annealing at ordinary temperatures.

Gold Ruby Glass

The work of Zsigmondy, on gold ruby glass,[17] has given us an understanding of what happens when a metal is dispersed in glass. When gold is added to a glass melt (usually 1 part of gold chloride to from 3,000 to 10,000 glass), it dissolves, and the molten glass is colorless and upon slow cooling may become red or remain colorless, depending upon the nature of the batch. If quickly cooled to a set, all grades of gold ruby glass remain colorless. Upon reheating colorless ruby glass to the softening point, a portion of the dissolved or molecularly dispersed gold separates out upon nuclei or crystallization centers already formed in the previously chilled mass, and the glass usually develops its normal red color. Spoiled batches, upon reheating, generally yield a blue or violet shade, but may yield an unsatisfactory red. Reproduced in Table II are the ultramicroscopic observations of Zsigmondy made upon good and upon spoiled ruby glass, using bright sunlight and a homogeneous immersion objective. Both specimens had been slowly cooled and then reheated more quickly than they had previously been chilled; they were heated so that at one end they began to melt (hot end), whereas at the other end they remained cold (cold end).

TABLE II.

	Color Red Decreasing ↓	Good Ruby Glass	Color Decreasing ↓	Spoiled Ruby Glass
Hot End				
a		Color intense red. Numerous green ultramicrons, very close together, their brightness diminishing.		Color blue. Ultramicrons fewer, copper-red, further apart.
b				Color violet. Ultramicrons yellow.
b'				
c		Homogeneous green light cone		Color bright red. Ultramicrons green.
d		Colorless and homogeneous.		Colorless. Few faint specks visible.
Cold End				

That with these particular specimens no new crystallization nuclei were formed upon reheating is evident from the fact that the average distance between the ultramicrons was the same in the intensely heated portions as in the less heated portions of the glass. "Colorless, slowly cooled gold ruby glass contains one part of its gold, therefore, in supersaturated solution, and the remainder in the form of nuclei so small that they affect the homogeneity of the glass only slightly or not at all. With batches of different composition, the temperature for the spontaneous formation of nuclei is so much higher that such glass colors up red on slow cooling."

Applying these principles to technical practice, Zsigmondy was able to explain certain heretofore incomprehensible observations. Thus, "The rim of a piece of pressed ruby glass remained colorless, while the middle became red. In the press the rim was more quickly cooled than the middle, and by subsequent heating was heated more quickly and to a higher temperature. Investigation showed that the rim contained a much lesser number but considerably larger green gold particles than the rest of the glass. The rim of the glass had very quickly passed through the optimum temperature for the formation of nuclei, so that only few were formed; subsequent heating to a higher temperature, therefore, led to a speedy growth of these nuclei into particles of 110 to 145 $\mu\mu$. The middle section of the glass had time enough to form a large number of nuclei, which, being less strongly heated, grew more slowly. In spoiled ruby glass the formation as well as the growth of nuclei is disturbed; fewer nuclei are formed and these grow more slowly than in good ruby glass."

Devitrification of Glass

Zsigmondy emphasizes the fact that the coloring of ruby glass should not be confounded with ordinary devitrification. "The difference between the two is that in the formation of ruby glass several milliards of nuclei exist and grow in a cubic millimeter, and that the hypothetical little crystals, of whose form and structure we know nothing, are so small that their presence changes only the visible appearance and not the working properties of the glass; whereas, in the case of devitrification, relatively few nuclei are present and lead to the formation of quite large crystals, which prevent the usual working up of the glass."

This difference is clearly seen on considering the facts brought out by N. L. Bowen in a recent paper[18] on the devitrification of glass. While many silicates may be cooled quite slowly without crystallizing, $MgSiO_3$, Al_2SiO_5 and $CaSiO_3$ crystallize unless quickly chilled, a condition difficult of realization because molten silicates combine high thermal capacity with low thermal conductivity. The composition of the batch must be chosen to prevent supersaturation with any component at any temperature at which the glass is to be subsequently maintained. If devitrification occurs when the glass is cooled preparatory to working (or prior to the final stirring in the case of optical glass), the crystals formed are usually large. When the glass is cooled from the plastic to the rigid state, as during

[15] So do soft metals; lead and tin, for example.

[16] See H. Bechhold, "Colloids in Biology and Medicine," p. 52, translated by J. G. M. Bullowa. (D. Van Nostrand Co., 1919.)

[17] "Colloids and the Ultramicroscope," (translation by J. Alexander). John Wiley & Sons Co., 1909.

[18] *J. Am. Ceramic Soc.*, vol. 2, pp. 261-281 (1919).

blowing, drawing, casting and particularly when optical glass is being cooled in the melting pots, devitrification may occur through the separation of spherulites or minute crystals uniformly disseminated throughout the glass, making it opalescent. Microscopically these crystals were found to be trydymite and cristobalite in most cases investigated. Particularly interesting is the fact that their formation is facilitated by "mineralizers" such as SO_3 or Cl; arsenic acts similarly if in excess, and fluorine may do so. This reminds one of a "salting out" action; the opposite or protective action of constituents in a melt is illustrated by the facts brought out in a paper[19] by H. F. Bellamy on gold ruby glass. His results show that SnO_2 acts as a powerful protector or stabilizer, deepening the color of the glass to such an extent when added in optimum proportions that the the percentage of gold present has to be diminished.

The tin also keeps the color uniform over a range of reheating temperatures and prevents the development of light blue, purple or rose colors (which are indicative of coagulation or undue aggregation).

We have here a typical instance of protection in the colloidal sense, which is quite in line with the work of Zsigmondy,[20] who showed that the purple of Cassius (an ammonia-soluble deep red precipitate obtained by mixing solutions of chloride of gold and stannous chloride) is simply colloidal gold stabilized by colloidal stannic acid. Berzelius regarded the purple of Cassius as a chemical combination of tin sesquioxide and purplish oxide of gold, and Gay-Lussac, Debray, Müller and others contributed to the extensive literature concerning it. Zsigmondy settled the moot question, for he actually synthesized the purple of Cassius by mixing together the hydrosols of gold and stannic acid, thus proving it to be an adsorption compound of the two.

(Part II, dealing with Crystallization, will appear in a subsequent issue.)

The Claude Ammonia Process

AT A joint meeting of the Chemical Engineering Group of the Society of Chemical Industry and the Institution of Mechanical Engineers recently, J. H. West read a paper on the Claude synthetic ammonia process and plant, published in abstract in the Dec. 9, 1921, issue of *Iron and Coal Trades Review*. The author is associated with the Cumberland Coal Power & Chemical Co., which is erecting works at Workington to operate the process. The company has acquired three collieries in Cumberland, whose coke ovens are capable of making 3,000 tons of coke per day. With the view of obtaining a supply of hydrogen immediately and under the best conditions, a controlling interest has been acquired in the Tysse Water Power Co., in Norway, which has a plant of a capacity of 145,000 electrical hp. The cost of power for the production of hydrogen is about £1 per hp.-yr., or 0.04d. per kw.-hr. This acquisition also gives the company rights over the carbide factories at Odda, and with these means for the production of hydrogen it will be able to get to work more quickly than by producing the hydrogen in this country. The electrolytic-hydrogen plant in Norway has a daily capacity of over 9,000,000 cu.ft.

Claude's experimental work has shown very clearly that for a given temperature the proportion of nitrogen and hydrogen remaining combined under conditions of equilibrium increases rapidly with rise of pressure, and that the lower the temperature the higher is the proportion of combination. However, the lower the temperature the longer it takes to reach equilibrium, so that a compromise is necessary. Claude finds it best to work at 600 deg., and he uses a pressure of 900 atm., or nearly 6 tons per sq.in., as against the 200 atm. used by Haber. The hydrogen and nitrogen, mixed in the proper proportions, are first compressed to 100 atm. in an ordinary three- or four-stage compressor, passed through separating bottles, where any condensed moisture and oil from the compressor are drained off, and the gas mixture thence goes to the supercompressor. This is a simple two-stage machine capable of dealing with enough gas to make 5 tons of liquid ammonia per 24 hours—i.e., 426 cu.ft. per minute. One of these machines has been running in France for 9 months without trouble.

Small Pipe-Work Facilitates Gas-Tight Joints

An important result of working at superpressure is that the pipe-work becomes small; the pipes carrying the mixed nitrogen and hydrogen for a plant making 5 tons of ammonia per day are only 8 mm. bore, and the difficulty of making gas-tight joints is thereby greatly reduced.

Quite small catalyst vessels can be used which can be heated initially by external electric circuits, and after that the problem is to get rid of the excess heat. A Haber catalyst vessel for 20 tons of ammonia per day weighs 74½ tons, against 11¼ tons for Claude tubes. In the Claude plant there are four catalyst tubes, the first two of which are parallel, and the other two in series with the first two and with each other. The Claude tubes are of special chromium alloy without a lining. Some of these tubes have been made in France, and some in England by Messrs. Vickers, who use a metal called Vicronic which is said to have remarkable heat-resisting properties. The tubes are cast solid and bored out. The basis of the catalyst used by Claude is peroxidized iron prepared by burning iron in oxygen, with the addition of other equally cheap materials which are added in order to increase its activity and immunity from poisons.

Another important detail in the Claude process is the manner of removing the ammonia from the catalyst tubes. Under the Haber conditions it is necessary to inject water into the system and thereby recover the ammonia as an aqueous solution, leading to consumption of power and plant complication. At 900 atm., however, simple cooling by a coil immersed in water suffices to liquefy the whole of the ammonia with the exception of 2 or 3 per cent, and this small quantity is easily removed from the residual gases either by further cooling produced by the vaporization of part of the ammonia or by absorption in sulphuric acid.

Cheap hydrogen is essential to the commercial success of synthetic ammonia and the most economical source at present is the existing coke ovens. In countries where cheap water power is available electrolytic hydrogen becomes attractive.

The packing of the stuffing boxes in the Claude apparatus is merely a single hydraulic leather. The Haber plant requires three days to heat up after being allowed to get cold, whereas the Claude plant will begin to produce again in four to five hours. The tubes in the Claude process are encased in ferro-concrete containers for safety.

[19] *J. Am. Ceramic Soc.*, vol. 2, pp. 313-322 (1919).

[20] Colloids and the Ultramicroscope, p. 65. E. A. Schneider anticipated Zsigmondy, whose discovery, however, was made independently.

Notes on the Chemistry of Chromyl Chloride

By Elton Richmond Darling

THE experimental work which is being carried out with chromyl chloride, CrO_2Cl_2, in the manufacture of organic dyes and compounds gives evidence of its greater use.

The literature on the subject is not extensive and the following notes may be of service to those interested.

The first mention in the literature of chromyl chloride is that of Thomsen (*Phil. Trans.*, 1827, p. 159), who claimed to be its discoverer. Thomsen prepared it by fusing a mixture of 20 parts of sodium chloride and 24 parts of potassium bichromate with 60 parts of concentrated sulphuric acid. It was purified by repeated crystallization. He also prepared it by heating chromium trioxide in a current of hydrochloric acid and distilling to separate the chlorochromic acid which was also formed. This product was investigated by Berzelius and Wöhler (*Pogg. Ann.*, 1834, vol. 33, p. 343).

Geuther (*Ann.*, vol. 106, p. 239) prepared it by heating equal parts of chromic anhydride and ferric chloride together in a retort. He also prepared it (*Ann.*, vol. 118, p. 69) when chromic anhydride and chromic chloride were heated together in a ratio of 2 parts of the former to 3 parts of the latter.

Schiff (*Ann.*, vol. 106, p. 116) prepared it by heating 1 part of chromic anhydride and 2 parts of phosphorus pentachloride together. He further stated that it could be prepared (*Ber.*, vol. 10, p. 104) by suspending chromic anhydride in concentrated sulphuric acid and passing in hydrogen chloride.

Moissan (*Ann. Chim.* (6), vol. 5, p. 568) prepared it by passing hydrogen chloride over chromic anhydride.

Etard (*Ann. Chim.*, vol. 5, p. 218) prepared it by the method of Thomsen and obtained a yield of 70 per cent of theory. He carried out the distillation several times in the presence of carbon dioxide gas.

E. Moles and L. Gomez (*Z. physik. Chem.*, vol. 80, pp. 513-30) prepared the chromyl chloride by the method of Thomsen except they used fuming sulphuric acid in place of the ordinary sulphuric acid.

H. Moissan (*Compt. rend.*, vol. 98, pp. 1581-1583) prepared it by submitting chromic anhydride to the action of a mixture of chlorine and hydrochloric acid and then heating the whole to 150 deg. C. He further states that the chromates of the alkalis, barium, lead and silver all give chromyl chloride when treated with hydrogen chloride. He further states (*Bull Soc. Chim.*, vol. 43, p. 6) that it can be prepared by using chlorine and steam in place of the hydrochloric acid, but the reaction is not possible if only the dry chlorine is used.

H. D. Low and F. M. Perkins (*Proc. Chem. Soc.*, vol. 23, p. 11) obtained a nearly theoretical yield by dissolving chromic acid in more than the equivalent of concentrated hydrochloric acid and then adding to the solution concentrated sulphuric acid in small amounts until the chromyl chloride separated out as a heavy underlayer which was drawn off. This was purified by blowing air through it and then distilling.

Thomsen (*Phil. Mag.*, 1827, p. 452) prepared ammonium chloride from chromyl chloride by passing its vapors into a vessel of dry ammonia gas. This was, however, but one of the products formed.

Wöhler (*Ann.*, vol. 60, p. 203) found that upon heating chromyl chloride to a dull red heat it was decomposed, splitting up into chromic oxide, oxygen and chlorine.

V. Thomas (*Compt. rend.*, 1899, vol. 129, pp. 828-831) treated chromyl chloride with nitric acid, which resulted in the formation of higher nitrogen oxides. He then investigated and studied a series of double compounds prepared from it.

Liebig (*Pogg. Ann.*, vol. 21, p. 359) in carrying out some research work on chromyl chloride believed that he had prepared metallic chromium when brown fumes resulting from the action of chromyl chloride vapors upon dry ammonia were obtained.

G. Odde and E. Serra (*Gazz. chim. ital.*, 1899, vol. 29, ii, pp. 318-329) carried out work on the polymerization of inorganic chloro-anhydrides.

P. Pascal (*Compt. rend.*, 1909, vol. 148, pp. 1463-1465) treated chromyl chloride with dry nitric oxide and produced chromyl subchloride. This product he found to possess strong magnetic properties.

G. G. Henders and I. M. Heilbron (*J. Chem. Soc.*, vol. 99, pp. 1887-1901), in their work on the chemistry of the terpenes, investigated the action of chromyl chloride upon bornylene.

C. Pagel (*Chem. Centr.*, 1900, vol. 2, p. 784) used chromyl chloride to destroy organic substances in toxicological analysis.

Sell (*Proc. Roy. Soc.*, vol. 33, p. 267) found that no chlorine was formed when chromyl chloride was heated with carbamide.

R. F. Weinland and M. Fiederer (*Ber.*, 1906, vol. 39, pp. 4042-4047) found that when the chlorides of the alkali metals were treated with chromyl chloride double salts were formed.

E. Beckmann (*Z. anorg. Chem.*, vol. 77, pp. 90-102) studied chromyl chloride as an ebullioscopic solvent.

E. Moles and L. Gomez (*Anales soc. españ. fís. quím.*, vol. 12, pp. 142-154) made extensive studies regarding the properties of chromyl chloride and its action toward various chemicals.

S. Rideal (*J. Chem. Soc.*, 1886, vol. 49, pp. 367-368) made a quantitative study of the action of ammonia upon chromyl dichloride.

D. Spense and J. C. Galletly (*J. Am. Chem. Soc.*, vol. 33, pp. 190-194) noted that as a result of treating various rubbers of different botanical origin with chromyl chloride a compound was formed which was analogous to a compound that resulted when terpenes were similarly treated.

A. Haller (*Compt. rend.*, vol. 84, pp. 558-559) prepared anthraquinone by dissolving anthracene in glacial acetic acid and treating this to the action of chromyl chloride.

H. S. Frey and J. L. Donnelly (*J. Am. Chem. Soc.*, 1918, vol. 40, pp. 478-482) studied the action of chromyl chloride upon phosphorus halides dissolved in carbon tetrachloride so as to prevent any explosion from taking place. This was a continuation of an earlier work (*J. Am. Chem. Soc.*, 1916, vol. 38, pp. 1923-1928).

H. Quantin (*Compt. rend.*, vol. 104, pp. 223-224) prepared phosgene by the action of carbon tetrachloride upon chromyl chloride. He also noted that carbon monoxide decomposed it with the formation of chromic oxide and chromic chloride.

Jose R. Mourele and A. G. Banus (*Anales soc. españ. fís. quím.*, vol. 9, pp. 355-362) were unsuccessful in their attempt to prepare phosgene by the action of carbon upon chromyl chloride. The products formed were chromic anhydride and chromic chloride.

Corrosion of a Producer-Gas Cooling System

Cooling Water of High Acidity and Containing Much Dissolved Oxygen and Suspended Coke Dust Causes Deterioration of Cooling System at the Plant of the Providence Gas Co., Providence, R. I.—Remedial Measures Are Suggested*

By LLOYD E. JACKSON

THE manufacturing plant of the Providence Gas Co. has been described in detail in articles published recently.[1] It is sufficient to mention here that the plant as a whole consists of coal-gas and water-gas plants, with auxiliary equipment necessary for their operation.

The gas producers, five in number, were designed to produce gas from coke or from bituminous coal, either with or without recovery of ammonia. However, under existing conditions, the producer plant did not operate successfully with bituminous coal. Some minor changes were made and the producers were put in operation again with small-size coke for fuel instead of bituminous coal. After six months' operation with coke, leaks developed in the producer-gas cooling-water system and a thorough investigation was undertaken to determine the causes and remedies for the deterioration of the piping and other iron parts. The writer, an Industrial Fellow of the Mellon Institute of Industrial Research of the University of Pittsburgh, was assigned to conduct the investigation, and it is the purpose of this article to discuss the results of eight months of extensive tests, analyses and observations.

FIG. 1. PANORAMIC VIEW OF THE PLANT OF THE PROVIDENCE GAS CO., PROVIDENCE, R. I.

Fig. 4 is a line-drawing of the producer-gas cooling system as the plant was operating when the greatest number of leaks developed. Starting at the coke filters near the spray pond, cool water is distributed to the dust catcher, collecting main and condenser sprays. From here the water, after coming in contact with the hot producer gas, falls into the decanter below and is pumped to the spray pond, cooled, and again pumped through the same cycle. Make-up water from the city water mains enters the system over the tops of the producers and through the separator. During the eight months of testing, one leak, the first in that line, developed in the 10-in. pipe line conveying cooled water from the coke filters to the producer plant. Leaks occurred in the small distributing pipes which carry cool water to the dust catcher and collecting main sprays. Most of the leaks developed in the 6-in. pipe line which conveyed warm water from the decanter to the cooling pond, a distance of approximately 550 ft. It has been necessary to renew every piece of this pipe line at least once and parts of it have been renewed twice. The impellers in the centrifugal pumps which pump the cooling water to and from the cooling pond also gave considerable trouble. Those in the pumps pushing water from the decanter to the cooling pond had to be renewed more frequently than those bringing water back.

Four Possible Causes for the Deterioration

It was decided that the deterioration of the cooling-water system could be due to any one or a combination of two or more of four causes, as follows: (1) electrolysis caused by stray electric currents; (2) free mineral acid; (3) suspended erosive matter, and (4) dissolved oxygen. Observations made from time to time during the investigation tended to discourage the probability of stray currents being a factor in the problem. In the first place, tests with a millivoltmeter failed to indicate any difference in potential between various parts of the piping system. In the second place, the general nature of the corrosion was not characteristic of electrolysis by stray currents. Corrosion of pipe lines due to stray currents causes very rapid corrosion at points where the current leaves the line, while at other places in the line the pipe will appear practically untouched. If the producer-gas cooling-water pipes carried a stray electric current, that current would have

*Published by permission of the Providence Gas Co., Providence, R. I., under whose auspices the research was conducted at the Mellon Institute of Industrial Research of the University of Pittsburgh, Pa.

[1] Russell, CHEM. & MET. ENG., vol. 21 (1919), pp. 34, 88 and 147; and Bauer, *Gas Age*, vol. 43 (1919), pp. 46 and 516.

TABLE I. MINERAL ANALYSES OF WATER COLLECTED FROM THE PRODUCER-GAS COOLING SYSTEM (PARTS PER MILLION)

Sample No. (See Fig. 4)..	1	2	3	4	5	6	7
Source = Filtered Samples From.....	Decanter Near Intake Spray Pond Pump	Weir Near Prod.-Gas House	Overflow Ash Pan Prod. No. 1	Decanter After Condenser	Left Coke Filter	City Water	Narragansett Bay Water
Silica.....	9	10	9	14	9	1	16
Iron.....	25	29	2	31	29	1	4
Calcium.....	10	14	5	11	10	4	260
Magnesium..	3	3	2	3	4	2	790
Sodium.....	84	71	1	81	69	1	6,600
Chlorides....	80	53	5	60	55	8	11,500
Sulphates....	131	147	15	153	135	9	1,467
Total solids..	442	327	39	353	311	26	20,317
Acidity as calcium carbonate....	16	11	..	19	12	..	.....
Alkalinity as calcium carbonate.	...	...	14	...	...	17	82

to enter and leave the line at certain points. At the point or points where it would leave the line, marked corrosion would take place both on the outside and inside of the pipe, while other parts of the line would last indefinitely. Furthermore, if corrosion were caused by stray currents, the pipe line from the producer plant to the cooling pond would not corrode so much more rapidly than the pipe line conveying the water from the cooling pond to the producer plant. One more argument, and a convincing one, against the probabilities of stray currents being a factor in the problem is the fact that during the time that the plant has operated with bay water for producer-gas cooling, which totals almost five months, fewer leaks have developed than was the case with fresh water. If the pipe lines were carrying stray currents, the much greater concentration of dissolved salts in bay water would tend to increase corrosion greatly and develop more leaks than would develop with fresh water.

FIG. 2. CRUSHER BUILDING AND COAL-CONVEYING MACHINERY

As a step to determine the cause of the trouble, samples of water were collected from the producer-gas cooling system at the places marked in Fig. 4 with numbered arrows. Complete mineral analyses of these samples were made and the results are presented in Table I.

One of the characteristic properties of the cooling water which might cause corrosion is acidity. Acid was found not only in the samples analyzed and reported in Table I, but also in numerous check samples collected later. It is well known that even traces of free mineral acids in water cause the rapid corrosion of pipe lines carrying it. The most economical way to treat acid water is to neutralize it with lime, but before starting to treat the water to correct its corrosive properties, some carefully cleaned test-pieces of iron, 5 in. x 2 in. x ⅛ in., were suspended by means of a piece of wrapping cord in the cooling system at the same points from which water samples were collected. The test-pieces were allowed to remain several days and then were removed, dried and weighed. Losses per sq.in. of exposed surface were calculated and the results are presented as test 1 in Table II. This test was made to obtain data with which to compare future data to be obtained from tests made following successive steps in treating.

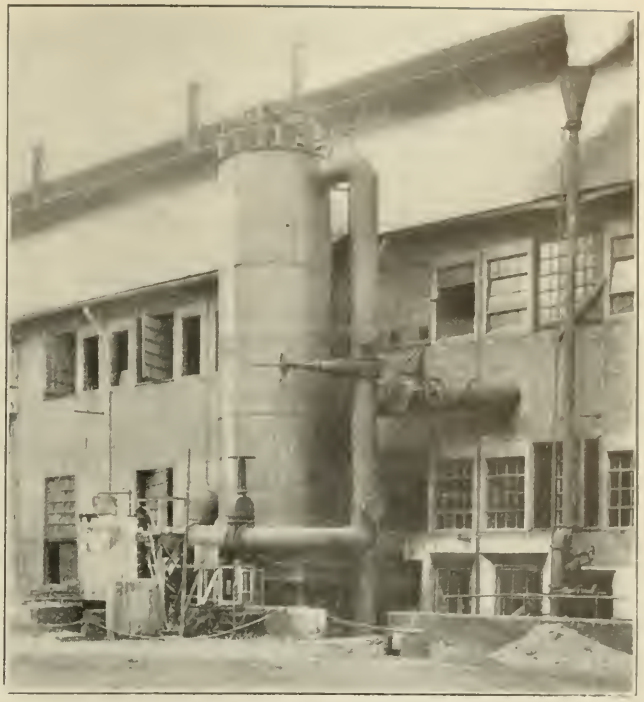

FIG. 3. EXTERIOR OF THE PRODUCER-GAS PLANT, SHOWING CONDENSER, EXPERIMENTAL LIME-TREATING APPARATUS AND DECANTER

Apparatus to treat the water with lime next was installed. At first the water was treated with sufficient lime to make it alkaline to methyl orange indicator. During this time the same test-pieces of iron were suspended in the cooling system at the same points as described for test 1. The weights lost per 24 hours per sq.in. of exposed surface are shown by test 2 in Table II. The results of these two tests show that the corrosion of iron is about one-half as great when the water

TABLE II. CORROSION TESTS ON PIECES OF IRON. (MILLIGRAMS OF WEIGHT LOST PER SQ.IN. PER 24-HR.)

Cooling Medium	Test No.	End of Decanter Intake to Spray Pond Pump	Decanter Near Condenser	Weir From Prod. House	Before Steel Turnings Filter	After Steel Turnings Filter
Recirculated City water not treated; test 7/12 to 7/16/20.....	1	15.2	29.4	11.5	8.3	.
Recirculated City water alkaline to methyl orange; not deactivated; test 10/13 to 10/18/20.....	2	7.4	19.3	4.6	4.6	3.7
Recirculated City water alkaline to methyl orange, deactivated; test 10/25 to 11/3/20.....	3	3.6	4.7	3.1	5.6	2.6
Bay Water Deactivated Test 8/25 to 9/1/20.....	4	4.0	14.4	5.2	1.7	0.0

TABLE III. DISSOLVED OXYGEN IN SAMPLES OF WATER COLLECTED FROM THE PRODUCER-GAS COOLING SYSTEM

Location	City Water Tap in Exhauster Room	Intake Spray Pond Pump	Weir From Prod. House	Overflow From Ash Pan	Decanter After Condenser	Left Coke Filter
Temperature (deg. F.)	73	122	131	136	131	93
Dissolved oxygen (p.p.m.)	4.6	2.3	2.2	3.8	1.4	5.2

is treated with sufficient lime to make it alkaline to methyl orange. Figuring the quantity of lime used on a basis of 100 per cent CaO, from 50 to 100 lb. per day was required to maintain the decanter water alkaline to methyl orange. The variation in quantity of lime required was due to operating conditions in the producers and to the number of producers in line.

Methyl orange indicates free mineral acid only, while phenolphthalein shows acidity caused by dissolved carbon dioxide as well as the free mineral acid resulting from the hydrolysis of iron salts. An attempt was made to treat the decanter water with sufficient lime to maintain it alkaline to phenolphthalein; but, due to the presence of carbon dioxide in the producer gas with

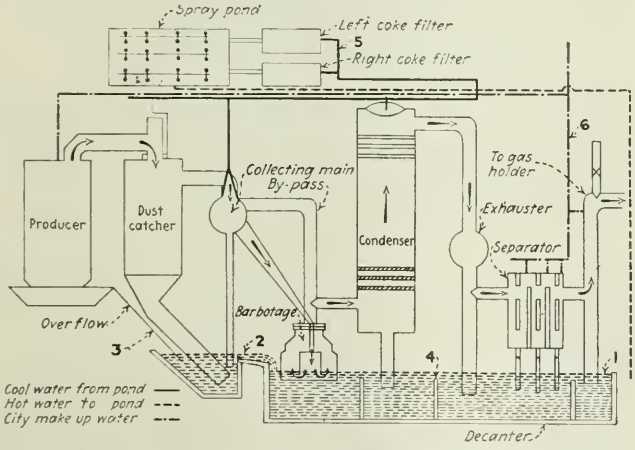

FIG. 4. PRODUCER-GAS COOLING SYSTEM. NUMBERS INDICATE POINTS AT WHICH WATER SAMPLES WERE TAKEN

which the cooling water came in direct contact, so much lime was required to maintain the water alkaline to phenolphthalein that it was not considered a practical method of treatment.

About the same time that samples were collected for mineral analyses more samples were taken from the decanter at the same points and analyzed for dissolved oxygen. The results are presented in Table III.

Many more samples were later collected from the cooling-water system and tested for dissolved oxygen. The results obtained were practically the same as reported in Table III. These tests indicated that the city water used for making up evaporation losses was highly saturated with dissolved oxygen. It is also evident that, as the water gives up its dissolved oxygen in the gas-cooling system, it is continually receiving a fresh charge when it is sprayed into the cooling pond.

It is a fact that dissolved oxygen is an active corrosive agent either in a neutral or acid solution. It is particularly active in the presence of free mineral acids. To free the cooling water of dissolved oxygen, it was proposed that the coke in the coke filters be replaced by steel turnings. The dissolved oxygen in the water flowing from the cooling pond through the steel turnings combines with iron to form iron oxide and the water is pumped from the filters oxygen free. Test-pieces of iron suspended in the cooling system, after the installation of the steel-turnings filter, corroded as shown by the results tabulated under test 3 in Table II. For purposes of comparison, test-pieces hung in the decanter near the intake to the cooling pond pump are good examples, because the water at this point was about to enter the pipe line to be pumped to the cooling pond. It was this pipe line that corroded most rapidly. It will be noticed that the corrosion of test-pieces was about one-half as great when the water was maintained alkaline to methyl orange and less than one-quarter as great when treated for dissolved oxygen maintained alkaline to methyl orange (see tests 1, 2 and 3 in Table II.)

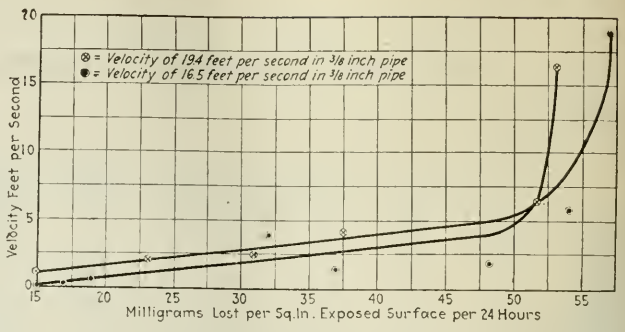

FIG. 5. EROSIVE ACTION OF COOLING WATER CONTAINING SUSPENDED COKE DUST

Erosion Caused by Suspended Coke Dust

To determine the erosive action of the suspended coke dust in the cooling water, apparatus was made up in duplicate consisting of weighed short equal lengths of pipe of different sizes, connected together with reducer couplings, starting with the largest size and tapering to the smallest. One set of testing apparatus was arranged so that the largest nipple was connected to the service pipe carrying the cooling water from the decanter to the cooling pond and the smallest nipple was connected through a valve with a meter so that the rate of flow through the pipes could be regulated. The other piece of apparatus was arranged so that the smallest nipple was connected to the service pipe and the largest nipple to a valve and meter. The rate of flow through the largest nipple was regulated to be less and the rate through the smallest nipple was regulated to be considerably greater than the rate of flow through

TABLE IV. RESULTS OF EROSION TEST WITH PRODUCER-GAS COOLING WATER

Pipe Size	Average Velocity Water During Test Ft./Sec.	Total Grams Lost	No. of Days in Line	Milligrams Lost per Sq.In. Exposed Surface	Milligrams Lost per Sq.In. per 24 Hr.
Direction of Flow Through Large Pipe Toward Smaller Pipe					
¾x24 in.	16.5	25.650	13	690	53
¾x24 in.	5.9	81.200	24	1,305	54
1x24 in.	3.7	61.100	24	775	32
1¼x24 in.	2.1	121.300	24	1,161	48
1½x24 in.	1.6	108.5	24	892	37
2x24 in.	0.9	70.600	24	453	19
2½x24 in.	0.7	75.700	24	406	17
Direction of Flow Through Small Pipe Toward Larger Pipe					
¾x24 in.	19.4	27.600	13	740	57
¾x24 in.	6.9	77.900	24	1,250	52
1x24 in.	4.3	72.000	24	910	38
1¼x24 in.	2.5	77.000	24	735	31
1½x24 in.	1.9	69.200	24	569	23
2x24 in.	1.1	51.400	24	329	14
2½x24 in.	0.8	65.600	24	353	15

the 6-in. service line between the decanter and the cooling pond. Water from the 6-in. service pipe was permitted to flow through the apparatus for 24 days. The apparatus then was dismantled, and the short pieces of pipe were reweighed and the weight lost per sq.in. of the exposed inner surface calculated. The results are presented in Table IV and plotted against water velocity in Fig. 5. Daily determinations of suspended matter in the cooling water made over a period of about two weeks showed a variation between 24 and 140 parts per million. Results of proximate analyses of samples of this suspended matter are shown in Table V.

TABLE V. PROXIMATE ANALYSES OF SUSPENDED MATTER IN PRODUCER-GAS COOLING WATER WHEN USING RECIRCULATED FRESH WATER (PER CENT)

Source	Shoveled From Bottom of Inside Decanter	Shoveled From Outside Decanter	Filtered From Water Collected Near Intake to Pump
Volatile matter	7.71	2.13	51.2
Fixed carbon	59.01	78.76	
Ash	33.28	19.11	48.8

Calculating Life of 6-In. Pipe

It is quite evident that erosion due to suspended coke dust and ashes plays a very important part in the deterioration of the cooling system.

Pitot tube readings indicated that the velocity of water in the 6-in. service pipe from the decanter to the cooling pond is approximately 12 ft. per second under average operating conditions. The erosion test showed this pipe to be wearing away at the rate of 55 mg. per sq.in. per 24 hours. From data presented in Table IV and from some measurements of standard 6-in. pipe, some interesting figures are presented below:

Thickness of standard 6-in. pipe = 0.3 cm. bottom of threads to inside surface.[2]

1 sq.in. of pipe, 0.3 cm. thick = 1.935 c.c. of iron and weighs 15,450 mg.

The life of 6-in. pipe eroding at the rate of 55 mg. per day is therefore 15,450 ÷ 55 = 281 days, or 9 months and 11 days.

During the period of the erosion test the water in the decanter was maintained alkaline to methyl orange and freed from dissolved oxygen. Test-pieces of iron hung in the decanter where they were not subject to the erosive action of suspended coke dust lost weight at the rate of 3.6 mg. per sq.in. per 24 hours. At this rate of corrosion a standard 6-in. pipe will last for more than 10 years. This figure represents what might be expected with treated and filtered fresh water.

Recommendations and Suggested Remedies

Having determined the causes for the deterioration of piping and other equipment in the producer-gas cooling system, the following remedies were suggested:

(1) Cool and clean the producer gas with fresh water, and permit the water to waste to the bay after going through the cooling system. (2) Treat, cool and recirculate fresh water. The treatment recommended consists of filtration to remove suspended coke dust, neutralization of free mineral acid with lime, and removal of dissolved oxygen with steel turnings. (3) Cool and clean the gas with an excess of bay water and let it waste back to the bay. A brief discussion of each remedy follows.

Fresh water can probably be obtained most economically from wells. This water, freed of dissolved oxygen, if there is any present, by means of steel turnings, would cause the least corrosion of any of the remedies mentioned. Treated and recirculated fresh water would have its deleterious properties removed and would cause very little, if any, more corrosion than fresh water not circulated.

Experiments With Bay Water

The average of several analyses shows that bay water pumped from near the gas plant has about two-thirds as many dissolved solids as sea water and that the solids are similar in character to those in sea water. It is known that sea water is an active corrosive agent, particularly when hot. Accordingly, tests were made with special apparatus and under actual working conditions with bay water for cooling producer gas to determine the degree of its corrosive action under the conditions existing in the producer gas plant.

In test 4, Table II, are presented results of a test to determine the corrosive action of cold bay water before and after removing its dissolved oxygen. The water in this case had a temperature between 70 and 75 deg. F. It will be noticed that cold deactivated bay water had no appreciable corrosive action on iron. From this experiment the conclusion was drawn that the piping and cooling equipment handling cold bay water would not corrode very rapidly. There probably would be more corrosive action than this test indicated at points in the system where there is chance for galvanic action—e.g., where brass and iron are in contact. This action could be reduced by using iron valves and fittings in pipe lines. Table II also gives a very good comparison between the action of cold bay water and fresh water.

Effects of Increased Temperatures

Sea water, in this case bay water, is more corrosive at higher temperatures than it is when cold. This property is due to the presence of calcium chloride and particularly magnesium salts. For example, magnesium chloride hydrolyzes to form hydrochloric acid and the latter readily reacts with iron. The extent of this reaction increases as the temperature rises. Because of this property of bay water, tests were made to determine its corrosive action in the presence of hot producer gas. These tests were made with raw bay water and with deactivated bay water—i.e., bay water from which the oxygen had been removed by passing through steel turnings. The results of these tests are presented in Table VI.

Comparing test 1, using raw bay water, with test 2, using deactivated bay water, it will be noticed that, in the presence of deactivated bay water, iron corrodes about three-fifths as rapidly as in the presence of raw bay water; also that, when using either raw or deactivated bay water, its corrosive action increases rapidly as the temperature rises. Test 3 was made at a higher temperature than test 2 and shows a correspondingly greater corrosive action. Test 4 with deactivated city water shows that, at a high temperature, there is some corrosive action in the presence of fresh water and producer gas. Tests 5 and 6 were made with weighed test-pieces of pipe resting on the bottom of a dustcatcher, which is probably the hottest part of the cooling system and where the most corrosion would take place when using salt water. These results agree closely with the results of tests 1 and 2. In the column "Calculated time to corrode through ¼-in. stock of dustcatcher, etc.," are figures obtained by dividing the weight of a sq.in. of

[2] Practically all the leaks in the cooling-water piping system developed near joints where threads cut in the pipe had made the iron thinner than the remainder of the pipe.

iron ¼ in. thick by the average milligrams lost per sq. in. per 24 hours by test-pieces of pipe during each test, and converting this result to years and months. The figures in this column may be considered the life of the cooling system at its weakest point under varying conditions when using bay water to cool producer gas. The farther away from the dustcatcher the gas travels the cooler it gets; therefore the life of the collecting main and condenser should be longer.

TABLE VI. CORROSION OF TEST-PIECES OF PIPE IN THE PRESENCE OF HOT PRODUCER GAS AND BAY WATER AND HOT PRODUCER GAS AND FRESH WATER

Test No.	Location of Test-Pieces	Days Duration of Test	Approximate Temp. of Test, Deg. F.	Kind of Water and Condition	No. of Test-Pieces of Iron Subject to Condition of Test	Av. Mg. Lost per Sq.In. per 24 Hr.	Calculated Time to Corrode Through ¼-In. Stock of Dust-catcher, Etc.
1	In joint 6-in. pipe near No. 1 producer	14	130–160	Raw bay water	4	25	3 yr. 4 mo.
1	Ditto.....	14	100	Ditto.....	2	18	4 yr. 8 mo.
1	Ditto.....	14	70–80	Ditto.....	4	8	10 yr. 7 mo.
2	Ditto.....	14	130–160	Deactivated bay water	4	16	5 yr. 3 mo.
2	Ditto.....	14	100	Ditto.....	2	8	10 yr. 7 mo.
2	Ditto.....	14	70–80	Ditto.....	4	5	17 yr.
3	In nipple on top of dust-catcher No. 3	14	230–260	Ditto.....	7	30	2 yr. 10 mo.
4	Ditto.....	14	230–260	Deactivated city water	7	10	8 yr. 6 mo.
5	In bottom of dustcatcher No. 3	14	90–100	Raw bay water	6	22	3 yr. 10 mo.
6	In bottom of dustcatcher No. 3	14	110–120	Deactivated bay water recirculated from end of decanter	9	20	4 yr. 3 mo.

When 60 deg. F. or cooler water is available, the producer gas can be cooled sufficiently by pumping the cold water over the condenser and pumping warm water from the decanter over the dustcatchers and collecting main. To determine whether warm bay water causes greater corrosion under these conditions, weighed pieces of iron were suspended on the bottom of a dustcatcher and permitted to remain there for 14 days; then they were removed and reweighed. Water entered the dustcatcher at a temperature of 100 to 110 deg. F. and left at a temperature of 110 to 120 deg. F. The results are presented in test 6 of Table VI, and show that practically the same amount of corrosion takes place in the dustcatcher as when cold water which has not been deactivated is pumped. This recirculation, whether with bay water or fresh water, should not be practiced, because the water when tested contained 50 to 70 p.p.m. of suspended coke dust. Under these conditions, it is to be expected that pipes and pumps carrying the water from the decanter to the dustcatchers will erode rapidly. Bearing out this contention, several leaks developed while test 6 was in progress.

Because of the deleterious action that dissolved salts in bay water would have on the refractories if carried over with the producer gas when the latter is burned in the coke-oven battery, some tests were made to determine if the gas carried any of these salts while bay water was used for cooling.

The results of the tests showed that a small quantity of chloride was being carried over. Further tests indicated that this must have been due to hydrochloric acid, probably derived as a product of the hydrolysis of magnesium chloride at high temperatures.

When chlorides were found in the gas, the producers were delivering gas at times at a temperature of 1,700 to 1,800 deg. F. Since that time numerous tests have been made when the producers were delivering gas under 1,400 deg. F., and only traces of chlorides were found in distilled water through which more than 100 cu.ft. of producer gas was passed. One sample through which gas had been passed was analyzed for magnesium, which is a common substance found in sea water, but only a trace was found. The conclusion reached after these tests is that no bay water salts are carried into the battery when bay water is used to cool producer gas.

Comparing Bay Water With Recirculated Fresh Water

Comparing tests made when using bay water for cooling producer gas and permitting the water, after passing through the system once, to waste to the bay, with tests made with unfiltered recirculated fresh water, it is obvious that the advantage lies with bay water. Tests show the life of the weakest points of the cooling system to be approximately nine months when recirculating unfiltered fresh water, compared with three to four years when using cold deactivated bay water. However, at best the use of bay water can be considered as being merely the lesser of two evils. Tests indicate that with an abundant supply of fresh water which can be allowed to waste to the bay after going through the cooling system once or with recirculated fresh water which has been treated and filtered, the life of the weakest point in the cooling system will be ten years or more. These figures must be qualified to the extent that they were calculated for a cooling system not deteriorated. There are probably places in the cooling system which are almost corroded through, due to having recirculated water containing suspended coke dust, and, no matter what change is made in the cooling water, these places will give way sooner than calculated above. In order to know which is the best of the three remedies discussed, it must be known which is the most economical.

Consideration of Costs

The most economical source of fresh water in sufficient quantities so that it can be wasted to the bay after going through the cooling system once is a series of wells drilled adjacent to the plant. The total cost of cooling the producer gas by this means will be the cost of drilling wells plus the cost of pumping through the cooling system.

To cool the gas with treated and filtered water, it will be necessary to install sand filters and lime-treating apparatus to handle approximately 2,000,000 gal. of water daily with the present cooling apparatus. This could be cut to 1,000,000 gal. per day with more efficient cooling apparatus. The total cost of cooling producer gas under these conditions will be the original cost of installing the treating and filtering apparatus plus their upkeep and operation, together with the cost of pumping to and from the cooling pond and the cost of city water to make up for evaporation losses.

The cost of using bay water will entail the expenses due to pumping the water plus the extra cost of upkeep in the cooling system, which will mean the renewal every three or four years of those parts of the cooling system that come in contact with the cooling water and the hot gases.

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Manufacture of Pyroxylin Plastics

Properties of Celluloid—Methods of Mixing the Cellulose Nitrate With Camphor and Alcohol—Stabilizing—Filtering—Rolling—Baking—Sheeting—Polishing—Manufacture of Rods and Tubes—Scrap Utilization—Camphor Substitutes and Synthetic Camphor—Chemical Control

By J. R. DuPONT

WHEN cellulose nitrate prepared according to the methods outlined in a previous article[1] is mixed with camphor and denatured alcohol, plastic products result which are usually referred to as celluloid,[2] although it would be more correct to call them pyroxylin plastics. Sometimes for the sake of economy the camphor and alcohol are replaced partly or entirely by substitutes which will produce a more or less satisfactory celluloid.

Pure celluloid is a transparent substance having a density of about 1.35. It is a poor conductor of heat and electricity. The tensile strength varies from 6,000 to 10,000 lb. per square inch. It cannot be exploded by percussion or pressure. Exposed to a flame, it softens and takes fire rapidly, evolving very disagreeable fumes resulting from the volatilization of the camphor and also from the nitrous gases produced by the decomposition of the cellulose nitrate. Heated without compression, celluloid starts to decompose around 125 deg. C., the action being accelerated by increasing the temperature—around 165 deg. C. the decomposition is complete. If kept in hot water at about 85 deg. C., celluloid is softened enough to permit the molding of objects which will retain the shape of the mold after cooling.

Although almost insoluble in water, celluloid is soluble in acetic, propionic, nitric and sulphuric acids, the latter two causing decomposition. Strong alkalis also decompose celluloid, and this property is used in the recovery of camphor from unusable celluloid scrap.

Celluloid is slightly soluble in ethyl alcohol and is soluble in methyl alcohol; ethyl, methyl, butyl and amyl acetates; ethyl propionate, acetine; diacetine; triacetine; epichlorhydrin; dichlorhydrin; and alcohol solutions of camphor, acetanilide, methylacetanilide, chloral hydrate, tricresylphosphate, triphenylphosphate, tribenzylphosphate, etc.

Mixing the Cellulose Nitrate and Camphor

Turning now to the manufacture of celluloid, the first operation consists in mixing the cellulose nitrate with camphor and alcohol so as to produce a gelatinized mass. The mixing may be done in boxes or by machine.

Mixing in Boxes.—When in slab form, the dry cellulose nitrate is first broken into small pieces in a specially constructed machine and then placed in heavy rectangular galvanized-iron boxes having sloping sides. Camphor alcohol solution or denatured alcohol is sprinkled on and mixed by hand with wooden paddles. These boxes are covered air tight and placed in a room where the temperature is kept around 30 deg. C. After 24 hours the mass is more or less gelatinized and ready to be rolled. This method requires from 50 to 60 per cent of alcohol when 35 per cent of camphor is used, and because of the high percentage of alcohol used and the time required, nearly every factory has abandoned this process for the following one:

Mixing by Machine.—The cellulose nitrate is dumped into a kneading machine in which two specially shaped steel blades turn in opposite directions, assuring a constant and thorough mixing of the cellulose nitrate with the camphor and alcohol. Camphor (if not previously mixed with the cellulose nitrate) is added and also the denatured alcohol, and the machine is kept in motion for about 1 hour. After this time the mass is completely mixed, but not converted, and at this stage is placed in galvanized-iron boxes which are transferred to a warm room, where they stay long enough to permit partial conversion of the cellulose nitrate.

A far better and quicker way to produce the gelatinization of the cellulose nitrate is to use a jacketed kneading machine which will permit heating of the cellulose nitrate, camphor and alcohol and produce a complete conversion in about 1 hour's time. The heating is done with hot water and complete control of the temperature is necessary. Generally it is not permitted to go above 60 deg. C. This method of mixing reduces not only the time of the operation but also the quantity of denatured alcohol required to obtain a good conversion and with a good grade of cellulose nitrate only 40 per cent of alcohol is necessary. As the conversion is complete, the subsequent operation of rolling is shortened.

Some factories prefer to use more alcohol for the conversion, say 55 to 65 per cent of the weight of the cellulose nitrate, and after the conversion has been effected, reduce the alcohol contents to about 30 per cent, using vacuum as means of recovery. To obtain this recovery the mass is first heated to around 60 deg. C. and as soon as the conversion is obtained the mixing box is connected with the vacuum pump. By raising the temperature the alcohol vapors are removed by the pump and after being cooled are collected in a tank. We think that it is better to use around 45 per cent of denatured alcohol for the conversion, because the recovery of an excess of solvent requires longer heating which may result in discoloration of the paste.

In any of the methods used, the temperature of the kneading machine has to be always the same, as a difference in the heating temperature will give a variation in color—particularly in the manufacture of transparent and ivory—which is termed "off-color."

When cellulose nitrate containing alcohol is used, the gelatinization can be accomplished more quickly and more completely than when dry cellulose nitrate is employed; also, and of great importance, the chances of accidents during the mixing are reduced to a minimum.

The author reserves the right of publication and translation of this article.

[1] "Manufacture of Cellulose Nitrate for Pyroxylin Plastics," CHEM. & MET. ENG., vol. 26, No. 1, p. 11, Jan. 4, 1922.

[2] Although celluloid is a trade name, it has become rather firmly established in the literature as a designation for pyroxylin plastics, and this usage has been followed in this article.

Often in using dry cellulose nitrate in slab form, the slabs are not broken in small pieces before mixing, and the excess pull necessary to start the machine may develop sufficient heat to ignite the cellulose nitrate dust and thus cause the explosions which occur from time to time, often with fatal results. By using the proper kind of kneading machines and breaking up the slabs the mixing of dry cellulose slabs is safe. The percentage of moisture in the cellulose nitrate affects the results of the conversion and when above 5 per cent, poor results can be expected. The quantity of alcohol necessary for good conversion of the cellulose nitrate varies with the solubility and viscosity, but at least 40 per cent of denatured alcohol is necessary.

Stabilizing

Celluloid made with a good grade of cellulose nitrate will keep its original color and structure for years, but as a preventive measure every manufacturer stabilizes his celluloid. The stabilizing agent will check any gradual development of acidity and for this reason is generally called an antacid. For white and ivory colors no antacids are used, as the pigment added to the cellulose nitrate, which is usually zinc oxide, will act as stabilizer. But for transparent, shell and other translucent stock, antacids must be used. These must be soluble in alcohol, impart no cloudiness to the finished celluloid, and reduce to a minimum the discoloration due to exposure to light. Many different antacids have been recommended, but the most used are urea, calcium lactate and zinc acetate for transparent celluloid, magnesium oxide and magnesium carbonate for the translucent or opaque stocks.

So as to obtain a perfect mixing of the antacid with the cellulose nitrate, which is essential, the addition of the former is generally made during the kneading operation. The quantity employed varies from 1 to 2 per cent of the weight of the cellulose nitrate. The study of antacids is very important, especially for transparent stock, since by selecting the proper one it is possible to obtain a transparent which will keep its original color instead of shortly becoming discolored, as is the case with many of the celluloid curtains used on automobiles.

Filtering

In spite of all precautions taken during nitration, washing and drying, it is very difficult to obtain a cellulose nitrate which will be absolutely clean and which will produce a first class celluloid. To remove these impurities or specks from the cellulose nitrate paste, it must be filtered. Two different kinds of machinery are used for this purpose. The first is a hydraulic press of the same type as used in the manufacture of celluloid tubes, but of larger capacity. The celluloid paste is heated around 65 deg. C. and pushed through a metallic or camel's-hair screen under a pressure of 3,000 to 3,500 lb. per square inch.

The other method consists in using a mechanical screw filter (Fig. 1) which is composed of a jacketed semi-steel cylinder 40 x 12 in. having two separate jackets so as to regulate the temperature of the cylinder. In the cylinder is a revolving steel worm of varying pitch which can also be heated by means of hot water circulation. The head of the machine, made of cast steel, is also jacketed and supports a steel perforated plate 2½ in. thick, on the front of which is placed the material used to filter the celluloid paste, which generally consists of a very fine mesh screen made of bronze wire or special filtering cloth (felt cloth, camel's hair, etc.).

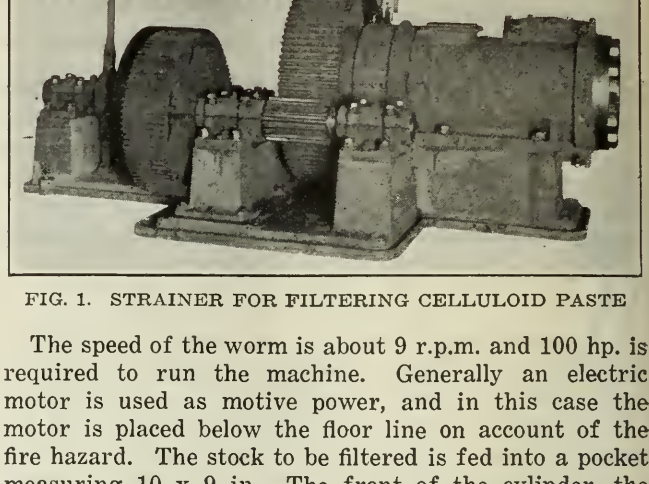

FIG. 1. STRAINER FOR FILTERING CELLULOID PASTE

The speed of the worm is about 9 r.p.m. and 100 hp. is required to run the machine. Generally an electric motor is used as motive power, and in this case the motor is placed below the floor line on account of the fire hazard. The stock to be filtered is fed into a pocket measuring 10 x 9 in. The front of the cylinder, the head and the worm are heated, but the back jacket is kept cool to prevent the stock from working back in the feeding pocket. The temperature is kept around 60 deg. C. by hot water circulation, and a recording thermometer permits the operator to control the heating at all times.

The productive capacity of the straining machine varies very much with viscosity and the alcohol content of the paste to be filtered, the kind of the filtering medium and also with the quantity of impurities to be removed, but generally an average of 400 to 500 lb. of celluloid paste can be filtered per hour. After burning off the impurities metal screens may be used again. In the case of scrap to be worked over, after mixing, it is submitted to a slight rolling before filtration.

Rolling

After mixing, the celluloid paste obtained contains more or less unconverted cellulose nitrate. To obtain a homogeneous paste, the mixed cellulose nitrate is rolled, using two horizontal hollow cylinders made of chilled steel, supported by a heavy frame and turning in opposite directions at about 13 r.p.m. The back cylinder is stationary, but the front roll can be moved, the space between the two rolls being regulated by two screws. Guards prevent the paste from working over the ends of the rolls. Iron pipes going inside the cylinders permit the heating or the cooling of the paste, this being done by steam and cold water. A specially constructed clutch controls the machine, and a safety device is provided for stopping the rotation of the cylinders in an emergency. Above the rolls a hood is generally installed and connected by large galvanized-iron pipes with a fan which carries the alcohol vapors outside of the building, where they are generally lost. The first rolls used were of small diameter varying from 10 to 12 in., but today practically every factory uses rolls of larger diameter—that is, from 18 to 22 in., for a length of 48 to 60 in. Fig. 2 shows a 22 x 60-in. mill with coil clutch.

The rolling process is as follows: The rolls are first heated at different temperatures, the front one, which carries the paste, having a temperature around 55 deg. C. The back roll is heated less, for if too hot the stock will leave the front roll and stick to the back one. The celluloid paste is then dumped on the rolls and the screws regulating the space between the rolls is opened so as to obtain a sheet about ¾ in. thick. At this

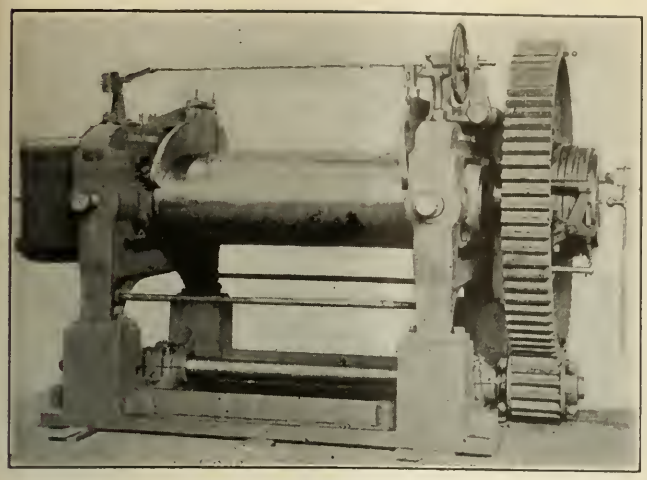

FIG. 2. CELLULOID MILL

stage the dye solutions or pigments are added to the paste according to the color desired. From time to time, the rollman cuts the sheet on the roll with a short knife so as to assure the complete homogeneity of the paste. If the paste is in a bad state of conversion, the screws controlling the front roll are tightened so as to obtain the minimum space between the rolls and thus produce a very thin sheet, which assures the crushing of the non-converted parts. When the operation is judged complete—that is, when the blending is as perfect as possible and the paste has attained the right proportion of solvent to permit pressing—the paste is taken off of the roll and passed again so as to obtain smooth sheets of stock, which are placed on a table of which the top has the dimensions of the plate of the block baking press. When all the paste has been thus sheeted, the sheets are trimmed to the exact size and are ready to be pressed.

The rolls are generally electrically driven and two to eight rolls can be placed on the same shaft. Even with an electric motor of the low-speed type a reducing gear has to be used to obtain the very low speed at which the rolls turn (13 r.p.m.). As to the power required, this varies from 10 to 12 hp. for 12-in. rolls up to 25 to 30 hp. for rolls of 18 to 22 in. diameter. The quantity of paste that can be rolled per hour varies much not only with the quality of the cellulose nitrate and the solvent content, but also with the kind of celluloid to be made. Generally two rolls are working on the same block and they are attended by four men, two rollmen with two helpers. Taking an average of 300 lb. of wet paste to make a finished block, this means that each roll will have to work 150 lb. of paste, which will require from 1¾ to 2½ hours.

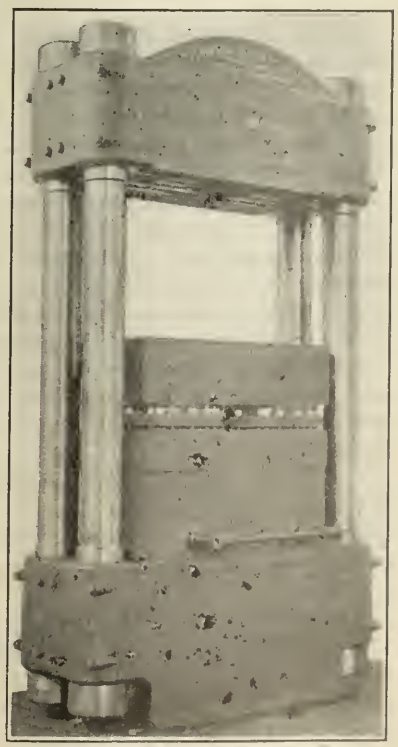

FIG. 3. CELLULOID PRESS

The loss of solvent during the rolling is variable, but as an average 17 to 20 per cent is lost during the operation, the paste going to the baking press containing 16 to 18 per cent of alcohol. The recovery of alcohol lost during rolling has been tried from time to time, but to the author's knowledge no factory has a permanent working installation.

Baking

After rolling comes the baking operation, which when rightly conducted will give a celluloid block absolutely homogeneous. To obtain this result the rolled celluloid is placed in a hydraulic press, where it is heated under pressure so as to obtain a plastic mass. At this stage the mass is cooled under a greater pressure, which operation will expel the air bubbles disseminated in the mass and also completely weld the sheets.

The presses used are composed of a heavy cast-iron bottom yoke, generally cast integral with the cylinder, supporting a plate on which a specially constructed rectangular bender receives the rolled celluloid sheets. Situated above the bender is a rectangular plunger which fits the bender and presses down the celluloid. The plate, the bender and the top plunger are hollow and can be heated by steam or hot water and cooled by water circulation. The rolled celluloid sheets are placed in the press on a semi-steel plate which has the dimensions of the bender and the surface of which has been grooved diagonally, thus permitting the block pressed to be fastened securely to the plate and stand the pulling which occurs during the sheeting.

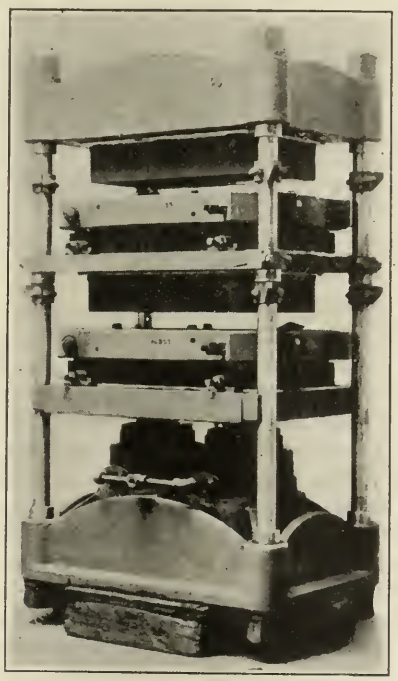

FIG. 4. DOUBLE DECK CAKE PRESS

In the early stage of manufacture the baking presses were made with only one deck and thus only one block was baked per operation. In order to reduce the labor, presses were made with two rams working in opposite directions so as to lift the plunger placed above the bender; by operating the lower ram the block was thus taken off the bender. This type of press is quite extensively used abroad. To obtain a greater production, the next step was the construction of presses with two decks, which would permit the baking of two blocks in the same press. Today most of the presses are made with four benders in which four blocks are baked in one operation. The dimensions of the benders are generally 55 x 23 x 6 in., the dimensions of the pressed block being about the same. Fig. 3 shows a 25 x 58-in. press and Fig. 4 a 23 x 44-in. double deck cake press.

The pressure used during the baking is generally 500 lb. per square inch; during the cooling the pressure is increased up to 3,000 to 3,500 lb. per square inch. The temperature at which the press is heated varies with the duration of the heating, but in no case is this temperature carried above 90 deg. C. On the average, from 4 to 5 hours at 85 deg. C. is required to bake a celluloid block weighing about 300 lb., and the same time for the cooling.

Originally the heating was done with live steam, which gave a very irregular operation, but today hot water is used almost exclusively. The water may be heated in a tank provided with a steam coil, and forced through the press by a centrifugal pump. Placed on the steam line is a regulator which stops the flow of the steam when the correct temperature of the water is reached, the temperature being registered by a recording thermometer.

Preliminary Seasoning of Blocks

After pressing, the celluloid if properly rolled is ready for the sheeting, but if the paste is too soft—and this occurs principally in summer—a preliminary seasoning is necessary. In the early stages of celluloid manufacture the blocks were cooled by cold water which was run on the top of the blocks, but today they are placed in cooling rooms where the temperature is kept around 12 deg. C. by refrigeration. If too soft and left in too warm an atmosphere, the celluloid blocks will be full of pin-holes due to the expansion produced by alcohol vapors.

Sheeting

The sheeting of the celluloid blocks is done on a specially constructed planer (Fig. 5), which is composed of a heavy frame or bed supporting a moving table or platen controlled by a driving screw, on the end of which are two pulleys turning in opposite directions. By means of a clutch either one of the pulleys can be shifted on and thus make the table move forward or backward. On the front of the bed is a knife supported by a frame connected by screws and gears to a controlling shaft which permits the lowering or raising of the knife. The plate supporting the celluloid block to be sheeted is placed upon the table and secured firmly by bolts; the knife is lowered so as to shave the top of the block and obtain a perfectly horizontal surface; then the knife is lowered to obtain the desired thickness, adding to this the known thickness which will be lost during the subsequent seasoning. This allowance varies directly with the final thickness desired. To obtain a sheet 0.010 in. thick the stock is sheeted 0.012 in.; for 0.100 the gage will be 0.113; for 0.200, 0.240, etc. The sheeting machine is generally driven by a 10-hp. electric motor, but 5 hp. is sufficient.

Recently there has been introduced a hydraulic sheeter which is constructed in a similar way to the mechanical one, except that the platen is propelled by a hydraulic ram. The advantages claimed are that this machine permits greater production and a more accurate sheeting, particularly when cutting thin sheets. Also the chances of having the sheets soiled with oil are less. Only a few factories have installed this new sheeter on trial and it is doubtful whether this machine will replace the old type of sheeter, which when rightly handled is very efficient and the cost of which is far less.

As soon as the sheets are cut they are marked so as to know the color, block number, thickness and date of

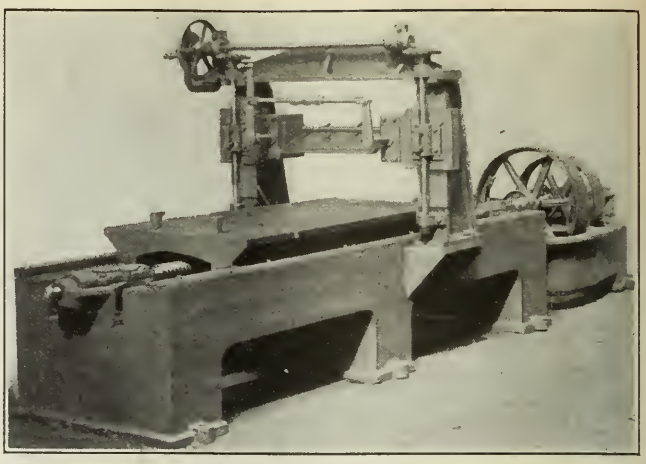

FIG. 5. PLANER FOR SHEETING CELLULOID BLOCKS

sheeting and are placed between special cardboard sheets, where they stay a certain time according to the thickness. During this period a certain amount of solvent is absorbed by the cardboard so that when taken out to be submitted to the real seasoning the sheets will not warp badly and will not necessitate a preliminary pressing before polishing. The cardboard after having been used for a certain time is submitted to a drying operation so as to remove the solvent absorbed. During the sheeting a certain quantity of scrap is made varying with the skill of the operator and also with the constancy and the thickness of the sheeted celluloid. Also a certain amount of imperfect sheets are made. The following shows a good average:

	Per Cent		Per Cent
Imperfect sheets	7 to 9	Scrap	6 to 7
Perfect sheets	82 to 84	Loss by evaporation	2 to 3

The imperfect sheets are sold as seconds and the scrap is sent to the mixing room, where it is worked again.

Seasoning Celluloid Sheets

After they have remained a certain time between cardboard, the sheets are transported to the drying room, where they are submitted to a final drying. Generally the drying is done by hot air circulation. At first the sheets were hung directly above protected steam-heated pipes, but today in most of the plants a fan is used to force the air over a steam-heated coil and then through the drying room, thus giving more uniform seasoning. The temperature of heating is regulated and kept around 38 deg. C. The time of drying is proportional to the thickness of the sheets and Table I shows the duration according to the thickness. During the drying a certain amount of solvent is lost and consequently the weight of the stock is reduced; the following table shows the loss for different thicknesses:

Gage, In.	0.085	0.060	0.090	0.040	0.100	0.085
Before drying, lb.	261	311	284	304	214	245
After drying, lb.	226	263	241	258	179	207
Loss, lb.	35	48	43	46	35	38
Loss, per cent.	13.4	15.4	15.1	15.1	16.3	15.5

The process referred to as "water drying," which is extensively used to dry smokeless powder, finds little application in the drying of celluloid. When used, the celluloid sheets are placed vertically in tanks where water at a temperature of about 45 deg. C. is kept in motion, the "drying" being done by the absorption of

the solvent by the water. This method is much quicker than that of using hot air, but at the end of the process the stock has to be heated so as to remove the water retained by the stock. Vacuum drying if properly conducted is efficient but requires an expensive installation.

During the drying of the sheets about 14 to 15 per cent of alcohol is lost, the recovery of which would represent a large saving, but so far little has been done to avoid this loss, largely because the changes which would have to be made in the present installations and the extra machinery required seem expensive. However, it is reasonably certain that in the case of a factory producing about 3,000,000 lb. of celluloid per year the installation of a system of solvent recovery, for the rolls and drying rooms, will prove a good investment.

TABLE I. TIME OF DRYING CELLULOID SHEETS

Thickness, In.	Time of Drying — Between Cardboard, Days	In Drying Room, Days
0.004 to 0.009	1	2 to 3
0.010 to 0.020	1	4 to 8
0.021 to 0.040	1	8 to 16
0.041 to 0.080	2	16 to 24
0.081 to 0.120	3	24 to 34
0.120 to 0.160	4	34 to 50
0.160 to 0.180	5	50 to 58
0.180 to 0.200	6	58 to 64

Polishing

After the celluloid sheets have been dried they have warped more or less and have to be straightened. As the celluloid sheets are generally sold to the trade polished, the two operations of straightening and polishing are carried out in the same hydraulic press. The press used is of very heavy construction and generally has two rams above which are twelve semi-steel plates which are supported so as to leave an opening of about 2½ in. between the plates. Each plate is cored and connected to the main pipes distributing steam and water. The dimensions of the plates are generally 56 x 25 in. and the maximum gage pressure used during the polishing is 3,500 lb. per square inch.

The polishing is done by heating under pressure the sheets placed between polished plates; after cooling the surface of the sheets will have a perfectly polished surface.

The polishing plates used have to be of first quality, and it seems that the best are made in Germany. During the World War every factory experienced great difficulty in getting a supply of good polishing plates. These plates are generally made of a steel sheet on each side of which a layer of nickel is rolled while the metal is hot. The rolling process is kept on until the metals are cold; then the plates are submitted to a special polishing process which will give a perfect finished surface. Different alloy compositions have been tried from time to time, but only pure nickel keeps this surface perfect for a long period and after the plates have shown wear marks they can be refinished.

The polishing operation is as follows: The cleaned celluloid sheets are placed between nickel polishing plates and two to eight sheets are then piled up, the number varying with the thickness of the celluloid sheets and the opening between two press plates. This is called a set; each set is placed between heavy pads of cotton sheets which are supported by steel sheets. The press, which has been heated during the laying operation to around 85 deg. C., is then filled and low pressure—that is, about 500 lb. per square inch—is applied during the heating period, which lasts from 1½ to 5 minutes, according to the thickness of the celluloid sheets to be polished. Then cold water is sent through the press, the pressure being kept around 3,000 to 3,500 lb. After the cooling operation, which takes from 15 to 45 minutes, the pressure is shut off and the sheets are taken out. In Europe the polishing presses are of the same construction but stronger so as to resist pressures up to 6,000 lb. per square inch.

After polishing, the celluloid sheets are trimmed to 50 x 21 in. generally and are then stored in unheated rooms until they are sold and shipped away.

Manufacture of Rods and Tubes

Celluloid rods can be made by two ways—by cutting or by stuffing. Generally the cutting method is used for shell and mottled designs, the stuffing process being used for uniformly colored rods. The cutting of the rods is done with the sheeting machine employed to cut sheets, the knife being replaced by a cross-feed screw supporting a tool head in which are inserted special steel cutters placed at different heights and on the side of which are small individual angle knives which edge the stock left after the rods have been cut. This method of cutting rods gives the best of results, the only disadvantage being the great quantity of scrap produced, this varying, with the gage of the rods cut, from 40 to 50 per cent. The loss of solvent during the operation reaches 5 to 8 per cent, and the solvent left in the rods after cutting varies from 8 to 10 per cent. Another method for cutting rods is to use special cylindrical presses in which the celluloid paste is pressed on a steel axle which is placed in the center. After cooling, the block is transferred to a specially constructed lathe on the front of which a cutter moves, thus cutting an endless rod.

The stuffing of rods is done on specially constructed hydraulic presses which are composed of a cylindrical cast-iron chamber which can be heated or cooled. (See Fig. 6.) In this chamber is placed the specially rolled paste, which is pushed through a die by a hydraulic ram working at a pressure varying from 500 to 3,000 lb. per square inch. The heating and pressure, combined with the density of the paste, are the factors regulating the production of a perfect rod. The heating has to be perfectly controlled around 75 deg. C., as above this temperature decomposition of the celluloid paste can take place and frequently disastrous accidents are reported which are generally due to the carelessness of the operator. In some factories the hydraulic stuffers are replaced by mechanical ones which are of the same construction as the mechanical straining machine described before, but the cylinders are smaller, being generally from 4 to 6 in. in diameter. These mechanical stuffers require 10-hp. motors and are as efficient as the hydraulic ones, although the density of the paste to be stuffed has to be varied.

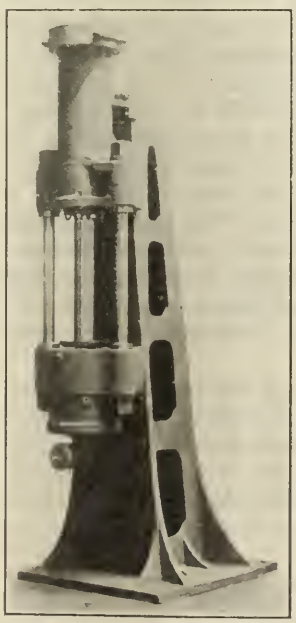

FIG. 6. EXTRUDING PRESS FOR RODS AND TUBES

The two machines just described can also be used for making tubes, and in this case a special die having a pin in the center is used. As to the production, this varies with the dimensions of the rods and tubes to be made and also with the capacity of the cylinder. As an indication, from 7 to 9 lb. of 0.100-in. gage rods or tubes can be made per hour using a machine having a cylinder diameter of 4 in.

Scrap Utilization

All scrap made in the factory, together with that coming from the manufacturers of novelties, is made into celluloid. The scrap coming directly from the factory is sorted by colors and thicknesses, and mixed as soon as possible. Dry scrap has to be washed and submitted to a cleaning and sorting process before mixing.

The scrap can be mixed in boxes similar to those described for the mixing of cellulose nitrate. Generally 3 to 5 per cent of camphor and 20 to 35 per cent of denatured alcohol is required according to the scrap used. After standing for a period varying from 3 to 6 days the scrap paste is cut and, after a slight rolling, is filtered. This scrap paste can be used alone, but it is generally mixed in different proportions with cellulose nitrate paste to make a celluloid block.

So as to reduce the quantity of alcohol and the time of mixing, most of the celluloid plants use large specially constructed tumblers in which the scrap and camphor alcohol solution are kept in motion for about 1 hour. This method reduces the time of the operation.

Camphor Substitutes and Synthetic Camphor

True celluloid is made with natural camphor which has been refined. Sometimes, when camphor prices are too high, as was the case during the war, substitutes have to be used. The number of substitutes which can be used is limited. Acetanilide, methylacetanilide, tricresylphosphate, triphenylphosphate, triacetine, etc., have all been tried. Acetanilide is a poor solvent for cellulose nitrate and above 10 per cent in mixtures with camphor gives a brittle celluloid which changes color with time. Methylacetanilide, having a very low melting point, produces a celluloid which is entirely too soft and discolors quickly. Generally the same can be said of the other substitutes; but nevertheless during the war great quantities of triphenylphosphate were used and some absolutely camphorless celluloid of excellent quality was manufactured which has kept perfectly up to this time. To obtain this celluloid specially purified triphenylphosphate was employed in connection with a specially prepared cellulose nitrate. By modifying the manufacturing process a little very good results were obtained, and the only contradictory fact observed was that the celluloid produced was harder than celluloid made with camphor, but this was probably due to the grade of cellulose nitrate used.

With the drop in price of Japanese camphor, the use of these substitutes (which are generally higher than camphor in price), has been discontinued, much to the satisfaction of manufacturers using outside celluloid scrap, as a great quantity of celluloid made with technically pure triphenylphosphate has given trouble on account of discoloration.

The subject of synthetic camphor requires only brief consideration. When properly prepared, synthetic camphor is practically identical with the natural product. Its manufacture is not a recent development, however. As far back as the Russo-Japanese war, when camphor was unobtainable in Europe, the writer was using synthetic camphor made by the Ampere Company working the Thurlow process, with very good results. Abroad, the manufacture of synthetic camphor has become active again due to the high price of camphor there. The resumption of the domestic industry depends upon several factors: The tariff; the price of camphor maintained by the monopoly; the price of turpentine. At this writing synthetic camphor of very good quality from abroad sells at the present price of Japanese refined camphor.

Chemical Control

The chemical control of a celluloid factory is quite a large undertaking, for if each step of the process is not regulated trouble will arise. Not only must the nitration, acid recovery, washing and bleaching operation be controlled very carefully, but the solvent, camphor and camphor substitutes, dyes and pigments must also be tested. In spite of this, almost every day the laboratory will receive some sample of stock which has given trouble during manufacture. Furthermore, there is always research work to be done on methods for improving the finished celluloid. In fact, every day something new has to be learned and the chemist is responsible in large measure for the success or failure of the manufacturing processes.

The writer desires to express his indebtedness to the following firms for the illustrations of celluloid machinery: Farrel Foundry & Machine Co. and the Allen Machine Co.

Corrosion of Underground Pipes*

In certain sections a very serious condition exists in connection with underground pipe systems, owing to the corrosive action of the soil upon the iron of which the pipe is made. The loss from this cause is so large that the Bureau of Standards has recently undertaken an extensive investigation of the subject with particular reference to the corrosive action of soils on gas and water mains.

In this investigation the bureau has the co-operation of the Bureau of Soils of the Department of Agriculture, the pipe manufacturers and the public utility companies through the research sub-committee of the American Committee on Electrolysis. Forty locations have been selected representing the different kinds of soils to be found throughout the United States, and at each locality a number of samples of every kind of iron and steel pipe in commercial use will be buried. Some of these samples will be uncovered from time to time to determine the rate of corrosion. Complete data on the physical and chemical properties of the soil and the pipes will be obtained and extensive laboratory experiments will be conducted to determine the effects of variations and individual characteristics of both soils and pipe materials. Some tests of representative pipe coatings will also be undertaken.

The results of the tests should be of great value in determining the importance of soil corrosion and in selecting the kind of pipe best suited for use in any particular soil. It is expected that considerable data as to the relative rates of corrosion of the different kinds of pipe in the soils under observation will be obtained within 2 or 3 years, but the investigation will probably continue over a period of 8 or 10 years.

*From Technical News Bulletin 55, Bureau of Standards, Nov. 9, 1921.

The Manufacture of Chromium Ball-Bearing Steel in the Heroult Furnace

A Description of Melting and Processing of Electric Ball-Bearing Steel, With a View of the Most Serious Defects in This Class of Material—Recommended Practice for the Elimination and Control of These Defects

By F. T. SISCO
Metallurgist

THE manufacture of electric high-carbon chromium ball-bearing steel in 6- to 8-ton lots has until recently been accompanied by the difficulty of producing a product which is free from surface seams and internal hair lines. The former defect, while serious, may be eliminated by proper treatment during melting and processing. The latter, which seems to be an oxidation defect not got rid of in melting, persists through all further working of the steel and appears finally as a failure in the hardened ball or race.

Previous to 1914 the finest carbon chromium ball and ball race steel was imported from Germany in the form of billets; completed manufacture was in this country. One large firm, at least, manufacturing ball bearings and ball races owes its reputation to this German steel. Excellent ball steel has been made by the crucible process, some being produced by this method of manufacture to this day. However, the manufacture of good ball steel in common with other alloy steels should be the feature of the electric furnace, which theoretically should produce a perfect ball steel from a cheap base material. This statement should not be construed to mean that no good ball steel is as yet made in the electric furnace. There are many manufacturers that are producing an excellent steel for this purpose, but the fact is they are not doing it consistently. Even those plants making a specialty of this grade of steel occasionally tap heats of which 20 per cent, 50 per cent or even all must be relegated to the scrap pile.

It is the object of the author to describe in the lines that follow the practice developed at an electric steel plant, a practice that was the result of four years' study of this steel and by which a more uniform and better product was obtained.

The three defects that seem to be especially common and prominent in carbon chromium steels are segregation, surface defects and internal defects. The first two are more or less under the control of the melting, rolling, chipping and inspection departments. The third presents a difficulty unique in that it is apparently caused by the raw materials charged into the furnace and not subsequently eliminated.

Carbon chromium steel for ball bearings and ball races is made of only one grade of material, the carbon ranging from 0.90 to 1.20 per cent, the manganese 0.20 to 0.50 per cent, the chromium 1.10 to 1.75 per cent. Silicon is generally under 0.30 per cent and phosphorus and sulphur low. The most common analysis for this steel is carbon 1.00 to 1.15 per cent, manganese 0.25 to 0.45 per cent, chromium 1.35 to 1.65 per cent, silicon 0.15 to 0.25 per cent and phosphorus and sulphur below 0.025 per cent. The steel owes its properties to the presence of double carbides of iron and chromium, which confer great hardness on the metal, a hardness which is not accompanied by as much brittleness as the hardness of carbon alone. On the behavior of these carbides depends the successful annealing and subsequent hardening of the steel. When properly hardened the steel is martensitic probably with a little troostite present, especially if slightly drawn, and in breaking presents a fracture that is very close grained and silky, not unlike the fracture of hardened high-speed steel.

Melting

The best melting practice[1] for the manufacture of this steel is melting with partial oxidation. Theoretically, in the Heroult furnace complete deoxidation is possible no matter how badly the molten bath is contaminated with oxides and gases. Practically, however, due principally to insufficient knowledge of the fundamental principles of deoxidation, and especially since the molten bath must be very thoroughly deoxidized to make good ball steel, melting down to avoid oxidation as much as possible is preferable.

The scrap used should be selected, free from excessive rust and scale and not exceeding 0.05 per cent sulphur and phosphorus. A mixture of ball steel crop ends, open-hearth scrap such as billet and bloom crops, boiler plate, etc., makes an excellent base. For a 15,000-lb. heat 600 to 800 lb. of limestone is charged on the bottom of the furnace, followed by the scrap. It is sometimes advisable, when considerable low-carbon scrap is charged, to introduce a few hundred pounds of low-phosphorus pig iron down toward the bottom of the charge. Care should be used to avoid too high a temperature during melting, as the selective oxidation of the phosphorus depends almost wholly on this factor. There will always be sufficient oxygen present in the scrap to permit the easy and complete elimination of all of this element. The cold charge may be melted down with high power until a fair-sized pool of molten metal is present around the electrodes. Complete melting of the charge is then hastened, and the temperature kept low, by pushing into the pool, by means of iron bars, the partly melted sticky mass of scrap clinging to the sides of the furnace.

When the charge is completely melted, a test sample is taken out and sent to the laboratory for immediate analysis of carbon, phosphorus, manganese and chromium. In case much chromium scrap was used in the charge, the slag may be viscous, especially if the chromium oxide, Cr_2O_3, is near 10 per cent. This slag can be thinned sufficiently by the addition of a little fluorspar.

[1]Many points in connection with the melting practice has been discussed in a previous article entitled "Deoxidation and Desulphurization in the Heroult Furnace," appearing in CHEM. & MET. ENG., vol. 26, No. 1, p. 17, Jan. 4, 1922.

In about 10 minutes the phosphorus result is reported, and if within specified limits the furnace is tilted slightly and the oxidizing slag removed by hand rabbling. The final portion of slag near the banks is easily removed by throwing a few shovelsful of lime on the metal and poling the now thick mass to the front by means of long green saplings introduced through each side door.

If the scrap was selected properly and if melting conditions were correct, the bath when melted will contain 0.50 to 0.75 per cent carbon, about 0.20 per cent manganese, chromium varying from a trace to 0.75 per cent, depending upon the amount of chromium scrap used, sulphur between 0.02 and 0.04 per cent and silicon and phosphorus below 0.025 per cent. The white slag is then immediately applied as described below. The presence of considerable carbon, some of the manganese and more than half of the chromium insures a metal in which oxides and dissolved gases cannot be present in large amounts.

When sufficient chromium scrap from the plant rolling mills and inspection sheds is available for a whole heat, the melting may be carried out quickly without oxidation. This method insures a more thoroughly sound and deoxidized steel than any other form of melting practice, but can be used only when scrap containing phosphorus well below the required percentage in the finished steel is used.

This rapid method consists essentially of melting a charge made up completely of ball steel scrap, and commencing the building up of the white slag as soon as there is molten metal present in the furnace. When this practice is used, the composition of the steel after melting will be carbon 0.85 to 1.00 per cent, manganese 0.20 to 40 per cent, chromium 1.10 to 1.30 per cent, silicon about 0.05 per cent and sulphur and phosphorus low. The phosphorus will be the same as or very slightly higher than the percentage in the scrap, as none is lost in melting. Even though this melting under a white slag produces quicker heats, more satisfactorily deoxidized heats in many cases, as well as a steel to which no alloy additions except a little ferrochromium need be made, however as a daily practice it is impractical on account of the scarcity of suitable scrap. It is often possible when melting and working large tonnages of chromium steel to collect enough plant scrap so that a series of white slag heats may be made, but due to the fact that chromium steel scrap, and other scrap for that matter, containing less than 0.02 per cent phosphorus is never available in large tonnages, the partial oxidation process above described is preferable. In no case should a complete oxidation in melting be tolerated for this grade of steel. This practice, so common in electric steel plants, consists essentially in melting down almost any kind of scrap with limestone and iron ore or roll scale, so that all of the carbon, silicon, phosphorus, manganese and chromium, if present, is oxidized and removed from the metal. This practice when applied to chromium steels produces almost without exception a low-grade product. High-carbon, high-chromium steel is perhaps one of the most sensitive of the alloy steeels made in the Heroult furnace, and one of the most difficult to deoxidize completely.

In the case of most other steels it is not difficult to remove excessive oxide and gas contamination caused by melting with iron ore or roll scale; with chromium steel, however, as most of the trouble occurs between the time of the ferro-alloy addition and the pouring of the ingots, it is highly desirable to have a steel almost 100 per cent deoxidized before making the ferro-alloy addition.

Why it happens in many cases that a charge of ordinary scrap melted low in carbon, recarburized on the bath, apparently completely deoxidized by a good carbide slag will make an almost perfect heat of carbon tool steel on one hand, and why on the other hand the same practice will make a heat of chromium steel with thousands of microscopic hair-line seams, the author will not attempt to explain. It is practically proved that the addition of ferrochromium is largely responsible.

Experiments, in which ingots were made by different melting practices and followed through all further processing, proved conclusively that melting to retain a portion of the carbon, manganese and chromium produced uniformly a better product, more nearly free from surface seams and internal hair-lines than melting with complete removal of these elements followed by recarburization on the bare metal.

Deoxidation

The deoxidation is accomplished with the customary white or carbide slag. This slag is composed of lime, crushed coke and fluorspar in the proportion of 6 to 2 to 1 and is mixed before being added to the furnace. Best practice with a 6-ton Heroult furnace requires 1 lb. of slag to each 15 or 20 lb. of metal. Under high power

FIG. 1. TAPPING A HEAT OF CARBON CHROMIUM BALL-BEARING STEEL

the slag should be in condition and should carry 1 to 3 per cent calcium carbide within 45 minutes after being applied. By luting the furnace doors to exclude atmospheric air as much as possible 30 minutes further should suffice for an almost complete deoxidation of the bath. A sample for analysis is now quickly taken and all of the ferrochromium and ferromanganese added. Five minutes suffices for the melting of the alloys, after which the bath is well stirred through each door. Further slag additions are now made if necessary and the furnace is again sealed until carbon results are obtained from the laboratory. The results of the analysis will probably show that some recarburization is necessary; addition of carbon is made in the form of washed metal

or low-phosphorus pig iron. When this is melted down, a few shovelsful of slag are scattered on the bath and the furnace is again sealed. If the bath appears too hot, the power may be reduced slightly for the remainder of the heat. At least 1 hour should be given to complete the deoxidation after all alloy additions are made.

Results of continued investigations have shown that this period is absolutely necessary if surface seams are to be avoided. It is also advisable to keep the metal very hot during the deoxidation period, a bath temperature of 3,200 deg. F. (estimated) being the best. If, after being under the white slag for 2½ hours, a metal test is "quiet" with no perceptible bulging or sparking, the ferrosilicon is added and the bath stirred as soon as the alloy is melted. Doors are now closed tight and the power is shut off completely for 5 minutes or more or until the metal cools to tapping temperature (3,000 to 3,050 deg. F.). If a heat test and if slag test show temperature and slag conditions correct, the ladle is placed in position and the heat tapped. (See Fig. 1.)

Tapping and Pouring

In tapping, the slag should be held back completely if possible. On some of the older furnaces it is necessary to use a skimmer for this purpose. More recent types have a tap hole instead of the wider spout, an arrangement that permits the rapid tilting of the furnace until the slag line is above the tap hole. In no case should metal and slag be tapped together, permitting the mechanical intermixing of the two in the ladle. As soon as the ladle is filled, five or six large shovelsful of lime are thrown on top and the ladle is held 5 or 10 minutes before pouring. Holding the heat in the ladle during this period is an extra precaution with chromium steels, as it permits the last traces of oxides and entrapped gases to rise to the surface.

The additional wear on furnace and ladle linings by deoxidizing and by tapping exceptionally hot heats is more than justified by reduction in segregation and oxidation defects.

FIG. 2. POURING A HEAT OF CARBON CHROMIUM BALL-BEARING STEEL

With ball-bearing steel it is necessary that every precaution be taken to prevent oxidation or contamination of the metal after it leaves the furnace. Clay ladle washes commonly used should be avoided, as the thin clay coating invariably spalls off and some of it becomes entrapped in the metal.

The most common ingot size for 6-ton heats is 9 x 9 in. The molds may be either solid or split, the former undoubtedly giving the better results. The molds are slightly round cornered, are 9 x 9 in. at the top and taper to 8 x 8 in. at the bottom. Stools accommodate two molds and are so designed that the connection between mold and stool is sufficiently tight that packing is unnecessary. The top is offset in such a way that the sink-head sets 2 in. down into the mold. (See Fig. 2.) The clay sink-heads are dried and warmed over gas burners before being placed on the mold. To prevent sticking, the inside of the mold is slurred with a mixture of hot tar and kerosene oil applied with a long-handled brush. Ingot markers containing the heat and

TABLE I. MELTING WITH PARTIAL OXIDATION

Furnace A. Heat No. 3137 — Analysis Ordered: C 1.00/1.15, Si 0.15/0.25, S 0.20 max., P 0.20 max., Mn 0.25/0.45, Cr 1.35/1.65

Time		Lb.	Metal Tests C	Si	S	P	Mn	Cr	Slag Tests SiO_2	FeO	Al_2O_3	MnO	CaO	MgO	CaS	CaC_2	Cr_2O_3	P_2O_5	P
5:05 p.m.	Previous heat tapped																		
5:15 p.m.	Bottom repaired—magdolite and dolomite	300																	
	Began charging—limestone	650																	
					—About—														
	Scrap—mixed low phos.	3,740*	0.40	....	0.040	0.040	....	....	....	....	....	....	....	....	....	....	....	....	....
	Scrap—chromium butts	5,240*	1.05	0.20	0.020	0.020	0.35	1.45	....	....	....	....	....	....	....	....	....	....	....
	Scrap—country mixed	2,080*	0.30	....	0.060	0.080	....	....	....	....	....	....	....	....	....	....	....	....	....
	Scrap—low-phos. pig iron	500*	3.50	....	0.050	0.040	....	....	....	....	....	....	....	....	....	....	....	....	....
	Scrap—scrap shell rounds	3,820*	0.60	....	0.030	0.030	0.60	....	....	....	....	....	....	....	....	....	....	....	....
					—About—														
5:55 p.m.	All scrap charged—power on	15,380*	0.75	0.10	0.035	0.040	0.40	0.50	....	....	....	....	....	....	....	....	....	....	....
8:20 p.m.	Completely melted—added fluorspar	30																	
8:25 p.m.	Began slagging	.....	0.59	0.026	0.031	0.012	0.25	0.37	12.75	8.63	3.06	4.08	50.21	14.37	0.041	†	...	4.72	1.38	...
8:35 p.m.	Oxidizing slag off																		
8:40 p.m.	Deoxidizing slag on—burnt lime	600																	
	Furnace on high power—powdered coke	175																	
	Fluorspar	125																	
8:55 p.m.	Slag partly white	.....	0.60	0.031	0.027	0.013	0.26	0.39	14.16	3.07	2.13	0.46	57.03	14.83	1.43	0.13	0.06	.....	0.009
9:10 p.m.	Slag all white, partly carbide	.....	0.61	0.031	0.025	0.014	0.26	0.39	14.31	1.01	2.27	0.24	55.86	17.24	1.55	1.47	Nil	.....	0.003
9:15 p.m.	Added ferromanganese, 80% Mn, 6% C	20																	
	Added ferrochromium, 65% Cr, 6% C	280																	
9:25 p.m.	Bath stirred, slag added	50	0.73	0.053	0.015	0.014	0.35	1.51	16.03	0.65	1.86	0.34	56.21	15.46	2.07	1.76	0.32	.....	0.005
9:30 p.m.	Slag strongly carbide	.....	0.74	0.055	0.013	0.014	0.35	1.50	14.78	0.34	2.21	0.04	62.17	13.37	2.14	2.13	0.03	.....	Trace
9:50 p.m.	Washed metal added	1,000																	
10:00 p.m.	Bath stirred—slag added—power reduced	50	0.96	0.051	0.012	0.014	0.34	1.47	15.67	0.94	1.67	0.05	59.80	14.65	2.23	1.65	0.08	....	Nil
10:30 p.m.	Heat test quiet—added ferrosilicon, 50% Si	65	0.98	0.217	0.012	0.015	0.34	1.46	16.03	0.46	2.03	0.03	60.45	13.86	2.20	1.46	Trace	....	Nil
10:45 p.m.	Slag strongly carbide—bath stirred	.....	1.00	0.214	0.011	0.015	0.34	1.46	16.47	0.33	1.98	0.04	61.31	13.53	2.46	2.64	0.02	.....	0.003
10:50 p.m.	Metal hot—power shut off	.....	1.01	0.217	0.011	0.015	0.35	1.46	15.85	0.37	2.11	0.03	60.93	14.21	2.31	2.02	Nil	....	Ni
10:55 p.m.	Heat tapped																		
	Ladle	.....	1.05	0.209	0.011	0.015	0.34	1.47	17.01	0.43	2.26	0.04	59.37	13.81	2.36	1.87	Trace	....	0.004

Total ingot weight, 15,980, or 95.4 per cent.
*Analysis of scrap approximate. †Reported as sulphur.

TABLE II. MELTING WITHOUT OXIDATION

Furnace A. Heat No. 3209

Analysis Ordered — C 1.00/1.15 — Si 0.15/0.25 — S 0.20 max. — P 0.20 max. — Mn 0.25/0.45 — Cr 1.35/1.65

Time		Lb.	Metal Tests						Slag Tests								
			C	Si	S	P	Mn	Cr	SiO_2	FeO	Al_2O_3	MnO	CaO	MgO	CaS	CaC_2	Cr_2O_3	P
3:25 a.m.	Previous heat tapped	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3:40 a.m.	Bottom repaired—magdolite—dolomite..	250	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3:45 a.m.	Began charging—limestone	50	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
					—Aver	age—												
	Scrap—chromium steel crops	7,870*	1.05	0.20	0.015	0.015	0.38	1.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	—scrap rounds	3,260*	1.10	0.20	0.018	0.016	0.37	1.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	—ball scrap	3,010*	1.00	0.15	0.020	0.020	0.40	1.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	—chisel steel scrap	1,380*	0.70	0.10	0.020	0.014	0.35	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
					— Ab	out—												
4:30 a.m.	Scrap all charged—power on	15,520*	1.01	0.18	0.018	0.015	0.38	1.27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6:50 a.m.	Charge nearly melted	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Began adding deoxidizing slag																	
	Burnt lime	550	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Powdered coke	150	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Fluorspar	100	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7:05 a.m.	All melted—all slag charged	.....	0.94	0.047	0.017	0.015	0.32	1.11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Furnace on High Power																	
7:30 a.m.	Slag white—partly carbide—added slag..	50	0.95	0.050	0.014	0.016	0.35	1.16	13.41	2.06	1.37	0.45	59.21	14.17	1.17	0.56	0.43	0.011
7:45 a.m.	Added ferromanganese, 80% Mn, 6% C...	10	....	.....	.....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Added ferrochromium, 65% Cr. 6% C.....	75	....	.....	.....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7:55 a.m.	Slag strongly carbide—bath stirred	.....	1.00	0.057	0.013	0.017	0.39	1.50	15.17	0.63	1.57	0.21	61.07	13.62	1.57	1.78	0.31	0.006
8:20 a.m.	Slag strongly carbide—added slag	75	1.02	0.059	0.012	0.017	0.38	1.48	16.21	0.47	1.86	0.06	60.27	13.17	1.63	1.51	0.06	0.002
8:30 a.m.	Slag strongly carbide—metal test quiet...	.....	1.03	0.056	0.012	0.017	0.39	1.50	15.37	0.31	1.76	0.05	59.07	15.47	1.58	2.11	0.07	Trace
	Added ferrosilicon, Si 50%	60	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8:40 a.m.	Bath stirred	.....	1.04	0.247	0.011	0.017	0.39	1.48	17.31	0.41	1.73	0.07	57.36	14.09	1.69	1.32	0.03	Nil
8:45 a.m.	Slag O.K.—metal O.K.—bath hot—power off	.....	1.04	0.243	0.011	0.017	0.38	1.48	18.07	0.35	1.67	0.05	58.41	14.71	1.78	1.47	0.06	Nil
8:55 a.m.	Heat tapped	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Ladle	.....	1.08	0.240	0.010	0.018	0.39	1.49	19.31	0.41	1.83	0.07	56.93	14.88	1.69	1.67	0.02	0.003

Total ingot weight, 15,030 or 95.9 per cent.
*Analysis of scrap approximate.

ingot number are placed in the top of the ingot as soon as poured.

Pouring should be as rapid as possible and through a 1¼-in. nozzle; the temperature at the start should be about 2,950 to 3,000 deg. F. Extensive pouring tests covering months have shown that direct pouring when handled correctly is by far the best for chromium steels. After trying all possible forms of box and pot pouring, these were finally abandoned in favor of the direct-poured practice. This practice at an initial temperature of 2,950 deg. F. leaves, after pouring fourteen to seventeen ingots, a slight skull of 50 or 100 lb. in the ladle.

The ingots are covered with a mixture of lime and powdered coke and no special precautions are taken to eliminate pipe. The temperature and pouring practice just described practically eliminates possibility of secondary pipe and throws the main pipe and all segregation well up into the sink-head, where it is cropped and scrapped.

The ingots are stripped 90 minutes after pouring and placed in a pit, where they are covered with ashes for 36 to 48 hours. Table I shows the chemical history of a heat of chromium ball steel melted with partial oxidation; Table II shows the same kind of steel, the charge being wholly chromium steel scrap and melting being under a white slag.

Processing

The ingots are chipped, if necessary, to remove any pits, pock marks or metal shots. A little chipping of the ingots will frequently save much chipping labor after roughing to billets. The ingots are then reheated for rolling. It is a characteristic of chromium ball steel that with the exception of internal hair-lines most defects if present will be found on or very close to the surface. For this reason the heating for initial rolling should be controlled so as to produce free and heavy scaling. If forging billets are made, rolling is direct, 10 per cent top discard and about 5 per cent bottom discard being scrapped. When large bars (2 to 4 in.) are made, and this constitutes the most important and the bulk of the chromium steel business, two procedures are followed—direct rolling and roughing and re-rolling. The latter method unquestionably produces the best result and will be described in detail. For the large size rounds (2 to 4 in.) the ingots are heated to a free scaling temperature and roughed to 4- to 6-in. gothic billets. The top, 3 or 4 in. below the sink-head, is nicked on all sides by the hot saw and the bottom discard of about 5 per cent completely removed by the saw. The billets are rolled onto the hot bed and placed in close contact with one another, being covered in cold weather with a layer of lime or ashes. Finishing temperatures, while not so important in the roughing, should not be too high.

After cooling, the sink-head end of the billet is removed by breaking and the fracture examined for pipe. In case this appears, the billet is nicked back 6 in. with an acetylene torch and again fractured, which process is repeated until there is no evidence of pipe. The top discard in this class of steel should never be below 10 per cent and preferably should approach 15 per cent.

After fracturing, the billets are pickled and chipped clean from any seams or flaws. If melting was correctly accomplished, chipping should be slight. The billets are then reheated and rolled to finished size, excessive scaling being prohibited in the finished rolling, which is done with careful attention to surface appearance and finishing temperature, the latter being near the critical range, 1,375 to 1,400 deg. F.

At this point both top and bottom discard from the finished bars representing the first, middle and last ingots of each heat are sent to the laboratory and analyzed for carbon, manganese and chromium. If the maximum variation among the six tests on the heat does not exceed 0.05 per cent on each element, segregation is considered absent. By the method above outlined, fracturing top discard on roughed billets and re-rolling, segregation is practically impossible with good melting and pouring practice.

The bars are given a close file inspection for seams

and one bar from each heat is selected for hair-line tests. The inspected bars are then annealed. Consumers of this grade of steel require that chromium steel bars be soft enough for satisfactory work in automatic machines—that is, 170 Brinell or below—and that bars pass rigid hardening tests. To fulfill both requirements means that in annealing, all cementite, both excess and combined with the pearlite, must be spheroidized. This is very essential if the complete absorption in hardening, which is necessary for a uniform martensitic structure, is to be attained.

All bars above 1 in. in size must be normalized as well as annealed. To this end and to prevent decarburization the bars are packed in heavy walled cast-iron pipes, 14 in. in diameter and 16 ft. long. Any spaces not occupied by the steel are filled with a mixture of charcoal and ashes and the ends sealed with brick and fireclay.

To facilitate rapid and economical handling during normalizing and annealing, a car type furnace is used, with doors at both ends. Two cars are provided, being fastened together. Car No. 1, being loaded, is pulled into the furnace, the doors are closed and sealed and the furnace is fired. The mass is heated as rapidly as possible to 1,725 to 1,750 deg. F. and then held at this temperature for 12 hours. While at this temperature car No. 2 is loaded. After the 12 hours' heating at normalizing temperature the furnace doors are opened, car No. 1 is drawn out, No. 2 being drawn in at the same time. After car No. 2 is held at temperature (1,725 to 1,750 deg. F.) for the specified time, it is withdrawn, car No. 1 being drawn in simultaneously and the open furnace now cooled rapidly to 900 deg. F. or slightly below. The doors are then closed and the first lot is now heated at the rate of 20 deg. per hour to 1,400 to 1,420 deg. and held at this temperature for 24 hours. Cooling is at the rate of 10 deg. per hour down to 800 deg. F., when the doors are opened and car No. 1 is withdrawn. While this charge is cooling and the pipes are being unloaded and recharged, car No. 2 is being annealed at 1,400 to 1,420 deg. F. for 24 hours, with subsequent slow cooling as in the case of car No. 1.

This method of annealing insures complete spheroidizing of all the carbide and produces a steel which will range from 155 to 165 Brinell.

After unloading, the bars are run through a machine that straightens and imparts an oiled polish to the surface. A disk $\frac{3}{8}$ in. thick is cut from every third bar for hardening tests. The steel is now ready for shipment.

Rough Turning Chromium Bearing Steel

An extensive study of comparative costs and quality of product was made between the practice above described and the following. Knowing that the majority of defects in chromium steel (aside from hair-line seams, which will be discussed later) are surface seams, another method was tried to eliminate these. The ingots were chipped, reheated and rolled to finished size direct in the case of the larger bars, roughed to gothic billets and finish rolled to size in the smaller bars. In all cases finish rolling was $\frac{1}{16}$ in. full. The bars were open annealed, straightened and rough turned to size. Inspection was after rough turning. This practice eliminated pickling, much of the chipping and the extra pipe cost in annealing. The product was undoubtedly better in appearance, was somewhat freer from seams than the regular product and on the basis of cost studies could be made just as cheaply as the regular product. The only objection to regularly rough turning chromium steel is the large amount and excessive cost of the equipment necessary to handle a considerable tonnage in this manner. In a plant where this equipment was available this practice would be preferred as producing the best product possible.

Hardening Tests

These tests are made to determine the correctness of the normalizing and annealing operation and to determine whether all of the cementite is completely spheroidized. The disks cut from the finished bars are placed in a small gas-fired or electric heat-treating furnace and brought to 1,435 to 1,450 deg. F. and held at this temperature for 20 minutes. They are then withdrawn and immediately quenched in cold water. With a sledge the disks are broken in half and the fracture of the hardened steel is examined. A perfectly annealed piece results in a fracture that is very fine grained, silky and silvery in appearance. Dark streaks or spots due to undissolved carbides should be entirely absent.

Tests for Hair-Line Seams

One annealed bar about 6 ft. long is picked from each heat, straightened and rough turned to remove scale. It is then placed in a lathe, 6-in. sections being turned down so that each section is progressively $\frac{1}{4}$ in. smaller in diameter than the preceding. A $3\frac{1}{2}$-in. round bar 6 ft. long will have twelve sections ranging from $3\frac{1}{2}$ in. down to $\frac{3}{4}$ in. diameter, exposing successively the whole bar from center to surface. With a reading glass that magnifies about five diameters the bar is closely examined and the number of hair-line seams on each section counted.

The Hair-Line

The following peculiarities and characteristics of the hair-line seam have been noted by the author in the past 5 years. This defect is a very small, almost microscopic crack in the bar, always running in the direction of rolling. It is undoubtedly an elongated hole caused by very small particles of gas being entrapped in the steel. It may be present in any part of the bar and is apparently well distributed throughout the mass of metal. It is a spot of weakness and, due to the drastic hardening treatment accorded to this grade of steel, will form a spot from which ultimate failure of the hardened ball or ball race will originate. It is a defect that is found in appreciable amounts in this grade of material only, it being especially evident when the chromium content is around 1.50 per cent and the carbon 1.00 per cent. The best melting practice will reduce the number of hair-lines present, but will not eliminate them entirely.

Given a uniform melting practice, uniform conditions of rolling and annealing, the hair-line seam will appear in steel in which high-carbon (6 to 8 per cent) ferrochromium was used, but will be almost entirely absent in steel made from 2 per cent carbon ferrochromium. A heat made from ball steel scrap entirely, scrap consisting of billet crop ends and bars rejected on account of seams and hair-lines and melted under a white slag without oxidation, will be almost free from this defect. Some shipments of 6 per cent carbon ferrochromium produce a steel badly contaminated with hair-line seams, while other shipments of the same class of alloy will produce

a steel with few of these defects. Steels made from 6 per cent carbon ferrochromium purchased in 1916 and 1917 were singularly free from hair-lines, while steels made from the same alloy made under pressure of war conditions in 1918 and 1919 were badly contaminated.

From these facts it is probable that in the ferrochromium lies the origin of the hair-line seam. Melting with as little oxidation as possible in the presence of a strongly carbide slag and adding the ferrochromium as early in the heat as possible will help to reduce the number of the hair-line seams.

While the origin of the hair-line has been accounted for by a well-developed theory, lack of conclusive evidence to substantiate this theory makes it unwise to publish it at this time.

Another interesting fact in connection with chromium steel of the above composition: The author had noted for some time the peculiarity of the relative solubility of chromium steels in nitric acid. Treatment accorded to all ladle test samples of chromium-bearing steel was as follows: The small test ingot[2] was stripped from the mold as soon as solid and buried in a bucket of lime for 45 minutes. It was then quenched in water and drilled at slow speed with a high-speed drill. The drillings were screened and 5 g. of the steel that passed 20 mesh and was retained on 40 mesh was digested just below the boiling point with 100 c.c. of dilute nitric acid, sp.gr. 1.16. Some of the steels dissolved completely in 15 or 20 minutes, others dissolved much more slowly, and still others, notably white slag heats, were practically insoluble. In conjunction with the inspection department an attempt was made to correlate these phenomena with the quality of the steels. In every case it was found that rejections were the highest on those heats whose drillings dissolved most easily in nitric acid, while the heats whose drillings dissolved with great difficulty or were practically insoluble were free from surface seams and internal hair-lines. By means of this test the chief inspector was prepared several days in advance and had an accurate idea of the quality of the steel he was to pass upon.

The relation between solubility and hair-lines was especially noticeable. After a few trials it was possible to foretell with fair accuracy the percentage of rejections on this account. The accuracy of the solubility test, however, is absolutely dependent upon the degree of hardness of the test-piece drilled. It is comparative only and fails utterly unless all ladle test-pieces have been similarly treated and unless all are fairly hard. The least softening of the steel affects its solubility very markedly and comparisons are then impossible.

Deoxidizing Ball-Bearing Steel With Ferrotitanium and Ferrovanadium

Several heats of this steel were made using ferrotitanium as an additional deoxidizing agent. In some heats the titanium alloy was added to the furnace after the ferrosilicon and just before tap. Two to three pounds of the alloy was used for each ton of steel and the melt was well stirred after the addition. In other cases the alloy was thrown into the ladle as soon as the bottom was covered with metal. In both cases the steel was held in the ladle 5 to 10 minutes before pouring.

A few heats to which sufficient ferrovanadium was added to the metal to give a vanadium content of 0.03 to 0.05 per cent were made and processed for comparative tests. No departures were made from the usual practice in processing from the ingot to the finished bar. Inspection and hair-line tests showed that both alloys produced a steel slightly superior to the regular product. It is questionable, however, whether the slightly better results were justified by the increased cost, especially in the case of ferrovanadium.

[2]Standard test No. 1; an ingot 1½ x 1½ x 8 in. high, top flared to act as sink-head. See p. 8, U. S. Steel Corporation pamphlet "Methods for the Commercial Sampling and Analysis of Plain Steels."

Summary

From the results of 5 years' experience on high-carbon, high-chromium ball steel the following was adopted as the practice productive of the most satisfactory steel at the lowest cost:

Melt selected scrap with partial oxidation to eliminate phosphorus and to retain most of the carbon, manganese and chromium. Deoxidize with a strongly carbide slag, excluding atmospheric air from the furnace as much as possible and adding the ferrochromium as soon as the metal is deoxidized and the slag in good shape. Allow at least 1 hour for further and complete deoxidation after the alloy has been added. Deoxidize on a very hot bath and tap metal at about 3,000 deg. F. or a little above, holding 5 to 10 minutes in the ladle before pouring. Bury ingots for at least 36 hours in ashes.

Chip ingots and reheat, permitting them to scale freely. Rough to a gothic billet and fracture to expose possible pipe. Pickle, chip and reheat for final rolling. Roll to finished size with particular attention to finishing temperature. Inspect for seams, normalize, air cool and anneal for 24 hours at 1,400 to 1,420 deg. F. with slow furnace cooling. Machine straighten. Adherence to this practice, provided a clean ferrochromium is used, will produce a product free from surface defects and with a minimum of hair-lines.

Charleston, W. Va.

Effect of Upper Silesian Plebiscite on Chemical and Metallurgical Industries

The *Chemisch-Technische Industrie* estimates that the result of the partition of the plebiscite area in Upper Silesia is to give Poland nearly 76 per cent of the coal production, 96.9 per cent of the iron ore production, 81.9 per cent of the zinc ore, 70.9 per cent of the lead ore and 26 per cent of the sulphur ore. Of the production of coke 50.6 per cent and of coke byproducts 50.2 per cent goes to Poland. The zinc and zinc byproducts industries and the lead and lead byproducts industries fall entirely into the hands of Poland, with 43.8 per cent of the petroleum-refining industry and 75.6 per cent of the coal-distillation industry. Poland also obtains the whole sulphuric acid industry.

Preparation of Synthetic Organic Chemicals at Rochester

The address on "The Preparation of Synthetic Organic Chemicals at Rochester" presented by Drs. C. E. K. Mees and H. T. Clarke before the Society of Chemical Industry, Montreal, Aug. 31, 1921, has been published in the form of an illustrated booklet, copies of which are obtainable upon request from the Eastman Kodak Co.

As a natural consequence of the attempt to produce a great variety of highly specialized products, methods for carrying out organic syntheses were developed which should be of interest to organic research workers in general. Typical set-ups are illustrated and many novel features explained.

Manufacture of Phosphoric Acid and Phosphates

General Treatise on the Acid-Decomposition Process in Industrial Production—Dissolving the Raw Ore—Removal of Impurities—Monocalcium and Dicalcium Phosphates—Concentration and Grading of the Salts—Production of Sodium Salts From Phosphoric Acid

By JACOB T. MECKSTROTH
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THE manufacture of phosphoric acid and phosphate salts may be divided into two general processes. One is called the pyrolytic or volatilization, the other the acid-decomposition process.

The pyrolytic or volatilization process is at present used only in the manufacture of the highest grade of the so-called chemically pure phosphoric acid. This process has not yet been developed to the commercial efficiency of producing an acid at a cost to compete favorably with the acid-decomposition process. There is, however, no doubt that the day is not far distant when the pyrolytic or volatilization process, as described by Waggaman and Wagner in the *Journal of Industrial and Engineering Chemistry* for May, 1918, and reported by Waggaman and Turley in the *Journal of Industrial and Engineering Chemistry*, vol. 12, 1920, p. 646, and in CHEMICAL & METALLURGICAL ENGINEERING, vol. 23, p. 1057, 1920, will become a commercial possibility and a strong competitor to the acid-decomposition processes.[1]

Acid-Decomposition Process

The process of decomposition, by means of 60 to 66 deg. Bé. sulphuric acid, is today the best developed and commercially successful, yet it is far from being satisfactory. The larger proportion of the acid is manufactured from phosphate rock, a tricalcium phosphate, with an admixture of silica and fluorspar, often called apatite or phosphorite. In the United States the important beds or deposits of this rock are found in Tennessee, Kentucky, Florida, South Carolina, Idaho and Montana. It is generally sold or purchased on a guaranteed basis of 75 to 80 per cent tricalcium phosphate, $Ca_3(PO_4)_2$, and its color varies from blue-green or gray to red-brown. The Tennessee and Kentucky rock has a color varying from blue to brown and has generally a higher percentage of iron and aluminum than the Florida, Idaho or Montana rock. The blue grade is usually lower in iron and aluminum than the brown grades, but is lower in the P_2O_5 content.

The Idaho and Montana deposits are being developed at the present time and are considered equal to if not actually better than either the Tennessee or Florida grade. On account of location and unknown quantity these deposits have not received the attention to which they are entitled and which they should receive. Large sums of money are being expended to utilize both the sulphuric acid from the smelter industry and the rock of the Montana and Idaho regions.

The rock deposits are frequently purchased outright by the manufacturer, although often concessional rights for a definite tonnage of definite quality are contracted for, and sometimes the rock is bought as run of mine and shipped to the plant where the grinding is done. The rock is mined by removing the overlying earth, separating the high grade by hand picking, washing, grinding and loading it in cars of approximately 40 tons capacity, to be transferred to the plant for its decomposition, purification and refining.

The disintegration of the rock begins with the mixing of definite quantities of water and acid or a weak acid with a weighed quantity of the ground rock. The following reaction takes place:

$$Ca_3(PO_4)_2 + 3H_2SO_4 = 2H_3PO_4 \text{ (soluble)} + 3CaSO_4 \text{ (insoluble)} \quad (1)$$

Remaining behind with the calcium sulphate in treatment of the apatite with sulphuric acid are impurities natural to apatite such as $AlPO_4$, $FePO_4$, unconverted CaF_2, SiO_2, etc. The H_3PO_4 filtrate carries with it as impurities more or less of the $AlPO_4$ and $FePO_4$, rendered soluble by the chemical action of the sulphuric acid. There is also some HF in the H_3PO_4.

During the mixing considerable heat is developed which may be controlled by the process of mixing or by the size of the mixes made. The mixing is best done in a lead or acid-resistant brick-lined tank of appropriate size. The agitation required during the mixing is such that mechanical stirring devices must be provided. Air agitation is quite expensive and unless the bath is heated is not to be recommended. Air cools the mixture, prevents efficient reaction and is often detrimental to the separation of the liquid from the solids. Ninety to 95 per cent of the reaction is complete in 1 hour after the last of the ingredients has been added —that is, if proper proportions are used.

Removal of Impurities

The removal of the insoluble and soluble impurities, consisting of the calcium sulphate, silica, as well as the compounds of iron and aluminum, fluorine, arsenic and lead, constitutes the problem of the phosphoric acid manufacturer.

The procedures for removing the various impurities differ with different manufacturers. It is possible to combine the removal of some of these impurities in one operation, and in order to decrease the number of processes it might be mentioned that the arsenic and any lead which may be present can be precipitated by treating the decomposition mixture with hydrogen sulphide gas. This leaves the insoluble arsenic sulphide, lead sulphide, calcium sulphate and silica, which may be separated or filtered from the soluble acid and impurities in one operation. By means of the counter-current decantation system or by means of filter presses, the insoluble calcium sulphate and silica may first be separated and the resultant liquid acid treated for the removal of the arsenic, which involves another filtering operation. The calcium sulphate is practically a worthless pro-

[1] See also CHEM. & MET. ENG., vol. 24, No. 11, March 16, 1921, p. 466, and vol. 25, No. 11, Sept. 14, 1921, p. 517.

ing a brown or chocolate or gray color. However, it may sometimes, if calcined, be used for the manufacture of ceramic products such as plaster, building blocks and tile.

After the removal of the calcium sulphate and silica, any weak liquid acid obtained in the process may be used in place of water for mixing in the decomposition tanks. By using a phosphoric acid of 16 to 18 deg. Bé. with 60 deg. sulphuric acid, an acid of 28 to 30 deg. Bé. can easily be obtained, which will contain from 37 to 40 per cent phosphoric acid depending upon conditions in the mixing. A liquid of almost any density and acidity may thus be obtained. It is economically impossible to remove all the soluble P_2O_5 from the insoluble calcium sulphate by washing. There is left, usually, from 1 to 2 per cent soluble, besides from 1 to 2½ per cent insoluble P_2O_5, calculated on a dry basis of the sulphate residue. From 1 to 2½ per cent of calcium sulphate will be held in solution by the liquid acid, part of which will, however, settle out upon standing.

Removal of Arsenic, Iron, Aluminum and Fluorine

To remove the soluble arsenic, treat the filtered liquid with hydrogen sulphide gas or a sulphide soluble in phosphoric acid. The latter will produce the hydrogen sulphide gas, which in turn will react with the arsenic in solution and form the insoluble arsenic sulphide. It is true that hydrogen sulphide is a dangerous and very objectionable chemical to use on account of its poisonous characteristics or properties. However, with the proper precautions, such as ventilating and aërating, all danger can be eliminated. After the arsenic has been completely precipitated or thrown out of solution the mixture or the acid liquid may be aërated by means of compressed air to remove the hydrogen sulphide gas before the filtration operation is to take place. The presence of hydrogen sulphide gas during any filtering or transferring operation is indeed objectionable even in small or dilute quantities. Hydrogen sulphide often produces colloidal sulphur or colloidal arsenic sulphide, which causes difficult filtration, but by having the mixture or liquid acid heated to not less than 40 to 65 deg. C. no trouble should be experienced. A clear liquid of straw color, practically free from arsenic and lead, is thus obtained.

The economical removal of the iron, aluminum and fluorine constitutes probably the most difficult problem of the phosphoric acid manufacturer. As in the case of the removal of calcium sulphate from the crude acid, a small percentage of these elements will remain in solution. Their removal may be accomplished in one treatment and one filtering operation. The phosphoric acid containing as impurities HF and iron and phosphates in solution can be purified by heating with carbonates or hydroxides of the alkalis or the alkaline earths. This brings about a precipitate, say if $CaCO_3$ is used, of the HF as CaF_2. The iron and aluminum salts also precipitate as $FePO_4$ and $AlPO_4$ respectively.

The insoluble iron and aluminum phosphate, the insoluble fluoride, together with some of the phosphate, which invariably combines or becomes insoluble during the specific treatment involved, may be removed either by the counter-current decantation process, or by using a wooden frame press, a box filter with pressure or vacuum or a rotary filter of the Oliver type. By adding sufficient amounts of alkali salts, all but the last traces of iron, aluminum and fluorine are removed from solution.

This insoluble material, after filtration and washing, is dried and sold to the fertilizer manufacturer. The dried product usually contains from 30 to 35 per cent of P_2O_5, depending on the care taken to perform the operation and the percentage of moisture it contains. The strength and specific gravity of the original crude acid and the temperature of the mixture during the operation are important factors to consider and need careful supervision and attention. A crude acid of 13 deg. Bé., for example, can be treated at ordinary temperature and good settling or filtration will result, whereas a crude acid of 25 to 28 deg. Bé. should be heated and very carefully treated to avoid any unnecessary loss and to produce a filtrable mixture.

The filtrate from this operation should have only a very small percentage of free acidity, but considerable phenolphthalein acidity or so-called total acidity. This liquid may be used in the production of a purified or edible phosphoric acid or dicalcium phosphate in the event a calcium alkali was used in the treatment. By treating the monocalcium phosphate solution with sulphuric acid free from iron, aluminum, arsenic and lead the insoluble calcium sulphate and phosphoric acid practically free of iron, aluminum, arsenic and lead are produced according to the following reaction:

$$CaH_4(PO_4)_2 + H_2SO_4 \rightarrow 2H_3PO_4 + CaSO_4 \qquad (2)$$

The calcium sulphate precipitated is a very white crystalline product, settles very readily and may be separated from the liquid acid by filter presses, by filter boxes, by the counter-current decantation system or by an acid-proof rotary filter. The white calcium sulphate after being thoroughly washed to remove the soluble phosphoric acid is either discarded or used in the manufacture of sulphated goods or materials. The dilute acid may be either marketed or concentrated to any desired strength and used in the manufacture or production of monocalcium phosphate or sold as concentrated liquid phosphoric acid.

Production of Dicalcium Phosphate

The monocalcium phosphate solution may be treated with milk of lime, hydrated lime or calcium carbonate, according to following reaction:

$$CaH_4(PO_4)_2 + Ca(OH)_2 \rightarrow 2CaHPO_4 + 2H_2O \qquad (3)$$

$$CaH_4(PO_4)_2 + CaCO_3 \rightarrow 2CaHPO_4 + H_2O + CO_2 \qquad (4)$$

In the production of the dicalcium phosphate, the concentration and temperature of both the milk of lime and acid solution play an important part in the process. As a general rule, the more dilute solution and higher temperatures give the higher grade product, both as to chemical and mechanical characteristics. There is little choice between using milk of lime or the hydrated lime except that the hydrated lime is the higher in price. The use of calcium carbonate, often called marble dust, is not recommended, on account of undecomposed carbonate resulting in the finished product.

The dicalcium phosphate is a white, crystalline product and may be separated by means of filter presses or boxes or settled in a Dorr thickener and filtered by a rotary type filter. Then it is dried by steam and with vacuum iron driers and ground to any mesh desired. This neutral product is invariably used by the manufacturer in the production of the mono-acid salt, according to the following reaction:

$$CaHPO_4 + H_3PO_4 \rightarrow CaH_4(PO_4)_2 \qquad (5)$$

The production of tricalcium phosphate may be accomplished by adding a solution of sodium phosphate to

a solution of calcium chloride in the presence of ammonia, washing the precipitate free from chlorides and ammonia, drying and grinding the product to a fine white powder. The ammonia and chloride may be recovered and again utilized.

As stated above, the weak purified liquid phosphoric acid, having a straw color, may be concentrated to a Baumé of 50 to 53 deg. and used in the manufacture of the mono-acid salt, according to reaction 5 or by the addition of ground, burnt lime or hydrated lime according to reactions as follows:

$$2H_3PO_4 + CaO \rightarrow CaH_4(PO_4)_2 + H_2O \qquad (6a)$$
$$2H_3PO_4 + Ca(OH)_2 \rightarrow CaH_4(PO_4)_2 + 2H_2O \qquad (6b)$$

Concentrating, Filtering, Grinding and Grading

During the concentration the acid invariably becomes dark in color, and common practice is to add oxidizing agents, such as chlorates or permanganates, until practically a water-white liquid is obtained. Care must be taken not to add the oxidizing agent in excess, on account of the presence of manganese, originally in the rock or in the permanganate used in the bleaching, which will cause the acid to turn a pink or a deep purple color. The concentration may be accomplished by passing the weak liquid acid over lead steam coils, through acid-resistant brick concentrators, or it may be concentrated by means of hot air-spraying systems.

The separation of small crystals of calcium sulphate from the hot solutions during the concentration process is troublesome, especially where lead steam coils are being used. These steam coils continually become coated with a hard sulphate scale, which must be removed by treating them with a solution in which the scale is soluble, by hammering or by picking the coils. This latter is a rather tedious and destructive method and contaminates the acid with lead. If an acid-resistant brick constructed concentrator is used, an occasional cleaning out is necessary, but no trouble with lead contamination is experienced.

Before the concentrated acid is to be mixed with the alkali or neutral salt to produce the mono-acid salt, the precipitated or insoluble calcium sulphate is removed by filtration. A small amount of calcium carbonate or dicalcium phosphate may be added before the filtering takes place. This will not only lower the percentage of soluble sulphate but will also cause the lead sulphate, if any is present, to be incorporated in the finely divided precipitate and be removed by filtration. The filtration may be accomplished with wooden frame filter presses, using air pressure or force pump. The acid, now ready for the production of the acid salt, is weighed and added slowly, under continual agitation, to a weighed amount of the alkali or neutral salt and thoroughly mixed. As the reaction requires considerable time for completion, it is advisable to add a slight excess of acid and then give ample time for the reaction to go to completion and all the free acid to disappear. At least 24 to 48 hours should be allowed for this aging process to take place. After proper aging, the acid salt is dried at a temperature of approximately 85 deg. C., preferably in a rotary or shelf vacuum drier, until a product containing not over 1 per cent moisture is obtained. A higher moisture content is detrimental both to the grinding or milling process and in the baking chemicals in which it is to be used.

The grinding of the acid salt is not a difficult operation. Under unfavorable weather conditions, considerable caking takes place, especially in damp climates. The grinding is followed by the screening operation, in which the powdered and granular portions are classified.

After the acid salt is properly granulated or powdered, it may be standardized to any strength desired by the addition of a neutral or inert substance, such as corn starch, dicalcium phosphate or calcium sulphate. The calcium sulphate cannot be classed as an inert substance and the present tendency is to eliminate the so-called sulphate phosphate from the baking industry. The leading phosphate manufacturers are taking the initiative and advising their customers to use only the full strength or the higher test phosphate.

It is sometimes the custom of the baking powder manufacturer to have the starch incorporated in the phosphate, by having the phosphate and starch mixed in a wet state before the drying and milling process.

The following analysis is typical of a high strength and a good grade of phosphate for baking or leavening purposes:

	Per Cent
Free phosphoric acid (H_3PO_4)	None
Monocalcium phosphate $CaH_4(PO_4)_2$	88.50
Dicalcium phosphate $CaHPO_4 \cdot 2H_2O$	8.00
Calcium sulphate ($CaSO_4$)	1.00
Iron and aluminum phosphates	1.00
Moisture and insoluble	1.50

Arsenic and lead, both under government allowance.

The dicalcium phosphate often may be found as high as 12 to 14 or as low as 1 to 2 per cent, the iron and aluminum, the calcium sulphate and the moisture each as low as 0.5 per cent and as high as 4 to 5 per cent.

Production of Sodium Phosphates

In the production of sodium salts of phosphoric acid the crude acid, as obtained in the decomposition process, is treated with soda ash or caustic soda instead of with lime for the removal of the soluble impurities. The soluble iron and aluminum salts become insoluble and are removed by filtration. The monosodium liquid may be concentrated and used for the production of crystalline or powdered monosodium salt. This monosodium salt may be used for the production of the sodium acid pyrophosphate, which is practically non-hygroscopic and a desirable acid leavening chemical. Or the monosodium salt solution may be treated with caustic or sodium hydroxide to form the neutral disodium salt or the alkaline trisodium phosphate. In the production of the trisodium salt, the solution may be concentrated to from 28 to 38 deg. Bé. in large iron boiling tanks or boxes by means of iron steam pipes, and crystals of the salt are obtained upon cooling. The mother liquor is used repeatedly until it is too dark in color and must then be discarded or be used in the production of substances such as dark laundry soaps or boiler compounds, etc.

Bone as a Source of Phosphoric Acid

Phosphoric acid and phosphates are produced from bone by treatment with sulphuric acid. The bone used for this purpose may be either the burned or unburned bone of the large packing industry or the discard or spent bone black of the oil and sugar industries. If care is taken in the selection of the bone, a very good grade of phosphoric acid can be prepared, from which neither the iron and aluminum nor the fluorine needs to be removed as is the case in rock phosphate. The weaker acid obtained may be treated for arsenic and lead as described for rock phosphate, then concentrated and used as liquid acid for the production of [illegible] salts or sold as concentrated liquid phosphoric

Legal Notes

By Wellington Gustin

A Point on Steamship Shipments

The Distilleries Chemical Supply Co. filed a libel suit against the steamship *Devona* to recover for freight paid for a shipment of formaldehyde and acetic acid, which was put on board and then taken off, at the captain's direction, before the boat sailed. It appeared that the vessel was chartered by the C. H. Pattingill Corporation, and that the freight was paid to the Caravel Steamship Lines, Inc., agent for the latter corporation. It appeared that the boat's owner was willing that the Caravel Steamship Co. might book freight for the vessel.

The case was tried in the Federal District Court. The claimant urged that no action against the boat would lie to recover freight, even if the goods are received on board ship, unless the owner received the amount paid, with which proposition the court agreed. And the admitted receipt of goods on board does not necessarily make the ship liable for damages for failure to transport. (The Esrom C. C. A., 272 Fed., 266.)

The trial court said there was nothing to indicate that the claimant intended to give the Caravel Steamship Lines authority to bind the ship by the receipt of freight, and the equities are with the claimant, which is asked to return moneys which it never received and which it never authorized another to receive in its behalf. Judge Hough laid down the principle applicable in the *Saturnes* (250 Fed., 407), wherein he said: "This litigation exemplifies a common tendency to regard any floating property, used in the performance of contract, as in some sort of a pledge or surety for satisfactory performance; such security to be enforced by asserted maritime lien. No such principle is known to the admiralty."

Therefore, the court dismissed the action of libel against the steamship but gave a decree against the Caravel Steamship Lines.

Lincoln Chemical Company Fails in Tax Case on Its Process

The case of the Lincoln Chemical Co. vs. Edwards, as Collector, reported in 272 Federal, 142, was to recover a refund of a part of the excess profits tax for 1917. The case depended on the meaning of the phrase "invested capital" and "nominal capital" as used in section 209 and as defined in section 207 of the revenue law of 1917. The company filed its return for 1917 and calculated its capital upon the basis of section 209—that is, it assumed it had "no invested capital," or not more than a "nominal capital." The treasury officials re-assessed the tax at a larger figure upon a basis that plaintiff had incorrectly applied section 209.

The chemical company was organized under the laws of New York with a capital stock of $10,000 by two persons, Riddle and Loeb. Riddle was an inventor and came to Loeb with a process for extracting cocoa butter out of cocoa shells, a byproduct. This process proved worthless, and Riddle continued his experiments to convert the process into one from which he could extract from cocoa shells a chemical substance, known as theobromine, allied to caffeine. Loeb incorporated the company to carry out the venture. Nearly $20,000 was spent in Riddle's further experiments upon the process in 1910, when it was completed. A contract was made with a manufacturing chemist to exploit the process on a royalty basis, but the sales of theobromine were so few that the royalty was never earned. All the company's assets were used up by 1914.

The company never manufactured any theobromine after 1910. The Great War in 1914 increased the demand for the product and the business which it conducted through the manufacturing chemist as manufacturer of the product became very profitable. During 1917 the assets of the company, therefore, consisted only of its cash on hand, the contract with the chemist for the manufacture of the product which was resold and the secret process finally perfected by Riddle. Its stock was $10,000 and its surplus, as stated, $13,000, of which over $7,000 was in cash. Its other assets were valued at $16,000.

Plaintiff's Claim Not Upheld by Court

The plaintiff asserted that there was only $200 of cash paid in, no tangibles remaining after 1913, no surplus "used and employed" in the business, and that the secret process was an "intangible" which must be taken at its "actual cash value" in April, 1909, which was shown to be nothing. The defendant argued that the sums spent upon the process, which did in fact increase its value by $19,000, should be taken as a surplus "used and employed" in the business.

The federal court in passing on this case held that the increased value of a process resulting from expenditures thereon figures as asset in estimating "earned surplus." It said where the only asset of a corporation was a secret process, which was intangible and of no value in April, 1909, the date on which the actual value of intangible assets was to be determined under the revenue law, but thereafter money was expended in developing the process, so that in 1917 the company had a surplus above its capital stock which was its only liability, the increased value of the process, due to the expenditures thereon, is to be considered as "earned surplus" which under the revenue law of 1917, section 207, is an element of invested capital, in determining whether the corporation had more than a nominal invested capital under section 209, though the increased value of the process due to the war could not be so considered.

The court found that the chemical company failed to prove that its value in 1917 over $10,000 was "not more than nominal." Hence for failure of proof judgment was rendered against it.

Germany's Potash Production, January-June, 1921

The German Potash Syndicate's semi-annual statement shows that the German potash production during the first 6 months of 1921 came to 4,454,261 metric tons of salts, or 497,373 metric tons of K_2O. This is equivalent to 548,105 short tons of actual potash. Sales during the same period amounted to 1,546,353 metric tons of salts, or 366,633 metric tons (404,030 short tons) K_2O, of which 1,408,911 metric tons of salts, or 333,281 metric tons (367,276 short tons) were for domestic use.

The Beet-Sugar Industry in the U. S. in 1920*

By C. O. Townsend

Pathologist in Charge, Office of Sugar-Plant Investigations

In the United States in 1919, 98 beet-sugar mills were standing and equipped for extracting and refining sugar from beet roots. The oldest one of the mills now standing was built in 1870 at Alvarado, Cal. During the summer of 1919, 4 of the 98 mills had been erected and equipped for the campaign of 1919-20, 6

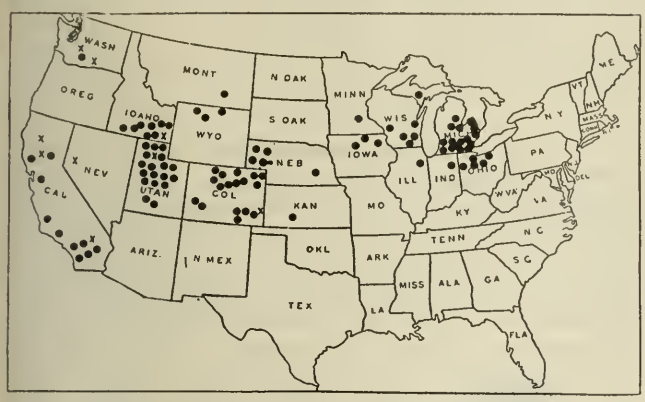

FIG. 1. LOCATION OF BEET-SUGAR MILLS

Dots indicate that the mill was in operation during the 1920-21 campaign. Mills that were standing idle are indicated by crosses.

additional ones were built and equipped for the handling of the 1920-21 crop, and 2 others are in process of construction, making a total of 106 beet-sugar mills now standing.

During the past 50 years 5 other mills have been built, but 3 of them have burned, 1 has been dismantled and 1 has been utilized for some purpose other than that of making beet sugar. Of the 106 beet-sugar mills now standing (Fig. 1), 26 were erected at some point other than the place where they are now located, but owing to certain limiting factors in beet-sugar production these 26 mills were removed to other locations; 2 of these were built in Canada and removed to the United States and 1 was built in this country and removed to Canada.

The 106 mills now standing are for the most part favorably situated for extracting and refining beet sugar under present conditions. In many instances certain limiting factors will need careful consideration and readjustment before a sufficient quantity of raw material can be assured annually to make all of them permanently successful. In many areas beet-sugar mills have been crowded in too rapidly, so that it has not been possible to readjust the farming operations and install the required drainage, irrigation and other improvements with sufficient rapidity to provide the necessary well-prepared acreage to supply enough sugar beets to insure a normal mill run. Consequently neither the mill owners nor the growers have received under these conditions a maximum return for the money and labor invested.

The production of sugar from beets in the United States for the 5-year period from 1916 to 1920, inclusive, is shown in the accompanying table.

*Abstract of Bulletin 995, Department of Agriculture.

Combined Crucible Holder and Thermocouple

By Charles Y. Clayton

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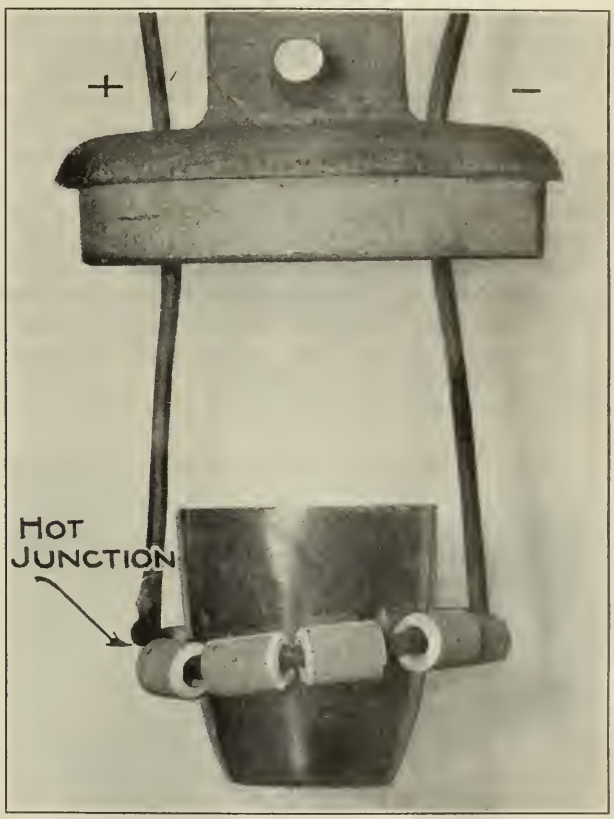
In "Standard Methods for Laboratory Sampling and Analysis of Coal," as published by the American Society for Testing Materials, the method for determining volatile matter is given as follows:

"Weigh 1 g. of the coal in a weighed 10 to 20 c.c. platinum crucible, close with a capsule cover, and place on platinum or nichrome-wire supports in the furnace chamber, which must be at a temperature of 950 deg. C. (±20 deg. C.)."

The design of furnace as given on page 10 of the



CRUCIBLE HOLDER AND THERMOCOUPLE

pamphlet shows an especially constructed furnace with thermocouple inserted through the bottom.

Wishing to utilize an ordinary crucible type furnace (nichrome resistor) the idea was conceived that if the crucible support was made of two dissimilar metals, the temperature of the furnace could be determined

BEET-SUGAR PRODUCTION, 1916 TO 1920

Year	No. of Sugar Mills	Days Operating	Beets Harvested, Acres	Beets Produced—Average per Acre, Tons	Beets Produced—Total Tons	Average—Extraction, per Cent	Average—Sugar in Beets, per Cent	Average—Coefficient of Purity	Sugar Made, Tons	Price Paid for Beets—Average per Ton	Price Paid for Beets—Total
1916	74	80	665,308	9.36	6,228,256	13.86	16.30	84.74	820,657	6.12	38,139,000
1917	91	74	664,797	9.00	5,980,377	13.60	16.28	83.89	765,207	7.39	44,192,000
1918	89	81	594,010	10.01	5,948,798	13.64	16.18	84.70	760,950	10.00	59,494,000
1919	89	78	692,455	9.27	6,421,478	12.34	14.48	82.84	726,451	11.74	75,420,000
1920	97	91	872,376	9.80	8,546,193	13.63	15.99	83.97	1,090,021	11.63	99,426,000

without the use of a special furnace, with thermocouple entering through the bottom. The photograph shows the crucible support and thermocouple as designed by the writer for the use of the students in the Missouri School of Mines and Metallurgy. By drilling two holes in any furnace cover and inserting the two dissimilar wires any electrically heated crucible type furnace can be used for this determination.

By using a slightly different design of thermocouple and support, a very similar arrangement can be used for the heat-treating of small steel samples in the laboratory. Using this in conjunction with a recording potentiometer, a heating curve can be obtained showing the transformation point, and no calibration of the thermocouple is necessary.

Rolla, Mo.

X-Ray Diffraction Apparatus for Crystal Analysis

Apparatus for X-ray studies of crystal structure according to the method outlined by Edgar C. Bain in this journal Oct. 5, 1921, p. 657, has been developed by the research laboratory of the General Electric Co.

The apparatus (see accompanying figure) consists of a cylindrical case containing the transformer and X-ray tube, a number of film holders, or cassettes, and a control panel. The case is made of sheet iron, with doors in front to permit access to the transformer and tube. To avoid the possibility of accidents from contacts with live parts when the case doors are open, the supply circuit of the transformer is brought across the doors, so that it must be disconnected before the doors are opened. The top of the case forms a table, with a steel tower in the center. The X-ray tube is inside the tower, which is provided with slits to direct the rays through the substance to be analyzed. A second set of openings is provided for calibration purposes.

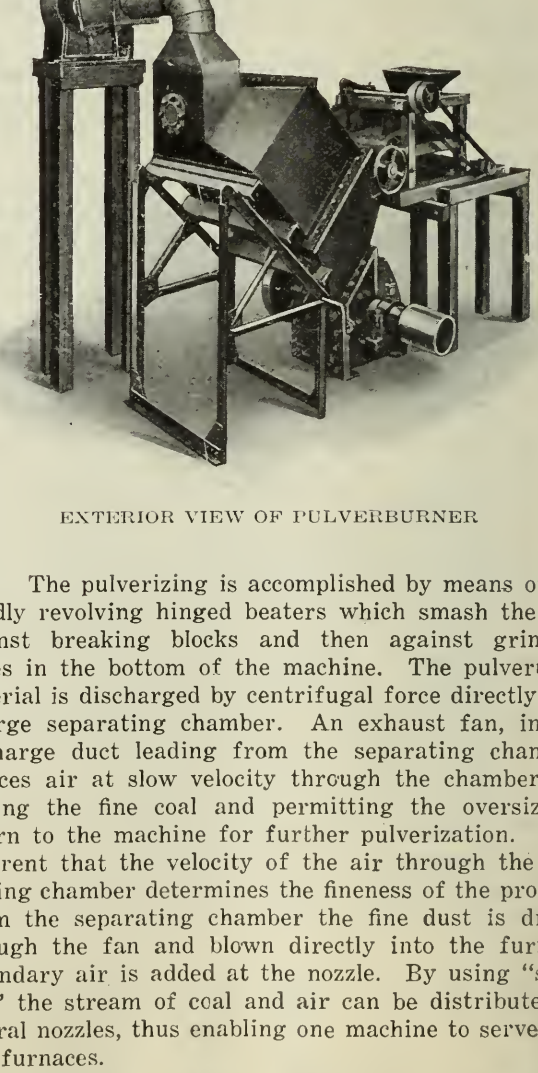
The substance to be analyzed, in powdered form, is inclosed in a small tube of special glass held in the cassette in a horizontal plane by spring clips. The cassettes, or film holders, slide on guides on the table fitting against the tower so that their glass tubes holding the specimens are in the path of the X-ray beam through the slit system. Rays passing through the substance are diffracted and register characteristic lines on the film which fits into the back of the holder.

X-RAY DIFFRACTION APPARATUS

The X-ray tube gives off molybdenum characteristic rays, of such long wave length that ⅛-in. iron or brass provides enough protection, and no lead is necessary. The tube is water-cooled; to prevent its running too hot, in case something happens to the water supply, a pressure-stat on the control board trips the breaker whenever the water pressure drops below normal.

The Pulverburner

The Pulverburner is a new machine for the preparation of powdered coal which has recently been placed on the market by the K-B Pulverizer Co., Inc., New York. The essential features of the machine are the pulverizing mechanism and the air-separating chamber. It will be seen from the accompanying illustration that the machine is fed by an automatic feeder of the bel



EXTERIOR VIEW OF PULVERBURNER

type. The pulverizing is accomplished by means of si rapidly revolving hinged beaters which smash the coa against breaking blocks and then against grindin plates in the bottom of the machine. The pulverulen material is discharged by centrifugal force directly int a large separating chamber. An exhaust fan, in th discharge duct leading from the separating chambe induces air at slow velocity through the chamber, re moving the fine coal and permitting the oversize t return to the machine for further pulverization. It i apparent that the velocity of the air through the sep arating chamber determines the fineness of the produc From the separating chamber the fine dust is draw through the fan and blown directly into the furnac Secondary air is added at the nozzle. By using "spli ters" the stream of coal and air can be distributed t several nozzles, thus enabling one machine to serve se eral furnaces.

By combining impact pulverization with air separ tion many advantageous features are obtained. Th

fines are removed from the machine as rapidly as produced so that the beaters are always operating on coarse material. This is an important item of power saving, even though impact pulverizing is known for its low power requirements. Coal that has not been dried can be successfully handled in this type of mill, and because of the air separator there are no screens to clog.

For efficient powdered coal burning close regulation is necessary, and this has been provided for in the Pulverburner. The rate at which the coal is fed is controlled by the automatic feeder by means of a cam arrangement that varies the speed of the belt. (The coal should be fed in such a size that a uniform "ribbon" is formed on the belt. Coal of 1 in. and under is satisfactory.) A magnetic pulley can be used with the feeder to prevent tramp iron from entering the machine. Quantity of air is controlled either by the speed of the fan, if a variable speed motor be used, or by a damper in the discharge passage. Air is introduced around the shaft. Velocity of the air through the separating chamber is regulated by two vanes in the chamber controlled through a worm and wheel. The beaters can be extended radially outward as they wear. The entire controlling mechanism can be operated by an automatic regulator.

The apparatus is designed to be driven by one, two or three motors. If one motor is used, both fan and feeder are driven from the pulverizer shaft. It is sometimes desirable to drive the fan from a separate motor, likewise the feeder.

The advantages claimed for the machine are its compactness, close regulation of fineness and air, simplicity, economy and adaptability to small as well as to large installations. It is being built in capacities up to 3 tons per hour.

Book Reviews

THE DESTRUCTION OF THE FRENCH METALLURGICAL PLANTS BY THE GERMANS (NOS USINES MÉTALLURGIQUES DÉVASTÉES) 1914-1918. Monograph edited by a group of engineers, with an introduction by Prof. *Léon Guillet*. Published, 1921, by *Revue de Métallurgie*. xxxiii + 270 pp. in quarto, with 300 illustrations. Price, 26 f.

In the introduction to the monograph *Nos Mines Métallurgiques Devastées* Prof. Guillet discusses the industrial importance of the French invaded region when compared with the similarly important regions of England (Lancashire, Chester, Derby, Leister, Nottingham, Stafford and part of York) and of the United States (Pennsylvania, Ohio, West Virginia and the states bordering the Atlantic from New Jersey to Florida) and gives a series of tables and maps showing the pre-war and war-time production of the French metallurgical plants.

The plan followed in the monograph is to give brief outlines of the history and pre-war importance of the plants and illustrative descriptions of their destruction. The plants described are:

Steel plants of the Denain & Anzin Co., by *Robert Jordan* (pp. 1-30); zinc plants of Noyelles-Godault, by *E. Demenge* (pp. 31-40); Denain plants of the Soc. Française de Constructions Mécaniques, by *L. Decroix* (pp. 41-48); aluminum plants of Mennesis (pp. 49-52); Homécourt plant, by *Paul Thomas* (pp. 53-63); Douai plant of the Etablissements Arbel, by *Alfred Brochard* (pp. 64-77); Joeuf plants of the Etablissements De Wendel & Cie., by *Jean Durand* (pp. 78-88). Ferrière-La-Grande plants of the Etablissements Delattre & Frouard, by *M. Lhonneur* (pp. 89-98); plants of Biache-Saint-Vaast (pp. 99-112); plants of the Micheville Steel Co., by *Paul Nicou* (pp. 113-130); plants of Mont-St.-Martin of the Longwy Steel Co., by *F. Meyer* (pp. 131-150); Rehon plant of Soc. de la Providence, by *P. German* (pp. 151-160); Aulnoye plants of the Soc. Métallurgique de Montbard-Aulnoye, by *P. Jarry* (pp. 161-166); Senelle plant of the Senelle-Maubeuge Metallurgical Co., by *Henri Lallement* (pp. 167-180); plants of Vireux-Molhain, by *M. Linard* (pp. 181-188); plants of the Forges et Aciéries du Nord et de L'Est, by *F. Villain* (pp. 189-204); plants of Givet of the Cie. Française des Métaux, by *A. Mercier des Rochettes* (pp. 205-220), and the plants of the Franco-Belgian Metallurgical Co. of Mortagne, by *M. Maréchal* (pp. 221-226).

Loose-leaf indexes of the illustrations in English, Spanish and Italian accompany the text.

A similar book has been published by the Société d'Encouragement pour l'Industrie Nationale, which is a reprint of an article by *L. Baclé* in the November-December, 1920, issue of the society's bulletin. In this book of 101 pages and 100 photographic views are described, in addition to some of the plants enumerated above, also those of Louvroil (Sté. Ame. de l'Espérance), Wringles (Sté. Métallurgique de Pont à Vendrin), Gorcy (Soc. Métallurgique de Gorcy) and Auboué (Soc. de Pont-à-Mousson). J. S. NEGRU.

* * *

THE CHEMICAL ANALYSIS OF STEEL-WORKS MATERIALS. *By Fred Ibbotson*, B.Sc., F.R.C., Sc.I., F.I.C. Pp. viii + 296. New York: Longmans, Green & Co., 1920. Price, $7.50.

This volume is a revision of "The Analysis of Steel-Works Materials," that was published under the joint authorship of Harry Brearley and Fred Ibbotson in 1902. The revision covers that part of the last-named book that treated of the analysis of the raw materials and the finished steel.

The book is divided into eight parts, including (1) General Processes and Notes. (2) Pig Iron and Steel. (3) The Analysis of Steel-Making Alloys. (4) Ores. (5) Refractories. (6) Slags. (7) Analysis of Fuels. (8) Boiler Water and Boiler Scale.

The book is well written and the methods are described in full detail. A most complete account of the reactions involved is to be found throughout the entire work. This is a valuable feature for students. However, some statements concerning methods need qualifications. For instance, the statement found on page 127 that "the determination of cobalt by the cyanometric method is of little or no value" is contrary to the facts. For it has been demonstrated that by the use of tartaric to keep the iron from precipitating in ammoniacal solution, and by always having at least 1 g. of iron present per 0.1 g. of Co, then cobalt can be determined in steel with the most satisfying accuracy up to 10 per cent. Cobalt steels never contain over 6 per cent and seldom over 5 per cent Co. This cyanometric method has been in continuous use in the United States for at least 13 years in some laboratories, and is to be preferred for speed, simplicity and reliability.

Certain methods and apparatus could well be omitted as obsolete, such as the determination of carbon by direct wet combustion and Geissler bulbs for weighing CO_2. The unwary beginner might try these and be severely discouraged with the art. But no doubt this is part of the author's scheme of giving some of the history of human progress in iron and steel analysis in its different phases.

A needless time-consuming detail, which is, also, still to be found in books by one or two other authors on iron analysis, is the recommendation given on page 142: Molybdenum is precipitated away from iron by saturating the solution with hydrogen sulphide. The "gassed" solution is then transferred to a pressure bottle; the latter is tightly stoppered and kept in boiling water for an hour. Yet on page 144 the author says that this boiling digestion under pressure is usually unnecessary in steel. Why give it at all then? For the fact is that it is always unnecessary. It would be better to emphasize the all-important detail in precipitating Mo by hydrogen to have the solution contain as little free acid as possible before passing any of the precipitant through it.

The author on page 57 outlines twelve different ways of

estimating phosphorus, and on the next page gives a thirteenth method which is described in detail. "An experienced operator can make thirty tests in a 7-hour day." The method is by "weighing as lead molybdate."

In the list of methods for manganese no space is given to the ancient and still honorable oxidation to permanganic acid by lead peroxide, which, when properly carried out, has the widest range accuracy of any of the methods up to at least 16 per cent of Mn.

On page 121 the use of a condensing lens is still advised to aid in the cynanometric titration of nickel in alkaline citrate solution, whereas this was made entirely avoidable 14 years ago (see *J. Am. Chem. Soc.*, vol. 29, No. 8, August, 1907) by the simple expedient of adding 12 g. of citric acid instead of 3 g. per gram of steel. The magic lantern detail should be omitted, as it was but little help at best.

In describing the determination of carbon by combustion one would expect to find an illustration showing an electrically heated combustion furnace with a modern purification and absorption train, but a gas furnace only is shown with a verbal account of the accompanying train. Mention is made that electric furnaces are used.

This work contains much excellent information and no iron and steel analyst can afford to have it absent from his ready reference shelf, even though it already be a 5-ft. one or a 10-ft. one. C. M. JOHNSON.

* * *

AN INTRODUCTION TO THE PSYCHOLOGICAL PROBLEMS OF INDUSTRY. By *Frank Watts.* 240 pp. New York: The Macmillan Co., 1921. Price $5.

This book by the lecturer in psychology in the University of Manchester and in the department of industrial administration, Manchester College of Technology, is the most interesting contribution to the literature of this subject that has recently appeared.

Perhaps the thing that Englishmen do best, as compared with American writers, is the discussing of a subject in a thorough and well-rounded manner, and yet in an interesting way. American writers are fluent in the production of literature on the details of a subject, but when it comes to a well-rounded summary on a whole topic, very often the best treatise is found to be by an Englishman. It is certainly true in this case, and is correspondingly curious, inasmuch as although study of the psychological problems of industry began first in this country and has been carried on by an immensely greater number of people here the best book on the subject now comes to us from England.

The reviewer is inclined to suspect that the author has probably a much more thorough acquaintance with industry than the American psychologists who write on this topic, and of course a good deal of the American literature has come from the pens of persons who are familiar with industry but who have a rather imperfect knowledge of psychology. At any rate, anyone who is interested in getting a reasonable grasp of the new viewpoint of the importance of mental problems in industrial life cannot do better than to read this book.

Evidently the author has been in fairly close touch with the work of the Industrial Fatigue Research Board, for his book begins with a discussion of industrial fatigue and inefficiency, and the first section of Chapter II deals with muscular fatigue. The second section is on organic variability, and the third section on mental fatigue. This section indicates the thoroughness of the study and how well balanced the author is, for fatigue investigators generally have continued to overlook the importance of mental fatigue in the study of the problem, although even the laboratory investigators know that if the subjects have worked an ergograph to the point of exhaustion and are then told that with the removal of a pound weight they can continue to work, but instead a pound weight is added, they will go on working just as happily as though the pound weight had actually been removed. There are those in this country who believe that mental aspects of industrial problems far outshadow the importance of those physiological aspects that have heretofore received practically all of the intensive study that has been given to the subject.

The third chapter deals with the elimination of fatigue from work by motion study, and is a good brief review of the work done on this topic. The chapter on vocational education is also good, and this is especially true of the third section, which deals with intelligence tests, and the criticisms which are made of the application of intelligence tests to industrial life are both temperate and apparently entirely sound. The chapter on scientific management and labor is perhaps the best in the book, and is an extremely interesting summary of the abundant literature on this subject. The chapter on industrial unrest similarly summarizes, in a brief and readable way, the rather abundant literature that to most operating men would seem so vague and far from their immediate problems as to be unattractive to them. When all these ideas are brought together, in their relation to one another, and concisely summarized, their importance and usefulness becomes apparent. The concluding chapter deals with the creative impulse in industry and deals with such apparently diffuse sub-topics as the decline of the traditional types of craftsmanship, modern recreation, ideals in industry, copartnership, state socialism, syndicalism, industrial democracy and industrial education. The author has brought these together, however, so that their bearing on one another becomes apparent. In other words, he has proceeded in his book from the central core of his subject out to the periphery. Each chapter is supplemented by a brief list of the more important works on the topic, which will be extremely valuable to those who care to pursue any of the topics further. Altogether, this is a most satisfactory book, and one that ought to be not merely in the library of anyone interested in industrial work, but kept at hand where it is easily available for re-reading from time to time. T. T. READ.

Recent Chemical & Metallurgical Patents

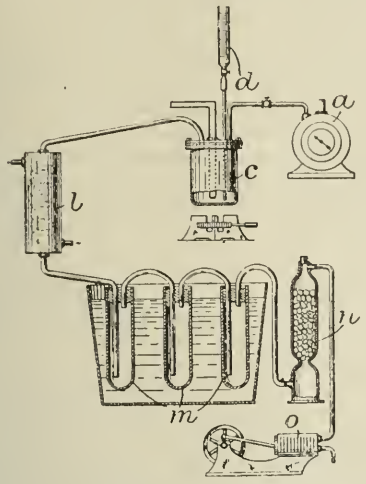
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Colloidal Elements and Compounds.—Colloidal solutions of copper, silver, mercury, cerium, arsenic and antimony, or of their insoluble compounds, are prepared by treating these metals or their compounds for some time at temperatures above 100 deg. C. with waste sulphite cellulose liquor or waste soda cellulose liquor. The metal or its insoluble compound in the powder form may comprise the starting material; or a soluble salt of the metal may be added to the cellulose waste liquor and the metal or its insoluble compound formed therein during the process either by the addition of precipitants, such as alkali, or by the reducing action of the cellulose waste liquor itself, with or without other reducing agents, such as sulphuretted hydrogen. The colloidal product may be precipitated or purified in any known manner and utilized in medicine, veterinary surgery, tanning, the preparation of cosmetics, for the protection of plants and the impregnation of wood or fabric. The colloidal products may be employed per se, or in conjunction with oil, resin, and other organic emulsions, or with the addition of colloids or filling substances. In the case of plant protection, such materials as aluminum hydrate, aluminum sulphate, gypsum, barium carbonate, lime or copper-lime mixtures may be added to the colloidal products. According to the examples: (1) Colloidal mercury is prepared by heating mercuric chloride with purified waste sulphite cellulose liquor; preferably with addition of caustic soda or potash; or by heating mercuric oxide with the lignine substances extracted from waste sulphite cellulose liquor in the known way; (2) copper sulphate, on heating with waste sulphite cellulose liquor and soda lye, is converted first into colloidal copper protoxide and then into colloidal copper; a similar result is obtained by heating powdered copper oxide with a mixture of waste soda cel-

lulose liquor and waste sulphite cellulose liquor; (3) colloidal silver is obtained by the heat-treatment of silver oxide with waste sulphite cellulose liquor; (4) colloidal sulphide of arsenic results from the introduction of sulphuretted hydrogen into a hot solution of arsenious acid in cellulose waste liquor. (Br. Pat. 169,758. Chemische Fabriken Dr. K. Albert und L. Berend, Amöneburg, near Biebrich, Germany. Nov. 23, 1921.)

Concentrating Ores.—Reagents for use in concentrating ores by froth flotation are obtained by subjecting organic substances to a partially decomposing heat in the presence of air or oxygen. The organic substances treated may be liquids or solids—for example, kerosene, gas oil, bitumen, bituminous coal, wood or mineral-frothing agents such



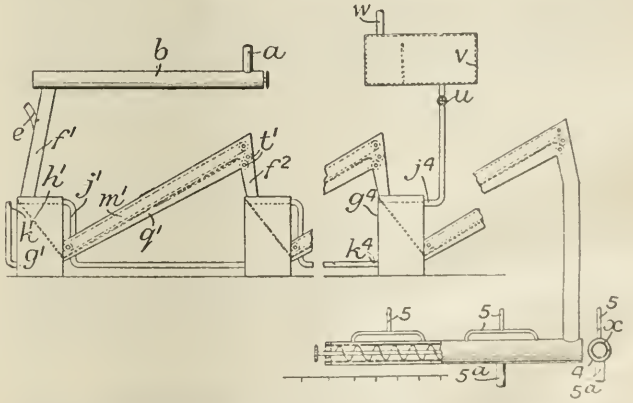
as oleic acid or cottonseed oil—and the oily or aqueous condensates or gaseous or vaporous distillates of the decomposition may be used in the flotation process. In the apparatus shown in the figure, for the treatment of liquids, the material to be treated is fed from a burette *d* to a heated chamber *c* to which a regulated supply of air is admitted from a meter *a*. The products are drawn by a pump *o* through condensers *l*, *m* and a scrubber *n*. In some cases the condensers may be omitted and the products passed direct to the flotation apparatus. Apparatus for treating solids may comprise a heated retort or chamber for a charge of material and a system of condensers, etc., similar to that shown in the figure. In another case, refractory material saturated with kerosene may be treated by igniting the kerosene, sucking air through it and passing the products to the flotation apparatus. (Br. Pat. 169,288. Minerals Separation, Ltd., London; E. W. Wilkinson, New York. Nov. 9, 1921.)

Resinous Compounds; Shellac Substitute.—A substitute for shellac consists of spirit copal, preferably Manila or Macassar copal, with 6 to 8 per cent of oleic acid, preferably in the form of Australian oleine; candelilla wax, resin and dyes are added to give imitations of different varieties of shellac. The materials are melted and stirred together for 2 hours in a steam-jacketed vessel, and then poured out and passed between rollers, which may be indented to form "buttons." The rollers may be cooled. (Br. Pat. 169,829. E. A. Muskett, Enfield, Middlesex. Nov. 23, 1921.)

Treatment of Aluminum Alloys.—To prevent surface corrosion, aluminum alloys in which aluminum predominates, and particularly those containing copper, manganese, and magnesium, are first boiled in an alkaline solution, such as of caustic soda, then treated in a steam bath, then immersed in a solution of zinc phosphate containing iron phosphate in suspension and of gradually increasing temperature, and finally washed in hot water. The first step may be effected in a water-jacketed porcelain vessel heated to 160 to 180 deg. F., the article being boiled in a caustic soda solution of ½ per cent strength for about 20 minutes until a black oxide is formed. Preferably the vessel is heated in a gas oven with a ventilating flue so that the article can be quickly dried on withdrawal from the solution with the aid if necessary of a warm jet of compressed air. The article is then suspended in a steam bath for a few minutes only until the coating becomes greenish yellow. Ammonia in small regulated quantity is introduced to prevent acidity during the steaming. A paste formed by the treatment of granular zinc with specified proportions of orthophosphoric acid and boiling water is dissolved in water, 1 oz. to 1 gal., and the solution is boiled in an iron tank for a few hours daily with small additions of the paste, pieces of scrap iron or steel being suspended in the solution. Equal parts of the residual liquor and cold water, with a small quantity of a saturated solution of the paste, form the phosphate solution into which the article is immersed direct from the steaming for 10 to 15 minutes. The coating changes in color to gray and finally pink, if the solution becomes stronger, and when all the yellow has disappeared the article is washed. (Br. Pat. W. B. Brunskill, Cark-in-Cartmel, Lancashire. Nov. 23, 1921.)

Dyeing Cellulose Acetates.—For the purpose of rendering them amenable to dyeing, threads or fabrics containing cellulose acetates having 2-2½ acetyl groups per cellulose molecule are treated, at temperatures between 40 and 80 deg. C., with an alkaline saponifying agent, the quantity of which is restricted to that necessary to produce a diminution in weight of not more than 10 per cent in the cellulose acetate originally present. The saponification treatment may precede the dyeing operation, or they may be performed together in the same bath. As saponifying agent, caustic soda, caustic potash or carbonate of soda may be employed, in concentration not greater than 1 per cent; any dyes, such as substantive, acid, basic, vat or sulphur dyes, are applicable, either directly or with the use of mordants. The provisional specification includes the treatment of any cellulose acetate lower than the triacetate and states that the restricted saponification may also be effected by using excess saponifying agent and limiting the time of action thereof. (Br. Pat. 169,741. British Cellulose & Chemical Manufacturing Co., Ltd., London, and J. F. Briggs, Spondon, near Derby. Nov. 23, 1921.)

Extracting Fats.—In a counter-current process for the extraction of oils, etc., from crushed seed or other vegetable matter by means of volatile solvent and in which solvent is expressed from the mass after each immersion, the meal from a pipe *a* is conveyed through a jacketed conduit *b* and falls on to a preferably inclined screen h^1 in a tank g^1 so that its progress is retarded while it mixes with used solvent from a pipe j^1. The meal is then conveyed to wringing rollers t^1 through a conduit m^1 having its bottom perforated from above the level of the pipe j^1 so that drained



or expressed solvent runs down an outer conduit q^1 to the tank g^1 but below the screen h^1. The pressed meal falls down a conduit f^2 and is passed through a series of similar tanks, conduits and rollers to a perforated conduit *x* in which it is freed from solvent by steam or vapor from a pipe 5a in the lower half of a divided jacket 4, the vapors being drawn off to a condenser through pipes 5. Pure solvent is fed from the tank *v* to the last tank g^4 by a valve *u* and pipe j^4 and through the series by pipes k^4 and j^1 to the last outlet pipe k^1, which leads to a solvent-recovery apparatus. The recovered solvent is returned to the tank *v* by a pipe *w*. Solvent vapor in the tank g^1 or pipe f^1 is drawn D. the recovery apparatus through pipe *e*. (Br
M. Whitehead and E. Scott, both in
Nov. 23, 1921.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Well-Known Glass Manufacturer Probable Ambassador to Germany

The nomination of Representative A. B. Houghton, of New York, to be Ambassador to Germany probably will be sent to the Senate this week by President Harding.

Mr. Houghton has been associated with the Corning Glass Works snice 1889, serving as second vice-president from 1903 to 1910, as president from 1910 to 1918 and is now chairman of the board of directors. He is also vice-president of the Ephriam Creek Coal & Coke Co. and a director of the Metropolitan Life Insurance Co.

Program for February Meeting of Institute of Metals Division

Following is the preliminary announcement of the forthcoming session of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, held in connection with the February meeting in New York:

Monday, Feb. 20, 2 p. m. Chairman, W. H. Bassett.

E. E. Thum, "Results Achieved by the Corrosion Committee of the British Institute of Metals."

R. J. McKay, "Corrosion by Electrolytic Concentration Cells."

L. McCulloch, "Experiments With Sherardizing."

W. H. Bassett and C. W. Davis, "Spectrum Analysis in an Industrial Laboratory."

H. J. Roast, "Arsenic-Bearing Metals."

Tuesday, Feb. 21, 10:45 a.m.

First annual lecture of the Institute of Metals Division, Prof. Wilder D. Bancroft, "Colloid Chemistry and Metallurgy."

Tuesday, Feb. 21, 2 p.m., Chairman, W. H. Bassett.

Z. Jeffries and R. S. Archer, "The Slip Interference Theory of the Hardening of Metals."

E. C. Bain, "Crystal Structure of Solid Sólution by X-Rays."

P. Hidnert, "Thermal Expansion of Copper and Some of Its Important Alloys," (Bureau of Standards.)

P. Hidnert and W. Souder, "Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel and Aluminum," (Bureau of Standards.)

W. McG. Peirce, "Studies on the Constitution of Binary Zinc Base Alloys."

There will also be a dinner and meeting of the executive committee and past officers of the division at the Engineers Club at 5:30 on Monday, Feb. 20.

All of the metallurgical members of the Institute will be interested in Prof. Bancroft's lecture, and the innovation is planned as the first of a series which will aid the busy members to get acquainted with the most recent advances in their science.

Senators Sidestep Dye Investigation

Senator Borah of Idaho has found that it will be impossible for him to devote the time likely to be required as a member of the sub-committee which will conduct the dye investigation recently ordered by the Senate. Nearly every member of the Judiciary Committee has been urged to accept service on this sub-committee, but all have declined, since they foresee that this investigation will be of long duration and will require a great deal of their time. While there is still hope that some member of the committee can be induced to accept this service, it is probable that some delay will result before the sub-committee can be completed. Senator Shortridge of California has accepted the appointment as chairman of the sub-committee and Senator Reed has consented to represent the minority on the committee.

Study of Plant Depreciation Planned by U. S. Chamber of Commerce

Practical studies by the various industries to ascertain a normal rate of depreciation shown by experience on buildings, machinery, etc., which may be used as a basis for reckoning depreciation in individual plants is urged by the Fabricated Production Department of the Chamber of Commerce of the United States. Such studies have the approval of the United States Treasury Department.

It is not the purpose to create within any industry inflexible standard rates of depreciation, but it is proposed to set up something that may be used as a guide to fit usual conditions, as explained in a bulletin in which the Fabricated Production Department puts forward its recommendation.

"Trade associations representing a single line of industry," says the bulletin, "are particularly well fitted to take up such studies. In lines not so organized groups may be formed to perform the same function."

The Fabricated Production Department of the National Chamber has been working on this problem for some time. The announcement that the Treasury Department approves investigation and study along the lines suggested will be of unusual interest to business men, particularly manufacturers.

Additional information may be obtained from the Fabricated Production Department of the Chamber of Commerce of the United States.

New Muscle Shoals Proposal Submitted by Shipbuilder

A new proposal for leasing and operating the Muscle Shoals plants has been received by Secretary Weeks from Frederick E. Engstrum, president of the Newport Shipbuilding Co.

Mr. Engstrum proposes to form a corporation which will guarantee (under bond) to complete the power stations, dams Nos. 2 and 3 and such other works as may be agreed upon, and to lease the property for a period of 50 years. Construction will be started within 60 days from date of possession and completed within 4 years.

Excess power would be sold by the company at a minimum price of 1 mill per kw.-hr. It is proposed to operate the nitrate plants by diverting to this purpose the net receipts, up to and including 1 mill per kw.-hr., from the sale of the excess power, over and above that required to operate the property, in addition to the gross receipts from the sale of the nitrate products (at prices and terms to be fixed by the government). At least one of the nitrate plants would be put in operation within 1 year from date of possession. A research department would also be maintained in cooperation with the government for the purpose of developing the processes for nitrogen fixation.

In consideration of the performance of these proposals the government would agree to pay to the power company $36,000,000, in four equal annual installments. All of the proceeds from the sale of power in excess of 1 mill per kw.-hr. would be retained by the power company as its compensation for the undertaking of this proposal.

Miniature Experimental Tannery Built at Columbia University

What is said to be the smallest complete tannery in the world has recently been completed at Columbia University, New York, under the direction of Prof. A. W. Thomas. The tannery is about 2½ ft. long and was designed to handle raw hides under a scientific tanning process. The purpose of the plant is to provide means for a careful and scientific study of the chemical action of tanning.

Biscuit and Cracker Manufacturers' Association Appoints New Director

As a step in the development of the Technical Bureau of the Biscuit and Cracker Manufacturers' Association, the technical committee has been authorized to obtain the services of A. V. H. Mory, well known for his success in the organization and direction of industrial laboratories. Mr. Mory's experience has been broad rather than special, but has been largely in food lines. Entering the employ of Armour & Co. as a chemist, he became head of the chemical department of that company's Kansas City plant. He later entered the Bureau of Chemistry at Washington and was appointed chief of the government's food and drug inspection laboratory at Kansas City, Mo. While in government service he was invited by Sears, Roebuck & Co. to develop an organization for the technical control of their whole line of merchandise and served there for 9 years as director of their technical laboratories. Two years ago he was invited by Procter & Gamble to reorganize and become executive head of the greatly enlarged chemical division then planned by them, but a short time ago he returned to Chicago to engage in consulting practice, specializing in organization work of the sort he is undertaking for the Biscuit and Cracker Manufacturers' Association.

Mr. Mory was chairman of the Chicago Section of the American Chemical Society in 1916 and later one of the Society's councilors at large. For a number of years he has been on the editorial advisory board of the *Journal of Industrial and Engineering Chemistry*. He is a member of the Chemists' clubs of New York and Chicago and enjoys wide acquaintance in food control circles.

Improved Business Conditions Indicated by Increased Operations of Plants

Paper. The Northern Paper Mill, Green Bay, Wis., is operating its plant at full capacity and has added about fifty operatives to the normal working force. All six machines at the mill are on a day and night schedule.

Glass. The Owens Bottle Co., South Glassboro, N. J., has established operations with full working shifts and purposes to continue production throughout the winter season.

A number of idle glass plants in the vicinity of Millville, Vineland and Bridgeton, N. J., are preparing for the early resumption of operations.

The three window glass manufacturing plants at Kane, Pa., are arranging for a continuance of production throughout the winter season, these being the American Window Glass Co., Pennsylvania Window Glass Co. and the Kane Glass Co. The plants are giving employment to a total of about 1,000 operatives.

Ceramic. The Fords Porcelain Works, Perth Amboy, N. J., manufacturer of sanitary ware, is operating its three local plants at full capacity.

The Perth Amboy Tile Works, Perth Amboy, N. J., manufacturer of floor tile and fine ceramics, is operating at capacity and has construction under way on an addition, to be placed in service as soon as completed.

Rubber. The B. F. Goodrich Co., Akron, Ohio, has added about 1,000 men to the working force at its tire-manufacturing plant during the past 3 weeks. Production is now in excess of 16,000 tires a day. The aëronautical department at the rubber mills is working at full capacity on government orders.

The Phoenix Rubber Co., Akron, Ohio, is planning to resume production at its local plant at an early date.

The Firestone Tire & Rubber Co., Akron, Ohio, is increasing the working hours at its plant. Additional workers have been added to the force.

Oil. The Francis Refining Co., Ada, Okla., has commenced operations at its new local oil refinery, and will run under a full-time schedule.

The Sinclair Refining Co. is arranging for the immediate resumption of operations at its refinery at Coffeyville, Kan. Reconstruction of a number of departments is now under way, involving improvements costing in excess of $1,000,000.

Copper. A number of copper companies in the Butte, Mont., district are perfecting arrangements for a resumption of operations at their mines and reduction plants, effective Jan. 16. The companies include the Anaconda Copper Mining Co., the Butte & Superior Mining Co., the Davis Daly Copper Co., the Tuolumne Copper Co. and the North Butte Mining Co. A wage reduction, based on a graduated scale approximately 50c. a shift, will go into effect at the time noted.

Iron. The McKinney Steel Co., Cleveland, Ohio, is arranging for the immediate resumption of operations at its Colby-Ironton iron mines, Bessemer, Mich., giving employment to about 500 men. The properties have been idle since last May.

The Charcoal Iron Co., Detroit, Mich., is making improvements at its mines in the Manistique, Mich., district, and proposes to place the plant in operation by Jan. 16. Effective early in January, the company will operate its Yale iron mines at Bessemer, Mich., under a day and night shift.

Steel. The Wickwire-Spencer Steel Co., Buffalo, N. Y., has increased production at its finishing mills to normal, or 100 per cent capacity.

Resumption of operations at the sheet mills of the Inland Steel Co. at Hammond, Ind., brings the company's production to 50 per cent capacity.

Zinc. The New Jersey Zinc Co., Palmerton, Pa., is increasing operations at its local works and it is expected that all departments will be running full, with regular working forces, at an early date.

Personal

Dr. JEROME ALEXANDER is now president of the Uniform Adhesive Company, Brooklyn, N. Y.

Dr. CHARLES BASKERVILLE, head of the department of chemistry, College of the City of New York, is seriously ill with pneumonia.

A. E. BUCHANAN, JR., formerly a member of the chemical department of E. I. du Pont de Nemours & Co., has assumed the duties of assistant editor on the staff of CHEMICAL & METALLURGICAL ENGINEERING.

S. G. BYAM, chief chemist at the Fairfield rubber works of E. I. du Pont de Nemours & Co., has resigned from that position to become chief chemist at the Plymouth Rubber Co., Canton, Mass., with entire charge of the technical development.

H. E. HANDY, who has been the metallurgist on the staff of the Washington Steel & Ordnance Co., has removed from Washington, as a result of the permanent closing of the plant and liquidation of this company's affairs. His new address is 773 Elmwood Ave., Providence, R. I.

H. T. HERRICK is with the American Aniline Products, Inc., at Lock Haven, Pa., and not Lock Haven, Conn., as stated in our issue of Dec. 21.

Dr. ERNEST FOX NICHOLS has resigned the presidency of the Massachusetts Institute of Technology and his resignation has been accepted by the executive committee of the corporation. His decision resulted from the unfavorable condition of his health. Dr. Elihu Thomson, of Swampscott, chief consulting engineer of the General Electric Co., who served as acting president after the death of President Richard C. Maclaurin in January, 1920, has again been appointed to that position.

WILLIAM RUSSEL, London representative of the Dorr Co., has recently made a professional trip to the Rand district of South Africa and is now in the Congo.

Dr. C. G. SCHLUEDERBERG of the Westinghouse Electric & Manufacturing Co. sailed on Jan. 7 for a trip to South America. He will visit points in Peru, Agentina, Chile and Brazil.

The newly elected officers of the American Chemical Society for 1922, are as follows: President, EDGAR F. SMITH; directors, M. C. WHITAKER and W. R. WHITNEY; councilors-at-large, A. M. COMEY, E. C. FRANKLIN, W. D. HARKINS and W. LEE LEWIS.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Announcing a Weighted Index of Chemical Prices

In order to assist our readers in following the week-to-week fluctuations in the chemical market and also to provide a ready means of comparing the trend of these prices with those of other commodities, CHEMICAL & METALLURGICAL ENGINEERING has undertaken the compilation of a weekly index number for chemical prices. It is apparent that the simple average of the prices for a selected group of chemicals would be of little value, since it fails to take account of either the relative importance of the article or the proportionate increase or decrease in its price. In order to avoid these difficulties CHEM. & MET. has adopted a system of weighting based on production and imports.

The base of 100 to which these prices were compared was calculated on the average monthly wholesale prices for the year July 1, 1913, to June 30, 1914. These figures are identical with those prepared and used by the Chemicals Section of the War Industries Board in connection with its comprehensive studies of prices during the war.

How It Was Obtained

It is believed that a detailed explanation of how the weighted index number was obtained will be of some interest and at the same time will give a clearer idea of what the number means and how it may be used. In the first place, twenty-five commodities were selected on the basis of their importance as representing qualitatively and quantitatively the principal component branches of the chemical industry. These chemicals included in the index number are as follows: Acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methyl alcohol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, crude potassium carbonate, salt-cake, soda ash, crude sulphur, benzene, aniline oil, cotton-seed oil and linseed oil.

The second step in the process was obtaining the statistics for the production and imports of each of these commodities for 1919. That year was selected primarily because of the completeness of the statistics compiled by the Census of Manufactures. A few of the articles included in the index are exported in considerable quantities, but these amounts were not taken into consideration, because it was intended that the index should represent total activity in the wholesale chemical market rather than merely the selling for consumption in this country.

The next step in the process consisted in multiplying the monthly prices by the commodity weights—i.e., the sum of the production and the imports. The sum of the figures thus obtained made up the total value of the year's business in these twenty-five chemicals, and from these data it was a comparatively simple matter to calculate a factor representing the relative importance of the separate commodities.

Finally, these war figures were compared with and expressed in terms of the pre-war base, which, as previously stated, was the average for the year ended June 30, 1914.

What It Shows

Wholesale prices of chemicals were not published in this magazine prior to 1917 and no effort is made in the present article to trace the trend of prices during the period 1914-1916. The monthly index numbers for the 5 years which have elapsed since that time are presented in the accompanying table. They show that during this period the chemical market has followed an unusually interesting course. From 191 in March, 1917, the index number had a gradual and consistent rise to 285 early in 1918. This high level of prices was maintained during almost the entire year, although immediately after the armistice, the cessation of the war-time demands and the lapse of the price control exercised by the government resulted in a noticeable decline in prices. The index number fell from 279 in November, 1918, to 227 in April, 1919. Shortly thereafter occurred the post-war boom during which the prices again rose almost to the levels reached in 1918. Unfortunately, however, our prosperity was short-lived. Beginning in October, 1920, there occurred one of the most precipitious declines of prices which history has ever recorded. The CHEM. & MET. index number fell off 74 points in 2 months and 123 in 6 months. In April, 1921, the prices of these chemicals stood at the lowest level noted during the 5 years. The remainder of 1921 saw only minor fluctuations in the chemical market, although by August the index number had risen to 158. From October and through the remainder of the year there has been a further, although very slow, decline. The past week, however, has been characterized by slight increase in prices, the index number showing a gain of 1.19 points.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

	1917	1918	1919	1920	1921
January	198	281	262	242	181
February	195	285	250	252	166
March	191	281	233	252	157
April	207	286	231	261	140
May	222	267	227	279	143
June	222	272	229	274	147
July	233	277	231	274	148
August	240	278	251	264	158
September	252	278	272	267	147
October	264	280	233	263	151
November	265	279	239	240	147
December	283	277	245	189	145
Averages	212	279	242	255	152

Last week..... 143.30
This week..... 144.49

Nation-Wide Reduction of Inventories Reported by Manufacturers

One of the outstanding features of the annual reports now being issued by manufacturers in every branch of industry is the emphasis placed on reduced stocks, both of raw materials and finished products. The national scope of this readjusting process has also been shown in an interesting manner by the Harvard University Committee on Economic Research. This committee points out that in July of this year the index for the volume of manufacturing reached its low point of 68.5 per cent of the average for 1919 and has since increased to about 90. The average for the first 10 months of 1921 was 79 per cent. On the other hand, car loadings for the first 44 weeks of this year are reported to be 94 per cent of the 1919 loadings during the corresponding period. Since car loadings serve as a direct index of goods distribution, it would appear that distribution has considerably exceeded production during 1921 and that therefore inventories must have been materially lessened.

Du Pont Dividend

A cash dividend of 5 per cent, or 25c., on both common and preferred stock has just been declared by the Du Pont Chemical Co. of Wilmington, Del. The dividend is payable Feb. 6 to stock of record Jan. 25.

Court Holds That Fusel Oil Is Not Subject to Import Control

The District of Columbia Court of Appeals on Jan. 3 upheld a decision of a lower court which had refused to restrain the Secretary of the Treasury from permitting large quantities of foreign fusel oil to enter the country in competition with butanol, which was alleged to be a similar product. Complaint had been brought by the Commercial Solvents Corporation of New York under the dye and chemical control section of the emergency tariff act.

The plaintiff contended that the Secretary of the Treasury had erred in declaring that fusel oil was not a synthetic organic chemical and therefore was not subject to the import control exercised over this class of chemical products. The judge refused to grant a temporary injunction to the butanol manufacturers and in doing so declared that he would not attempt to compare his technical knowledge with that of the Treasury Department experts. The question was clearly a matter of technical knowledge, the court held, and the judgment of the lower court was affirmed.

Is Calcium Carbide A Synthetic Organic Chemical?

The hearing of the claim of the British Cellulose & Chemical Manufacturing Co. to have calcium carbide included in the schedule of the safeguarding of industries act, which imposes a duty of 33⅓ per cent on the value of articles imported, was held in London on Dec. 22. The act requires all synthetic and organic substances to be in the schedule, and the point in dispute between the Cellulose company and the British importers of calcium carbide is as to whether this substance is organic or inorganic. It was stated in the course of a scientific argument that this question had never become acute until the present hearing.

Evidence in support of the case for the Cellulose company was continued. John Rogers, technical manager of Nobels Industries, Ltd., agreed with former witnesses that calcium carbide was synthetic and organic chemical. Matthew Dickie, general manager of the Cellulose company, said that at the request of the government his company erected a calcium carbide plant at a cost of £600,000. During 1919-20 the company was producing 19 tons of carbide per day. This was sold at that time at £26 per ton, although the cost of production was £33 per ton. Of course they could not carry on and the plant had been idle since 1920. They could have carried on if they could have obtained £40 per ton, but against that figure they had to compete with the price of £17 per ton charged by Austrian and German manufacturers. If the duty under the act was imposed it would enable his firm to resume operations. The inquiry was adjourned until Jan. 14, when the proceedings will be in private.

The Coal-Tar Products Market 1920, 1921 and 1922

The present condition of the coal-tar products market is due directly to the forces that have been at work during 1920 and 1921. In 1920 America reached its banner year of foreign business. Resale merchants contracted for large supplies of intermediates, with prospects of making turnovers at large profits to foreign customers. American products were greatly in demand and even though the exchange was very unfavorable, there were no other countries in a position to compete successfully with the United States. In the midst of this flurry of speculation and immense profits came the sudden reversal of affairs following the announcement of the collapse of the Japanese financial system. America with its inflated values became the center of deflation. Prices on all commodities took a sharp decline and speculators who had heavy stocks of chemical products added to the economic upheaval. Weak holders began to make their appearance and presently tremendous stocks were thrown into the market to realize ready cash.

By the end of 1920 the American export business in dyes was practically at a standstill. Large shipments of American-made products were brought back and dumped on the open market at ridiculously low prices. Consumers were losing their interest and would purchase only for immediate necessities. In the meantime, Germany became a more important factor in the domestic market. The extremely favorable position of the mark and the low production costs gave Germany an advantage over the rest of the world. At the beginning of 1921 the resale merchants were overstocked with dyes and intermediates and many of the plants of the domestic producers were closed tight waiting for favorable developments.

The coal-tar products market remained practically unchanged during 1921. An occasional advance on some particular commodity might be reported, but in general there were no outstanding features in the market. Prices have been reduced by producers consistent with manufacturing costs. However, it is believed that there will have to be a great many more revisions before the industry can compete in any successful manner with the German interests. The domestic producer maintains that freight rates must come down and that a protective tariff must be enacted.

COMPARATIVE PRICES OF COAL-TAR PRODUCTS, JANUARY, 1921–JANUARY, 1922

Article	Jan., 1921	April, 1921	June, 1921	Oct., 1921	Jan., 1922
Benzene, c.p., gal.	$0.32	$0.27	$0.27	$0.27	$0.29
Cresylic acid, 95-97%, gal.	.90	.85	.65	.65	.65
Dip oil, 25%, gal.	.38	.40	.40	.30	.31
Solvent naphtha, water white, gal.	.30	.25	.25	.25	.25
Toluene, water white, gal.	.33	.28	.28	.28	.30
Xylene, pure, gal.	.42	.42	.40	.40	.40
H acid, lb.	1.40	1.30	1.20	1.10	1.00
Phthalic anhydride, lb.	.60	.50	.50	.40	.37
Salicylic acid, tech., lb.	.30	.22	.19	.18	.20
Alpha naphthylamine, lb.	.40	.38	.35	.30	.30
Aniline oil, lb.	.22	.19	.20	.17½	.17
Aniline salt, lb.	.27	.26	.26	.24	.25
Anthracene, 80%, lb.	.90	.75	.75	.75	.75
Benzaldehyde, U.S.P., lb.	1.10	1.00	1.50	1.25	1.35
Benzoate of soda, U.S.P., lb.	.75	.65	.55	.52	.52
Benzidine, base, lb.	1.00	.90	.85	.90	.90
Benzidine, sulphate, lb.	.85	.75	.75	.75	.75
Beta naphthol, tech., lb.	.40	.33	.37	.31	.30
Dichlorbenzene, lb.	.08	.06	.06	.06	.06
Dinitrobenzene, lb.	.35	.32	.26	.23	.21
Diethylaniline, lb.	1.35	1.20	1.20	1.00	.90
Dimethylaniline, lb.	.70	.50	.40	.41	.40
Dinitrophenol, lb.	.40	.35	.35	.35	.38
Diphenylamine, lb.	.70	.60	.60	.60	.60
Naphthalene, flake, lb.	.08	.08½	.07	.06¾	.07
Naphthalene, ball, lb.	.08½	.09½	.08½	.08	.08½
Nitrobenzene, lb.	.14	.12	.12	.12	.11
Ortho-nitro-toluene, lb.	.25	.17	.15	.15	.15
Para-phenylenediamine, lb.	2.25	1.95	1.75	1.70	1.65
Para-aminophenol, base, lb.	2.10	1.75	1.50	1.40	1.30
Para-aminophenol, HCl, lb.	2.20	1.95	1.75	1.65	1.55
Para dichlorbenzene, lb.	.12	.15	.15	.14	.15
Paranitraniline, lb.	.93	.90	.85	.77	.77
Phenol, U.S.P., lb.	.12	.11	.11	.09	.11½
Resorcinol, tech., lb.	2.75	1.75	1.75	1.50	1.50
Toluidine, mixed, lb.	.45	.40	.40	.43	.35

The past few weeks have provided a few encouraging features. Phenol has been advanced and so also have the quotations on benzene and naphthalene. Japan has again become a consistent buyer of heavy tonnages of phenol and exports of benzene to England have resulted in a noticeable shortage in the domestic market. The consuming industries have again shown an urgent demand for naphthalene and have purchased large quantities on contract for the rest of the year. With these outstanding features and the general feeling of confidence that is permeating the entire industry, it is believed that we can look forward hopefully toward a marked revival in the coal-tar products industry.

The Outlook in the Fertilizer Industry

The fertilizer business, emerging from the worst year in its history, has definitely turned the corner and is looking forward to better business conditions in 1922. This is the view expressed by a number of industrial leaders in an article appearing recently in the *Wall Street Journal.* Among the encouraging factors are the better inventory conditions, the reduction of bank loans, and finally the lower freight rates on fertilizer, effective Jan. 1.

The three leading factors in the trade, controlling as much as 55 per cent of the industry, suffered losses in operation for the first time in 60 years. Although this was primarily caused by the agricultural situation, one of the contributing causes was the large amounts charged to inventories for reduction in prices to market levels. For instance, the American Agricultural Chemical Co. absorbed in income account $5,022,731 for deductions on account of writing inventories down to market levels.

Russia Introduces the Metric System

According to a decree of the Peoples Commissars published in official Soviet papers, the metric system of measures has been introduced in all Soviet institutions beginning with January, 1922, and from 1924 the metric system of weights and measures must be finally and universally adopted throughout Soviet Russia.

New Schedule for Classification of Exports of Domestic Commodities

A new schedule governing the classification of exports of domestic commodities was put into effect Jan. 1 by the Bureau of Foreign and Domestic Commerce. In order that the new regulations in regard to statistical returns of exports may be carried into effect, J. Hohn, the chief of the bureau's division of statistics, points out that the co-operation of exporters is essential. It is absolutely necessary to the accuracy of the statistics that the shipper fill out his export declaration in accordance with the new classification.

Texas Leads in Oil Production

Texas is leading the country in petroleum production, and the different fields in the state are showing a strong tendency to increase present outputs. The Mexia field, one of the latest to be developed, has advanced from an average of 35,000 bbl. a day in November to more than 95,000 bbl. per day at the close of the year. Within 12 hours' travel from Dallas more than one-half the oil of the United States is now being produced. This includes the Mexia field, the Burkburnett district, averaging about 40,000 bbl. a day, and the Stephens County oil regions, with an output approximating 55,000 bbl. daily.

The London Market

From Our Special Correspondent

London, Dec. 17, 1921.

The general tone, both in financial circles and in chemical markets, is improving and decidedly optimistic, with a fairly brisk demand and a slight rise in the general level of prices. Acetone, formaldehyde, lithopone, sodium acetate and certain coal-tar intermediates have been in request, particularly for prompt delivery. It is expected that after the approaching stocktaking period there will be a gradual departure from the present unfortunate habit of buying from hand to mouth, and with the removal of anxiety in various directions as to payments of preference dividends, sound business seems in sight.

The New York Market

New York, Jan. 9, 1922.

The only trading of any importance in the chemical market during the past week was the contract transactions among leading manufacturers. Consumers have been purchasing for future delivery in better volume than at any period during 1921 and producers are inclined to believe that these signs mark the beginning of better times for the industry. Importations have been falling off because of rising prices abroad and consumers have hesitated to place any large tonnage orders with importers for fear of non-delivery. The exchange rates have been a big factor in keeping prices higher abroad as well as maintaining steady prices for spot stocks.

General Chemicals

Although trading in the spot market remained dormant, prices did not sag, but in general continued to be steady. Imported bleaching powder has had a rather evident effect on the market and the domestic producers have been forced to reduce prices to meet this competition. German bleach is quoted here at $1.80 per 100 lb. Domestic prices are around $2.25 per 100 lb. f.o.b. works. *Bichromate of soda* has remained steady for the past month, with spot quotations around 7¼c. per lb. and contract prices at 7¾c. Imported *magnesium sulphate*, technical, is quoted around $1.05 per 100 lb., with a possibility of shading on firm business. Makers quote $1.85 per 100 lb., but apparently are willing to consider lower prices. Importers of *barium chloride* have raised their prices and quotations range around $53 per ton ex-dock New York. Manufacturers of *sulphuric acid*, 66 deg., have reduced their figures to a basis of $16.50 per ton, tank cars, f.o.b. works. A larger volume of business has been reported at the newly reduced prices. Quotations on imported *arsenic* are higher for spot and shipment and prices range around 6c. per lb. for immediate shipment from Japan. Spot prices are higher at 6½c.@7c. per lb., according to brand. Prices of *caustic potash*, 88-92 per cent, on spot are being well maintained and holders are asking 6c. per lb., this figure representing the lowest possible price. Resale prices of *soda ash* and *caustic soda* were a trifle higher on spot, but contract quotations remained quotably unchanged. Imported *tartaric acid* was slightly cheaper on spot. U.S.P. crystals were offered at 25½c. per lb. Domestic producers still quote 32c. per lb., f.o.b. New York.

Coal-Tar Products

The coal-tar products market showed very little change during the past week. Second-hand merchants find difficulty in moving any stocks and producers are still patiently awaiting some definite action that might stir up the industry. Contract bookings have been very scarce for the new year and dealers are practically at a loss to quote intelligently in the absence of any real business. Refiners of *benzene* have advanced their prices 2c. per gal., owing to the acute scarcity of supplies and the heavy demand. Prices on c.p. benzene are now quoted at 29@35c. per gal. in tank cars and drums. The 90 per cent grade is proportionately higher at 27@32c. per gal. *Naphthalene* refiners have also raised their prices after holding quotations at 6½c. per lb. for the past month. Prices for contracts now range from 7½@8½c. per lb. for the flake, according to quantity, and 8½@9½c. for the ball, on the same basis. The demand has been very good in the past week, since resale dealers have been unable to offer any fair-sized quantities for forward deliveries.

The St. Louis Market

St. Louis, Mo., Jan. 7, 1922.

The chemical and drug market has closed one of the most uncertain years in its history. However, the conditions prevailing are far healthier and buying can again be resumed with more confidence. The market has been pretty well cleared of the small broker and second-hand dealer, which has been a constant annoyance during the year just closed, but the heavy importations still continue to be a disturbing element. Many prominent and leading factors prophesy a great expansion in business for this year, and it is hoped that their prophecies will not fall short.

Alkalis

The price on *caustic* has not changed since our last report, but the market is somewhat firmer. Several contracts were made here in the last few days extending over the year 1922 which would seem to indicate that the consumer believes that prices have reached bottom. While these contracts carry protection against decline, they are firm orders and for large quantities. Carload price for solid 76 per cent in drums is $3.40 per 100 lb., f.o.b. point of production, less than carlots $4.25 per 100 lb. in single drums, with slight decline on 10-drum lots. Flake 76 per cent in carlots is $4 per 100 lb., f.o.b. point of production, in drum lots $4.75@$5 per 100 lb. *Soda ash* is $2.90 per 100 lb., *bicarbonate of soda* $2.50 per 100 lb. and *sal soda* $2 per 100 lb. in less than carlots, with the market very inactive.

Special and General Chemicals

A decided improvement has been noted in the demand for *aqua ammonia*, 26 deg., since the reduction. *Bismuth salts* have been in continual demand for several months, and apparently there will not be the usual lull this season. *Bromides* are not moving to a great extent, but manage to keep up with previous months. There is very little demand for *cream of tartar* and the market is uninteresting. *Creosotes* continue to hold an active position. *Glycerine* is still advancing, latest quotations for contract prices being 16c. The market is well sold up, and producers are firmly in control. *Sulphur* continues to move slowly, but manages to hold its previous place at $2 per 100 lb. Apparently no

contract business is being done at present, only spot goods being used.

Acids

There is nothing of great importance to mention in connection with the heavy commercial mineral acids. There is a constant and regular demand and a slight increase is noticeable. There has not been much change in the *citric acid* situation, and if anything the demand is somewhat better. The demand for *acid carbolic*, medicinal grade, is increasing and factors are capable of handling big business. *Acid phosphoric sirupy* is very slow. *Tartaric acid* business is practically nil.

Vegetable Oils and Naval Stores

Castor oil continues firm, easily maintaining its new price of 13c. in drums. That price is being shaded slightly on contract business, but all spot goods is being held at above price. *Linseed oil* is advancing, keeping step with the flaxseed market, which is now very firm. Producers of linseed oil expect a tariff on imported goods, and predict an increase of 10c. per gal. with the passage of the tariff measure. Contract business for a further period than May is being refused at 67c. *Turpentine* has shown a slight advance, reaching 86c. in single barrels and 82c. in 5-bbl. lots.

Paint Materials

The paint industry continues optimistic and substantiates its views by some good-sized orders. *Barytes* remain nominal, with movement slightly increasing. The *lithopone* manufacturers expect to be active soon, although imported goods have somewhat disturbed the market. *Whiting* in carlots can be had at around $13, f.o.b. cars St. Louis, and at $15 in ton lots f.o.b. buyer's door.

The Iron and Steel Market

Pittsburgh, Jan. 6, 1922.

The steel market enters the new year in better condition than would have been predicted from the practically universal reports of dullness in trade circulated in December. Few mills closed over the holidays, and the mills in general seem to have order books that will carry them in January with a production similar to production in the last 3 months of the old year.

The personal equation of the mills, so to speak, appears to have changed. There have been times when the mills colored somewhat too brightly the picture they drew of the trade they were enjoying. Of late, it would appear, they are disposed to minimize their trade. Presumably this is an outcome of the strongly competitive conditions that have existed in the market for 5 or 6 months. Each mill is indisposed to give its competitors an exaggerated idea of the volume of business it has obtained, lest the other mills seek by more strenuous competition to equal the record.

Production of steel ingots was fairly uniform during the last 3 months of 1921 at a rate of about 23,000,000 tons a year. Appearances are that mills will closely approach this rate even in January, and possibly exceed it, while in February and March, on account of seasonal conditions, the rate is likely to be exceeded.

What may be regarded as fundamental commercial conditions had little to do with the fluctuations in operating rates of the steel mills in 1921. The liquidation of stocks was the chief factor, hence it may be assumed that with general business conditions no better than they have been in the past few months the steel industry would be called upon to operate indefinitely at a rate of about 23,000,000 tons, while any improvement at all in general conditions would cause this rate to be exceeded. A change in conditions whereby there would be more incentive to regular investment construction would be a great aid to steel demand. There has been much building in the United States in the past few months, but chiefly in garages and dwelling houses, which do not require much steel.

Such a change cannot be predicted for any time within the next few months. In more immediate prospect is a movement on the part of buyers to restore their stocks part way to normal, say to 70 per cent of what is considered necessary and desirable for the efficient conduct of business, whether the business be that of manufacturing wares made from steel or distributing steel from the jobbing warehouse. All buyers reduced stocks in 1921 to an absolute minimum, partly on account of business uncertainties, partly on account of doubt as to steel prices, and partly as a general measure to liquidate in preparation for making a fresh start.

Steel prices are now relatively stable and there is encouragement to buyers to restore stocks, at least partially. As a matter of fact some conservative but well-posted distributors began even in December to build up stocks. Such a restocking, if only to one-half of normal, would provide a very substantial tonnage of business for the steel industry temporarily, and might send the rate of ingot production up to 30,000,000 tons a year before April 1.

Steel Prices Steadier

As to steel prices, they are distinctly steadier, on the whole, than at any time for months. They have not advanced, nor are they at all likely to advance, but from the prices currently quoted as representing the market in general there are smaller concessions possible in the case of large and desirable orders than were possible some time ago. Last August, when openly quoted prices were materially higher than at present, the extreme prices were probably fully as low as extreme prices are today.

One cause of the greater stability at present undoubtedly is that mills have a more exact appraisal as to the possibilities of operating. Last summer and early fall there was a disposition to make large concessions to build up an order book and get the lower production costs that would come from a larger operation. Prices were quoted not on the basis of existing cost but on a prospective cost based on a problematical operation. Today the mills know just about what operating rate to expect, and realize that they cannot swell the rate materially by cutting prices. Hence their prospective cost can be estimated with a considerable degree of accuracy, and there is excellent reason for believing that no mill of any size will knowingly sell steel at less than the prospective cost of production. Profits, of course, are not being sought and in not a few cases a slight loss might be tolerated for the purpose of giving employment to the men.

The market in general, unchanged in the past couple of weeks, now stands substantially as follows: Bars, shapes and plates, 1.50c.; hoops, bands and hot-rolled strip, 2c.; plain wire, 2.25c.; wire nails, $2.50; standard steel pipe, 71 per cent basing discount; black sheets, 3c.; galvanized sheets, 4c.; tin plate, $4.75. The American Steel & Wire Co., on account of price cutting by independents, has reduced its price on cold-rolled strip, effective Jan. 1, from 3.75c. to 3.50c.

Pig Iron

Pig iron continues very dull, but a buying movement of some proportions in foundry iron is expected toward the latter part of the month. A recent sale of basic iron by a steel works interest at $18.25 valley is now accepted by merchant furnaces as representing current value, the market having previously been quotable nominal at $19 valley. Bessemer remains quotable at $20 valley, and foundry at $19.50@$20 valley.

Coke

Contracts for Connellsville furnace coke for first quarter have been made at from $3.50 down to $3.25, and the latter price can now be done by buyers. It is said in some quarters that those who paid $3.50 and $3.40 bought too soon.

Of considerable interest is a transaction between the Youngstown Sheet & Tube Co. and the Trumbull-Cliffs Furnace Co., involving a coke supply for the Trumbull-Cliffs furnace, Warren, Ohio, of about 18,000 tons a month. This is a requirement contract, predicated on whether the furnace operates, while the seller reserves the right to discontinue the arrangement if it needs the coke for its own furnaces. The price is equal to $2.90, Connellsville basis. The price was not competitive, it appears, but was made to justify the furnace being blown in.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0 40 – $0 45
Acetone	lb.	$0 12½ – $0 12¼	13 – 13½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		10 00 – 10 50	10 75 – 11 00
Boric, crystals	lb.	12½ – 12⅝	13 – 13½
Boric, powder	lb.	12¼ – 13	13½ – 14
Citric	lb.	—	43 – 45
Hydrochloric	100 lb.	1 50 – 1 60	1 65 – 2 00
Hydrofluoric, 52 per cent	lb.	13 – 13¼	13½ – 14
Lactic, 44 per cent tech	lb.	09½ – 10	10½ – 12
Lactic, 22 per cent tech	lb.	04 – 04¼	04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg.	lb.	06¼ – 06½	06⅔ – 07
Nitric, 42 deg.	lb.	06¾ – 07	07¼ – 07½
Oxalic, crys tals	lb.	14½ – 15	15½ – 16
Phosphoric, 50 per cent solution	lb.	11 – 11½	11¾ – 12½
Picric	lb.	20 – 25	27 – 35
Pyrogallic, resublimed	lb.	—	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	—	11 00 – 12 00
Sulphuric, 60 deg., drums	ton	—	13 00 – 15.00
Sulphuric, 66 deg., tank cars	ton	16 50 – 17 00	—
Sulphuric, 66 deg., drums	ton	21 00 – 22 00	22 50 – 23.00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21 00 – 22 00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23 00 – 23 50	24 00 – 24 50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32.00	33 00 – 34 00
Tannic, U. S. P	lb.	—	65 – 75
Tannic (tech.)	lb.	45 – 50	51 – 55
Tartaric, imported crystals	lb.	—	.25½ – .26
Tartaric acid, imported, powdered	lb.	—	.26 – .27
Tartaric acid, domestic	lb.	—	— .32
Tungstic, per lb. of WO	lb.	—	1 00 – 1 10
Alcohol, ethyl	gal.	—	4 75 – 5 00
Alcohol, methyl (see methanol)		—	—
Alcohol, denatured, 188 proof	gal.	—	42 – 43
Alcohol, denatured, 190 proof	gal.	—	43 – 44
Alum, ammonia, lump	lb.	03½ – .03¾	.04 – 04¼
Alum, potash, lump	lb.	03½ – .04	04¼ – 04½
Alum, chrome lump	lb.	08 – 08¼	08½ – 09
Aluminum sulphate, commercial	lb.	01¾ – 02	02½ – 02¾
Aluminum sulphate, iron free	lb.	02½ – 02¾	03 – 03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ – 07¾	08 – 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – 30½	31 – 33
Ammonium carbonate, powder	lb.	.07 – 07½	08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.07 – .07¼	07½ – 07¾
Ammonium chloride, granular (gray salammoniac)	lb.	07 – 07¼	07½ – 07¾
Ammonium nitrate	lb.	07¼ – 07½	07⅔ – 08¼
Amylacetate tech	gal.	—	2 00 – 2 40
Arsenic oxide, (white arsenic) powdered	lb.	06¾ – 06¾	.07 – 07½
Arsenic, sulphide, powdered (red arsenic)	lb.	12 – 12¼	12⅔ – 13
Barium chloride	ton	51 00 – 52 00	53 00 – 60 00
Barium dioxide (peroxide)	lb.	21 – 21½	22 – .23
Barium nitrate	lb.	07 – 07½	.07¾ – .09
Barium sulphate (precip.) (blanc fixe)	lb.	03¾ – .04	04¼ – 04½
Blanc fixe, dry	lb.	04 – .04½	—
Blanc fixe, pulp	ton	45 00 – 55.00	—
Bleaching powder (see calc. hypochlorite)		—	—
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	21 – 22	23 – 28
Calcium acetate	100 lbs.	1 75 – 2 00	—
Calcium carbide	lb.	04½ – 04¾	.05 – 05½
Calcium chloride, fused, lump	ton	23.00 – 24 00	24 50 – 28 00
Calcium chloride, granulated	lb.	01¾ – .02	02¼ – 02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2 50 – 2 60	2 65 – 3 25
Calcium peroxide	lb.	—	1 40 – 1 50
Calcium phosphate, tribasic	lb.	—	.15 – 16
Camphor	lb.	—	.90 – .95
Carbon bisulphide	lb.	06½ – 06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	10½ – 10¼	.11 – .12
Carbonyl chloride, (phosgene)	lb.	—	60 – .75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chalk, precip.—domestic, light	lb.	03¾ – .04	—
Chalk, precip.—domestic, heavy	lb.	03½ – 03¾	—
Chalk, precip.—imported, light	lb.	04 – 04½	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	06 – 06½	.06½ – .07
Chloroform	lb.	—	.38 – .40
Cobalt oxide	lb.	—	2 00 – 2 10
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	20 – 20½	21 – 21½
Copper cyanide	lb.	—	58 – 60
Copper sulphate, crystals	100 lb.	5.60 – 5 65	5 70 – 6 25
Cream of tartar (see potassium bitartrate)		—	—
Epsom salt (see magnesium sulphate)		—	—
Ethyl acetate com. 85%	gal.	—	60 – 70
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	—	95 –
Formaldehyde, 40 per cent	lb.	10½ – 10¾	11 – 12
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	—
Fullers earth—imported powdered—net	ton	30 00 – 32.00	—
Fusel oil, ref.	gal.	—	2 50 – 3 00
Fusel oil, crude	gal.	—	1 50 – 1 75
Glauber's salt (see sodium sulphate)		—	—
Glycerine, c. p. drums extra	lb.	—	.16 – 16½
Iodine, resublimed	lb.	—	3 80 – 3 90
Iron oxide, red	lb.	—	.12 – 18
Iron sulphate (copperas)	ton	15 00 – 16 00	17 00 – 20 00
Lead acetate	lb.	—	10¾ – 12½
Lead arsenate, powd	lb.	15 – 15½	15¾ – 16¾
Lead nitrate	lb.	—	15 – 20
Litharge	lb.	08 – .08¼	.08½ – 09
Magnesium carbonate, technical	lb.	06½ – 07	07¼ – 08
Magnesium sulphate, U. S. P.	100 lb.	2 65 – 2 70	2 75 – 3 00
Magnesium sulphate, technical	100 lb.	—	1 65 – 1 80
Methanol, 95%	gal.	—	.62 – .63
Methanol, 97%	gal.	$.... – $....	$0 64 – $0.65
Nickel salt, double	lb.	—	11 – 11½
Nickel salt, single	lb.	—	12 – 12¼
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	45 – .46	47 – .50
Phosphorus, yellow	lb.	—	30 – 35
Potassium bichromate	lb.	10½ – .11	11¼ – 11½
Potassium bitartrate (cream of tartar)	lb.	—	.24 – .26
Potassium bromide, granular	lb.	—	.14 – .18
Potassium carbonate, U. S. P	lb.	.11 – .12	12½ – .15
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.05⅔ – .06	06¼ – .12
Potassium cyanide	lb.	—	43 – .45
Potassium hydroxide (caustic potash)	lb.	.06 – .06½	06½ – .06¾
Potassium iodide	lb.	—	2.90 – 3.00
Potassium nitrate	lb.	.07¼ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .16	16½ – .22
Potassium prussiate, red	lb.	.30 – 30½	.31 – .31½
Potassium prussiate, yellow	lb.	24½ – .24¾	.25 – .26
Rochelle salts (see sodium potas tartrate)		—	—
Salammoniac (see ammonium chloride)		—	—
Sal soda (see sodium carbonate)		—	—
Salt cake (bulk)	ton	—	18.00 – 21.00
Soda ash, light	100 lb.	1.85 – 2.10	2.15 – 2.50
Soda ash, dense	100 lb.	2.15 – 2.20	2.25 – 2.50
Sodium acetate	lb.	.04 – .04¼	.04½ – 05
Sodium bicarbonate	100 lb.	2.30 – 2.35	2.40 – 2.75
Sodium bichromate	lb.	.07⅞ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¾ – .05	.05½ – .06
Sodium borate (borax)	lb.	.05½ – .06	.06½ – 07
Sodium carbonate (sal soda)	100 lb.	1.80 – 1.90	1.95 – 2.15
Sodium chlorate	lb.	.06½ – .07	.07½ – .08
Sodium chloride	long ton	12 00 – 13 00	—
Sodium cyanide	lb.	.26 – .26½	.26¾ – .27
Sodium fluoride	lb.	.10½ – .11	.11½ – .12
Sodium hydroxide (caustic soda)	100 lb.	3.80 – 3.85	3.90 – 4.30
Sodium hyposulphite	lb.	—	.03½ – .03¾
Sodium nitrite	lb.	.06⅝ – .06¾	07 – .07½
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium potassium tartrate (Rochelle salts)	lb.	—	.19 – .21
Sodium prussiate, yellow	lb.	.17 – .17½	.17¾ – .18
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.05	1.10 – 1.30
Sodium silicate, solution (60 deg.)	100 lb.	2.75 – 3.00	3.25 – 3.50
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.30 – 1.50	1.60 – 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ – .04½	.04¾ – .05
Sodium sulphite, crystals	lb.	.03⅝ – .03¾	.04 – .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chl ride, red	lb.	.05¼ – .05½	.05¾ – .06
Sulphur, crude	ton	18.00 – 20.00	—
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	—	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	—	2.00 – 2.75
Talc—imported	ton	30 00 – 40 00	—
Talc—domestic powdered	ton	18 00 – 25 00	—
Tin bichloride	lb.	.09 – .09½	.09¾ – .10
Tin oxide	lb.	—	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.15 – .16
Zinc chloride, gran	lb.	.09 – .09¼	.09½ – .10
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11¼ – .11½	.11¾ – .12½
Zinc oxide, XX	lb.	.07½ – .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.15 — 1.20
Alpha-naphthylamine	lb.	.30 — .32
Aniline oil, drums extra	lb.	.17 — .18
Aniline salts	lb.	.25 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.35 — 1.45
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.30 — .34
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.24 — .26
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.90 — 1.05
Dimethylaniline	lb.	.40 — .45
Dinitrobenzene	lb.	.21 — 25
Dinitroclorbenzene	lb.	.25 — 27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.38 — 40
Dinitrotoluene	lb.	.25 — 30
Dip oil, 25%, car lots, in drums	gal.	.31 — 35
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.00 — 1.10
Meta-phenylenediamine	lb.	1.10 — 1.15
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.40 — 1.45
Naphthalene crushed, in bbls.	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — .08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.11 — .14
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	3.00 — 3.10
Ortho-dichlor-benzene	lb.	.15 — 20
Ortho-nitro-phenol	lb.	.75 — 80
Ortho-nitro-toluene	lb.	.15 — 20

Ortho-toluidine	lb.	.20 —	.25
Para-amidophenol, base	lb.	1.30 —	1.35
Para-amidophenol, HCl	lb.	1.60 —	1.70
Para-dichlorbenzene	lb.	.15 —	.17
Paranitroaniline	lb.	.77 —	.80
Para-nitrotoluene	lb.	.75 —	.80
Para-phenylenediamine	lb.	1.65 —	1.70
Para-toluidine	lb.	1.15 —	1.25
Phthalic anhydride	lb.	.37 —	.40
Phenol, U. S. P., drums	lb.	.11½ —	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.50 —	1.60
Resorcinol, pure	lb.	2.00 —	2.25
Salicylic acid, tech., in bbls	lb.	.20 —	.21
Salicylic acid, U. S. P	lb.	.22 —	.23
Salol	lb.	.75 —	.77
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.16
Sulphanilic acid, crude	lb.	.26 —	.28
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices are quotably unchanged for the entire list.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.30 —	5.35
Rosin E-I	280 lb.	5.40 —	5.50
Rosin K-N	280 lb.	6.05 —	6.75
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.82½ —	....
Wood turpentine, steam dist	gal.	.80 —	....
Wood turpentine, dest. dist	gal.	.79 —	....
Pine tar pitch, bbl	200 lb.	.... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	9.50
Retort tar, bbl	500 lb.	—	9.50
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	$2.30 —	2.90
Blood, dried, f.o.b., N. Y	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.30 —	2.35
Tankage, high grade, f.o.b. Chicago	unit	2.75 —	3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	4.50 —	6.50
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	33.00 —	34.00
Potassium sulphate	unit	.95 —	1.00

Crude Rubber

Quotations have remained unchanged since our previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10¼ —	$0.10¾
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13¼ —	.13¾
Cocoanut oil, Ceylon grade, in bbls	lb.	.08½ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.10 —	.10¼
Corn oil, crude, in bbls	lb.	.09 —	.09¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.07 —	.07¼
Cottonseed oil, summer yellow	lb.	.08¼ —	.09
Cottonseed oil, winter yellow	lb.	.09½ —	.09¾
Linseed oil, raw, car lots (domestic)	gal.	.69 —	.70
Linseed oil, raw, tank cars (domestic)	gal.	.64 —	.65
Linseed oil, in 5-bbl lots (domestic)	gal.	.72 —	.73
Olive oil, denatured	gal.	$1.15 —	$1.20
Palm, Lagos	lb.	.07½ —	.07¾
Palm, Niger	lb.	.06½ —	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08 —	.08¼
Peanut oil, refined, in bbls	lb.	.11 —	.11¼
Rapeseed oil, refined in bbls	gal.	.82 —	.83
Rapeseed oil, blown, in bbls	gal.	.88 —	.90
Soya bean oil (Manchurian), in bbls, N. Y	lb.	.08¾ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07¼ —	....

FISH

Light pressed menhaden	gal.	$0.46 —	....
Yellow bleached menhaden	gal.	.48 —	....
White bleached menhaden	gal.	.50 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

Prices remain unchanged throughout the list.

Refractories

All prices remain the same as figures appearing in our Dec. 28 issue.

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.12 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.13 —	
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00 —	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport	gross ton	54.00 —	58.35
Spiegelcisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	57.00 —	59.00
Ferrosilicon, 75%	gross ton	120.00 —	125.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00 —	23.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	22.00 —	23.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.23 —	.24
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.45 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13¼

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	38.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	32.375
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.40
Zinc, spot, New York	5.25@5.30
Zinc, spot, E. St. Louis	4.80@4.85

OTHER METALS

Silver (commercial)	oz.	$0.64¾
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	80.00-84.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00-60.00
Mercury	75 lb.	50.00-51.00

FINISHED METAL PRODUCTS AND OLD METALS

Quotations have remained unchanged since our previous report.

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.78	$2.88	$2.78
Soft steel bars	2.68	2.78	2.68
Soft steel bar shapes	2.68	2.78	2.68
Soft steel bands	3.28	3.48	3.28
Plates, ¼ to 1 in. thick	2.78	2.88	2.78

*Add 15c per 100 lb for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Great Southern Steel Co., Chicago, Ill., recently organized with a capital of $105,000,000 under Delaware laws, has plans in preparation for the erection of a new steel plant at Birmingham, estimated to cost about $500,000 for initial units. The company, also, has about 10,000 acres of iron ore and coal properties in Etowah County and neighboring counties of Alabama, and purposes extensive development and operation of the lands. John W. Baker, 711 Lumber Exchange Bldg., Chicago, is one of the principals in the organization.

ALBANY—A. G. Patterson, Albany, and associates have plans under way for the development of a large tract of asphalt deposits, recently acquired. A plant will be installed.

California

NATIONAL CITY—The California Gypsum Co. has made application to the State Harbor Commission for a lease of tideland property at National City, totaling about 40 acres, to be used as a site for a new plant for the manufacture of gypsum products, estimated to cost approximately $250,000.

Colorado

FORT COLLINS—Fire, Dec. 22, destroyed the chemical building at the State Agricultural College here, with loss estimated at about $60,000.

Connecticut

NEW HAVEN—The Seamless Rubber Co., manufacturer of small rubber goods, has awarded a contract to the Dwight Building Co., 67 Church St., for the rebuilding of the portion of its plant, recently destroyed by fire, with loss estimated at $200,000, including equipment. The new structure will be located on Hallock Ave.

BRIDGEPORT—The D. & C. Oil Co., Lindley St., has awarded a contract to George Lyelos, 220 Parrott Ave., for the erection of its new plant on Colonial Ave., estimated to cost about $25,000.

Florida

DAYTONA—W. K. Tavel and H. B. Schulte, Daytona, are organizing a new company for the establishment of a local plant for the manufacture of cement brick, shingles and kindred specialties.

MIAMI—The Pennsylvania Sugar Co., 135 South Second St., Philadelphia, Pa., has awarded a building contract for the erection of the first unit of its proposed new sugar mill on property recently acquired near Miami. The plant will have an initial output of about 1,500 tons of cane sugar per day, and is estimated to cost close to $500,000.

LEESBURG—The Leesburg Pulp Mill Co. is considering preliminary plans for the doubling of its present plant capacity.

TAMPA—The Florida Nu-Tex Brick Co., 109 Water St., is planning for the establishment of a number of branch plants in different sections of the state for the manufacture of cement brick. W. B. Coarsey is president.

MOORE HAVEN—The Moore Haven Sugar Corp. is installing additional machinery at its mill and will begin operations under increased production within a few weeks. This is the first mill of this kind to be established in the Everglades section of the state.

PENSACOLA—The Southern Paving Co. is considering plans for extensions and improvements in its wood-block creosoting plant, to include the installation of tanks and other equipment, estimated to cost about $40,000.

Indiana

MARION—The Mileage Oil & Refining Co., Kokomo, Ind., has acquired the property of the Service Oil Co., Marion, at a receiver's sale, for a total consideration said to be $400,000. The new owner will operate the plant as an extension to present activities.

Kentucky

LOUISVILLE—The Standard Sanitary Mfg. Co., Bessemer Bldg., Pittsburgh, Pa., has awarded a contract to the George Rommell Co., 956 Logan St., Louisville, for the erection of a 1-story addition to its local pant at Sixth and A Sts., to be equipped as an enameling works. It is estimated to cost about $100,000. O. P. Ward, Lincoln Trust Bldg., Louisville, is architect.

Louisiana

ALEXANDRIA—The Alexandria Refining Co. has taken out a state charter with capital of $50,000, to construct and operate a local oil refinery. Erection of the new plant has been commenced. H. T. Clark is president, and G. W. Zodar, vice-president.

Maryland

HAGERSTOWN — The Bostwick - Lyon Bronze Co., Waynesport, Pa., operating a plant at Hagerstown under the name of the Hagerstown Bearing Metal Works, has acquired the local plant of the Maryland Smelting & Refining Co., and will merge the property with the Hagerstown works. Extensive operatons are planned.

Massachusetts

LOEMINSTER—The Viscoloid Co., Lancaster St., manufacturer of celluloid products, will soon commence the erection of a 2-story plant addition, 40 x 50 ft. The building contract has been let to the Wiley & Foss Co., Fitchburg, Mass.

ARLINGTON—The Frost Insecticide Co. has completed plans and will soon commence the erection of a new plant unit, estimated to cost about $40,000, including equipment.

Missouri

KANSAS CITY—The Hydro-United Tire Co., Pottstown, Pa., has acquired a controlling interest in the A. J. Stephens Rubber Co., with plant at Kansas City, and plan for increased operations at the works. J. H. Phillips is president of the Hydro-United company.

Montana

GREAT FALLS—The local Commercial Club is developing plants for the organization of a new company, to construct and operate a beet sugar manufacturing plant.

New Jersey

NEWARK—The Gulf Refining Co., Doremus Ave. near the Plank Road, has had plans prepared for the erection of a 1-story, reinforced-concrete machine shop at its local oil plant, 100 x 230 ft., estimated to cost about $70,000. Headquarters of the company are at 21 State St., New York.

New York

BROOKLYN—The P. L. Andrews Corp., 45 Irving Ave., manufacturer of envelopes and other paper products, has awarded a contract to the Caye Construction Co., 356 Fulton St., for the erection of a new 2-story plant, 55 x 100 ft., on Jefferson St., estimated to cost about $75,000.

Pennsylvania

SPRING GROVE—The P. H. Glatfelter Co., operating a local paper mill, has completed plans for increasing the capacity of the plant from 50 to 100 tons per day. An extension will be erected to provide for the installation of a new 168-in. machine and other finishing machinery.

ELIZABETHTOWN—The Farmers' Fertilizer Works, William Schneitman, head, is considering the erection of a new 1-story plant for the manufacture of commercial fertilizers.

NEW CUMBERLAND — E. E. Fleurie, Fifth and Reno Sts., is planning for the immediate rebuilding of his brick-manufacturing plant, destroyed by fire, Dec. 23, with loss estimated at about $25,000. New machinery will be installed.

PITTSBURGH — The H. J. Heinz Co., Progress St., manufacturer of canned food products, has plans in preparation for the erection of a 2-story and basement laboratory building, 40 x 100 ft. Bids will be asked and construction inaugurated at an early date.

Tennessee

GRAYSVILLE—The Dixie Coal, Lime & Clay Products Co., Chattanooga, Tenn., has acquired clay properties in the vicinity of Graysville, totaling about 400 acres, and plans for the installation of a clay-mining plant. It is also proposed to establish a works for the manufacture of firebrick and other burned clay products. The acquisition includes a large tract of lime deposits and a plant will be established for this development.

WHITE PINE — G. M. Felmet, White Pine, and associates, are organizing a new company to construct and operate a local flour mill. Plans are being prepared for a 4-story and basement mill, 36 x 70 ft., and ground will be broken early in the spring. The W. J. Savage Co., 912 West Church St., Knoxville, Tenn., is architect.

Texas

HOUSTON—The Humphreys-Pure Oil Co. interests have organized under Delaware laws the Humphreys-Pure Oil Refineries Corp., with capital of $50,000,000. The new organization will operate in the Mexia, Tex., oil fields, and plans for the erection of a new oil refinery in the vicinity of Houston, with output of about 30,000 bbl. of oil per day. A pipe line will be constructed from the Mexia district to a point on the Gulf, provided with a series of pumping stations and other operating equipment. The entire project is estimated to cost close to $5,000,000. Col. E. A. Humphreys heads the company.

NEWCASTLE—The Common Council is perfecting plans for the construction of a new filtration plant at the municipal waterworks. The Henry, Exall, Elrod Co., Dallas, Tex., is engineer.

AMARILLO—The Amarillo Brick & Tile Co. is establishing a plant in the vicinity of clay properties about 6 miles from Amarillo, and will inaugurate operations at an early date.

McGREGOR — The Koury Calcium Co., recently organized with a capital of $400,000, has acquired the plant and property of the Lone Star Co. at Oglesby, near Waco, consisting of about 360 acres of lime lands, with plant equipped for an output of about 1,000 bbl. of lime per day. The new owner purposes to operate the plant and develop an extensive output of raw material. The company will also begin operations at an early date on its properties near McGregor, recently acquired, with proposed plant at this location estimated to cost close to $100,000. Michael Koury is president, and W. V. Hanover, secretary.

HOUSTON—The Texas Co. has started preliminary work at its sulphur deposits at Haskins Mound, Tex., and has blocked out an area to provide for an output of over 10,000,000 tons. It is said that plans are being perfected for the organization of a subsidiary company, to be capitalized at $5,000,000, for the operation of the lands, and to construct a large plant in this vicinity. Considerable equipment will be purchased for installation.

Virginia

RICHMOND—The Manchester Board & Paper Co., West Canal St., is planning for extensions and improvements in its plant to cost about $15,000.

CHARLOTTESVILLE—The City Council has plans under way for the installation of a new filtration plant on Observatory Mountain for the waterworks system, estimated to cost about $130,000. Williamson, Carroll & Saunders, Charlottesville, are engineers.

West Virginia

HUNTINGTON—The International Nickel Co., 67 Wall St., New York, is maintaining active construction on its new local plant, which is now more than 50 per cent completed. The works comprise a refinery and rolling mill, and will be used primarily for the manufacture of Monel metal products. It is intended to have the plant ready for operation early in May. W. L. Wotherspoon, company address, is engineer.

Wisconsin

APPLETON—The Appleton Coated Paper Co. has broken ground for the erection of a new 3-story and basement building at its plant, estimated to cost about $35,000. Charles Boyd is manager.

Capital Increases, Etc.

THE FLINT VARNISH & COLOR WORKS, Flint, Mich., has filed notice of increase of capital from $1,500,000 to $3,500,000.

THE HOOKER ELECTROCHEMICAL CO., 25 Pine St., New York, N. Y., with plant at Niagara Falls, N. Y., has disposed of a bond issue of $1,250,000, the proceeds to be used for general financing, operations, etc.

THE INLAND METALS REFINING CO., 4837 South May St., Chicago, Ill., has filed notice of dissolution under state laws.

THE NATIONAL CARBIDE CORP., a Virginia corporation, has filed notice of intention to operate in New York, with capital of $350,000. E. V. O'Daniel, 342 Madison Ave., New York, is representative.

THE VERSAILLES SANITARY FIBRE MILLS, INC., Sprague, Conn., has filed notice of increase in capital from $300,000 to $500,000.

THE AMERICAN SUGAR REFINING CO., 117 Wall St., New York, has arranged for a bond issue of $30,000,000, the proceeds to be used for general financing, operations, etc.

THE GRANDFIELD OIL & REFINING CO., Grandfield, Okla., has filed notice of increase in capital from $125,000 to $300,000 for proposed expansion.

THE ECONOMY PAPER CO., 847 Broad St., Newark, N. J., has filed notice of increase in capital from $6,000 to $125,000 for general expansion.

THE UNION CHARCOAL & CHEMICAL CO., a Delaware corporation, has filed notice of intention to operate in New York, with capital of $250,000. C. M. Hancock, Olean, N. Y., is representative.

THE FEDERAL MICA CO., 217 Center St., New York, N. Y., has filed notice of dissolution under state laws.

New Companies

THE SOUTH HAVEN CHEMICAL CO., South Haven, Mich., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are J. C. Randall, J. C. Johnston and John C. Hunt, all of South Haven.

THE C. B. CASTLE CORP., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture oils, greases, etc. The incorporators are W. W. Heaton, W. B. Seawell and J. K. Berry. The company is represented by Porter & Taylor, 30 Broad St., New York.

THE CHEMICAL CONVERTING CO., 15 Exchange Pl., Jersey City, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and affiliated products. The incorporators are Martin J. Connolly, Edward F. Johnston and Paul Henderson.

THE JOHNSON OIL REFINING CO., 208 South La Salle St., Chicago, Ill., has been incorporated with a capital of $2,000,000, to manufacture petroleum products. The incorporators are G. C. Lilly, I. H. and Homer H. Johnson.

THE GOOCH, OTIS CO., INC., Boston, Mass., has been incorporated with a capital of $25,000, to manufacture leather products. Albert N. Gooch is president, and Walter I. Otis, Everett, Mass., treasurer.

THE INSULATING PRODUCTS CO., Kalamazoo, Mich., has been incorporated with a capital of $25,000, to manufacture insulating specialties, pipe coverings and kindred products. The incorporators are Bailey A. Wright, Fred W. Myers and Donald P. Osborne, all of Kalamazoo.

THE RODIAN ELECTRO-METALLURGICAL CO., INC., Wilmington, Del., has been incorporated under state laws with capital of $10,000,000, to manufacture various metallurgical products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE ADVANCE CHEMICAL MFG. CO., 2756 Diversey Ave., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture chemicals, compounds, etc. The incorporators are Jacob Kaplan and Samuel L. Steinberg.

THE J. K. McIVER CO., Savannah, Ga., has been organized under state laws to manufacture fertilizer products. The company is headed by J. K. McIver and Bleecker P. Seaman, both of Savannah.

THE RUBBER PRODUCTS CO., Morgantown, W. Va., has been incorporated with a capital of $50,000, to manufacture rubber specialties. The incorporators are Earl Pepper, M. J. Melamphy, Jr., and C. W. Huston, all of Morgantown.

THE PRO-RALGIA CHEMICAL CO., Pittsburgh, Pa., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. H. A. Hauser, 323 Bailey Avenue, is treasurer.

THE LYNN IRON FOUNDRY, INC., Lynn, Mass., has been incorporated with a capital of $20,000, to manufacture iron, steel and other metal castings. Telesphor Mailloux is president; and I. George Pelletier, Salem, Mass., treasurer.

THE U. N. S. PAPER BOX CO., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture paper boxes and kindred products. The incorporators are R. Benrey, S. Redler and D. Crespi. The company is represented by W. R. Altman, 277 Broadway, New York.

THE SILVER REDUCTION CO., 155 North Clark St., Chicago, Ill., has been incorporated with a capital of $20,000, to manufacture metal products. The incorporators are Emerson B. Stoddard, Charles E. Johnson and Ralph E. Rich.

THE DURAND-WILCOX GLASS CO., Newfield, N. J., has been incorporated with a capital of $100,000, to manufacture glass products of various kinds. The incorporators are M. D. and Victor Durand, Jr., and Albert C. Wilcox, all of Newfield.

THE AMERICAN EAGLE OIL CO., Taft, Cal., has been incorporated with a capital of $500,000, to manufacture petroleum products. The incorporators are J. B. Baker, O. R. Tucker, A. S. Johnston and R. E. Havenstrite, all of Taft.

THE MARYLAND FELT & PAPER CO., Calvert Bldg., 101 East Fayette St., Baltimore, Md., has been incorporated with a capital of $1,000,000, to manufacture paper and other kindred products. The incorporators are Joseph P. Murray, Frank S. Muzzey, and P. Stanley Saurman.

THE CONRAD FOUNDRY CO., 615 Montgomery Ave., Elizabeth, N. J., has been incorporated with a capital of $100,000, to manufacture steel, iron and other metal castings. The incorporators are John F. Conrad, William R. Miller and John Ebel.

THE TRUTEST CHEMICAL CORP., Wilmington, Del., has been incorporated under state laws with capital of $500,000, to manufacture chemicals, compounds etc. The company is represented by the Corporation Service Co., Wilmington.

THE SAN CHEMICAL CO., Columbia, S. C., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. J. S. Hammoch is president and treasurer; J. B. Pratt, vice-president; and E. H. Salmon, secretary, all of Columbia.

THE ESSEX CHEMICAL & SPECIALTY CO., Newark, N. J., has been incorporated with a capital of $50,000, to manufacture chemicals, compounds, etc. The incorporators are Emanuel P. Scheck, I. V. Davis and Harry E. Young, 790 Broad St., Newark.

THE STORAGE PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture cement, asphalt and kindred products. The incorporators are S. D. Joseph, A. M. Steinberg and B. Mayer. The company is represented by E. Enselman, 220 Broadway, New York.

THE SURE LIFE PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with capital of $250,000, to manufacture polishes, dyes and kindred chemical specialties. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE VALLEY TILE & CONCRETE CO., San Benito, Tex., has been incorporated with a capital of $10,000, to manufacture cement tile and kindred specialties. G. W. Wilkerson, San Benito, is president.

THE COMANCHE POINT OIL CO., Los Angeles, Cal., has been incorporated with a capital of $1,000,000, to manufacture petroleum products. The incorporators are J. S. Farrow, B. S. Hunter, J. N. Kerwin and Glenn N. Deuel. The company is represented by Benjamin S. Hunter, Citizens' National Bank Bldg., Los Angeles.

THE PENNSYLVANIA SOAP CO., Pittsburgh, Pa., has been incorporated under Delaware laws, with capital of $250,000, to manufacture soaps and kindred products. The incorporators are Arthur C. Volbrecht, Louis A. Snyder. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE OSANTOS CHEMICAL CO., 110 South Dearborn St., Chicago, Ill., has been incorporated with a capital of 400 shares of stock, no par value, to manufacture chemical compounds, etc. The incorporators are A. M. Domber, F. W. Metz and Thomas S. Milcarek.

THE KNOXVILLE CEMENT PRODUCTS CO., Oakwood, near Carbondale, Tenn., has been incorporated with a capital of $10,000, to manufacture cement specialties. The incorporators are Chester Koehn, Harmon Austin and Charles A. Russell, Oakwood.

THE SENSO MFG. CO., Fort Wayne, Ind., has been incorporated with a capital of $10,000, to manufacture chemical compounds, disinfectants, etc. The incorporators are C. J. Shimer, R. J. Brown and J. C. Beyer.

THE HAGMAYER CHEMICAL & MFG. CO., Philadelphia, Pa., has been incorporated under Delaware laws, with a capital of $100,000, to manufacture chemicals, paints, etc. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

THE TRENTON CHEMICAL CO., Trenton, N. J., has been organized under state laws to manufacture chemicals and chemical byproducts. The company is headed by F. Walter Messler and M. L. Ward Suydam, 1109 Division St., Trenton.

THE SOUTHERN PACIFIC BRICK & TILE CO., Fresno, Cal., has been incorporated with a capital of $250,000, to manufacture brick, tile and other burned clay products. The incorporators are W. H. Shields, Fresno; W. D. Trewhitt, Hanford, Cal.; and L. E. Hayes, Exeter, Cal.

THE PHOENIX CHEMICAL WORKS, INC., Houston, Tex., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are John Pfeiffer, E. J. Blunt and M. H. Webster, Houston.

THE SHOPE BRICK CO., Springfield, Mass., has been incorporated with a capital of $125,000, to manufacture brick, tile and other burned clay products. William J. Kressler is president; Paul G. Seyler, vice-president; and Edward F. Seyler, treasurer, all of Springfield.

Manufacturers' Catalogs

W. S. ROCKWELL CO., New York, has just issued Bulletin 234, on "The Continuous Heat-Treatment of Metals With Automatic and Semi-Automatic Furnaces," which is the fourth of the series dealing with fundamentals that influence the quality and cost of heated products. This bulletin illustrates practical applications of the principles outlined by the previous bulletins of this series—namely, Nos. 230, 231 and 232. Attention is also called to Bull. 239, which relates to an improved type of forge furnace. The novel features of the furnace consist of means for better application of the heat, protection of the operator, and utilization of waste gases to preheat air and fuel for combustion.

THE ALBERGER CHEMICAL MACHINERY CO., New York, has issued Bulletins 34 and 36, on the Nelson filter presses and Alberger vertical mixers.

THE ENGINEERING MAGAZINE CO., New York City, in November, started publication of a new magazine known as *Industry Illustrated*.

THE STURTEVANT MILL CO., Boston, Mass., has made a new departure in the production of a catalog showing the use of Sturtevant equipment in the fertilizer industry. It has published a pretentious treatise entitled "The Modern Fertilizer Plant," covering every step in the production of fertilizer from rock phosphates. From the time the phosphate rock is received in box cars, from which it is removed by a power shovel, to the mechanical sacking and shipping of the finished product, every intermediate step is described and illustrated. Unquestionably this is one of the most complete treatments of an industrial process that has been covered in catalog form.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., has issued a new catalog on centrifugal pumps, catalog 108-C, which described construction details and fully illustrates the application of high-efficiency double suction pumps for every purpose. Single-stage horizontal and vertical shaft pumps and multi-rotor pumps are included. Of special interest are the illustrations of circulating pumps for condensers of all sizes. Several types are also shown for each of the other usual pumping services, many of special and unusual design. Methods are given for constructing the characteristic curves of a centrifugal pump at varying speeds where the characteristics are known for constant speed operation. Instructions are given for installing and operating centrifugal pumps and also many useful data for making calculations and writing specifications.

THE ELECTRO-REFRACTORIES CORP., Ellicott Sq., Buffalo, has issued a circular describing its new Tercod crucible which gives a list of the particular advantages such as high-conductivity, non-scalping, non-scaling, clean-pouring, etc.

Industrial Notes

THE RUBBER SERVICE LABORATORIES Co. appears in the list of new Ohio corporations. The incorporators are given as R. C. Hartong, C. W. Bedford, C. O. North and C. N. Hand, all formerly connected with the development department of the Goodyear Tire & Rubber Co. This concern will manufacture organic accelerators and other materials for the rubber trade and furnish free consultation service with its products, offering its entire staff for consultation, development and routine service to rubber and related industries. It will function as an auxiliary department to supplement the existing staff of its clients or to furnish such service to small rubber companies which do not maintain development departments. This service will be rendered on a highly ethical basis. It is not the policy of this company to "peddle formulas" or to disclose the secrets of its clients. It will develop formulas for specific uses or improve existing compounds, install new processes or modify old ones and aid in the development of suitable materials for the rubber trade in general. Manufacturers of raw materials, such as pigments, fillers or fluxes, will be interested in the availability of the service of this company. Many smaller rubber companies, and especially those just starting in the rubber business, will likewise welcome the prospect of obtaining expert advice without increase of overhead costs.

THE SEYMOUR CHEMICAL Co., Mount Morris, N. Y., at its recent annual meeting elected Howard I. Averill president. Other officers elected were: O. B. Dow, vice-president; W. T. Larkin, secretary and treasurer, and L. C. Donovan, foreman.

THE AMERICAN VITRIFIED CHINA MANUFACTURERS, East Liverpool, O., at its recent annual meeting elected the following officers for the ensuing year: President, C. E. Jackson, head of the Warwick China Co., Wheeling, W. Va.; vice-president, D. William Scammell, Maddock Pottery Co., Trenton, N. J.; secretary and treasurer, Arthur E. Mayer, head of the Mayer China Co., Beaver Falls, Pa.

THE DU PONT Co., of Wilmington, Del., at its recent stockholders meeting elected the following directors: H. F. Brown, H. E. Lackey, J. W. Elms, F. B. Davis, Jr., Hunter Grubb, W. F. Rascob, Fin Sparre and Clifford McIntyre.

THE STANDARD BRICK & TILE Co., Portland, Ore., has elected A. H. Wethey, Jr., president. Otis J. Fitch has been appointed sales manager for the company.

R. E. Clarke, formerly vice-president of the Seaboard Oil Co., New York, and F. W. Steadman, previously connected with the Carson Petroleum Co., have organized a new company under the name of CLARKE & STEADMAN, to engage in the oil business. Offices have been established in the Produce Exchange Bldg.

THE NICKLE ENGINEERING WORKS, Saginaw, Mich., manufacturer of agitator equipment for chemical tanks, has leased a portion of the Schemm Brewing Co. plant, 920 North Hamilton St., for machine shop purposes.

THE AMERICAN CREOSOTING Co., Louisville, Ky., is erecting a new plant for timber preserving at New Haven, Conn. This plant consists of a retort house with two cylinders 7 ft. in diameter and 150 ft. long, with the necessary pumping machinery and other required equipment. The boiler house will be a modern type of 600-boiler horsepower. In addition there will be large tie handling facilities. Contract arrangements have been entered into for the building of the plant and construction is now under way. The plant will be the last word in engineering design for tie treating. The product will be used chiefly by the New York, New Haven & Hartford R.R.

THE UNIFORM ADHESIVE Co., Brooklyn, N. Y., is now operating its new plant at Bush Terminal, producing glues, gums, pastes and adhesives. Dr. Jerome Alexander is president and Walter Alexander, vice-president.

THE QUIGLEY FURNACE SPECIALTIES Co., New York City, announces that it will be represented in the Chicago territory by H. M. Thompson, who was formerly identified with the Thomas Moulding Brick Co., who succeeds Bell & Gossett, former agents. Mr. Thompson will make his headquarters at 105 West Monroe Street, Chicago. It is also announced that the Federal Supply Co., East 79th Street, Cleveland, O., have been appointed representatives in that territory.

THE GREEN ENGINEERING Co., East Chicago, Ind., announces the opening of a direct branch sales office in suit 941, Monadnock Bldg., Chicago, Ill. The former agency representation has been discontinued in the Chicago district. J. W. Himmelsbach has been appointed district manager. P. Albert Poppenhusen, president of the company, will maintain an office at the Chicago address, while the general sales office will remain at the factory.

THE WILSON WELDER & METALS Co. announces the removal of its general offices and Bush Terminal factory to 132 King St., New York City. This company announces that the change has increased its facilities for service in certified plastic arc-welding metals by the installation of improved equipment.

THE CUTLER-HAMMER MFG. Co. has moved its Boston office from the Columbian Life Bldg. to Rooms 403 and 404, Harvey Bldg., Chancy St. C. W. Yerger is manager.

THE COMBUSTION ENGINEERING CORP. has opened a new branch office at 806 First National Bank Bldg., Pittsburgh, Pa., which will be in charge of W. C. Stripe, formerly manager of the Philadelphia office.

H. L. DICK, Chicago manager for Emil E. Lungwitz, has returned to Chicago after a six months' stay at the New York office of the company.

WESTINGHOUSE, CHURCH, KERR & Co.'s employees, to the number of 140, recently organized the "W. C. K. Association." The object of this organization is the maintenance of the friendship formed by its members during their years of service with Westinghouse, Church, Kerr & Co. The association meets every Wednesday for lunch between 12 and 1 o'clock at Zimmermann's restaurant, 108 Fulton St., New York City. The secretary, A. H. Tummel, 131 Warwick St., Brooklyn, N. Y., will be glad to hear from former employees who desire to join the association.

THE EXETER MACHINE WORKS, INC., West Pittston, Pa., has appointed J. E. Holveck district sales representative in the Pittsburgh district. Mr. Holveck was until recently connected with Crawford & Cameron of Pittsburgh, and was formerly designing engineer for the Aldrich Pump Co. of Allentown, Pa. This company also announces the appointment of the Allen Engineering Co. as sales agent for the Exeter rotary pump line in the Boston district.

THE ENGINEERING ADVERTISERS' ASSOCIATION of Chicago is now publishing a monthly bulletin in the interest of its members, giving a digest of the speeches made at the various meetings and other information and facts regarding the movement of goods from industry to industry, personal notes, etc. A limited number of extra copies of the "Bulletin" will be sent upon request to the advertising manager of concerns selling technical or engineering products.

THE MAHER ENGINEERING Co., Chicago, announces that C. B. Adams has been appointed vice-president and sales manager and C. H. Peterson has been appointed secretary-treasurer and general manager.

ALFRED M. BEST Co., insurance and advisory service, New York, announces the appointment of E. H. Seaman to take charge of its advisory and engineering departments. Mr. Seaman will direct all operations in the Eastern and Southern fields and will devote special attention to industrial plants with a view to reducing industrial waste and cost of insurance. He has specialized in fire protection and prevention for over 15 years in the United States and Canada.

The executors of the estate of JOHN C. WIARDA have sold the assets of the chemical manufacturing and jobbing business at 273 Green St., Brooklyn, N. Y., to Howard B. Bishop of 101 Park Ave., New York. Mr. Bishop is a chemical engineer and was for many years connected with the General Chemical Co. and the National Aniline & Chemical Co. The new management will continue the business under the name of John C. Wiarda & Co., Inc., and will enlarge and extend its manufacturing and jobbing facilities.

THE PITTSBURGH ELECTRIC FURNACE CORP., Pittsburgh, Pa., announces that A. D. Keene, formerly electric furnace engineer of the General Electric Co., Schenectady, N. Y., is now connected with it as engineer on electric furnace designs and applications in the steel and metal industries. Mr. Keene has moved his residence from Schenectady to Pittsburgh, Pa.

THE UNITED CHEMICAL & ORGANIC PRODUCTS Co., formerly at 217 Broadway, have moved to larger quarters at 401 East 45th St., New York City.

THE WHITING CORP., Harvey, Ill., has purchased a controlling interest in the Grindle Fuel Equipment Co., manufacturer of complete powdered coal plants for use in connection with malleable furnaces, annealing ovens, steam boilers, billet heating and various other types of furnaces. The Grindle Fuel Equipment Co. has moved its offices to Harvey, Ill., and will continue its business under the same name; the Whiting Corp. will manufacture all Grindle equipment. The following officers have been elected: President, B. H. Whiting; secretary and treasurer, T. S. Hammond; vice-president and general manager, A. J. Grindle. The members of the board of directors are as follows: J. H. Whiting, B. H. Whiting, A. J. Grindle, R. H. Bourne, N. S. Lawrence and A. H. McDougall.

JOHN T. HARRIS, of the Chicago office of the Allbright-Nell Co., transferred his activities to 829 New York Life Bldg., Kansas City, Mo., where he will act as Southwestern representative of the company.

LIPPINCOTT, MILL & Co., INC., has been granted a New York charter to deal in coal, coke, ores, scrap, iron and steel products and ferro-alloys, and to do a general importing and exporting business. The new company has offices at 17 Battery Pl., New York, and in the Hippodrome Bldg., Cleveland. G. W. Lippincott, head of Lippincott & Co., wholesale coal dealers, Hippodrome Bldg., Cleveland, is president. William H. Mills, New York, who retired 3 years ago as president of Naylor & Co. after a connection of 38 years with that interest, is vice-president and treasurer. A. L. Irwin, of Lippincott & Co., Cleveland, is vice-president. P. L. Smith, New York, for 19 years identified with Naylor & Co., resigned as assistant to the president and director of that company to become secretary of Lippincott, Mills & Co., Inc.

THE PEERLESS WIRE FENCE Co., with headquarters at Adrian, Mich., has acquired property at Memphis, Tenn., for the installation of a wire fence-manufacturing plant. Eleven weaving machines have been installed to date, and a shipment of 250 tons of wire is en route to the plant. This capacity will be doubled within the year. P. E. Underhill will have charge of the new plant, which is located at 1051 Florida Street.

ORTON & STEINBRENNER Co. of Chicago, manufacturer of locomotive cranes, clam and orange-peel buckets, has appointed the F. E. Richmond Machinery Co., 117 West Second St., Salt Lake City, Utah, as its Western agent.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN WOOD PRESERVERS ASSOCIATION will hold its annual meeting Jan. 24, 25 and 26 at the Hotel Sherman, Chicago, Ill.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

PERKIN MEDAL will be presented to William M. Burton by the Society of Chemical Industry at its meeting Jan. 13 at the Chemists' Club, New York.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Naval Influence in Abolishing Chemical Warfare

NEWS from Washington is gradually illuminating the report of the Advisory Committee to the Disarmament Conference recommending the abolition of chemical warfare. This report has always been more or less of a mystery to us because we knew that the Advisory Committee numbered among its members such men as General PERSHING, Secretary HOOVER, Senator SUTHERLAND and Governor PARKER of Louisiana. We felt that the favorable influence of General PERSHING could be counted upon, because he went on record strongly before the House Committee on Military Affairs in favor of the establishment of a chemical warfare division of the Army. The other members named we knew to have sane views on the impracticability of outlawing chemical warfare, although we felt that they might be too busy to give the subject much attetnion. Hence it was with surprise that we heard the first rumor that the Advisory Committee had resolved to recommend abolition of gas warfare. Rumors have also been afloat to the effect that the report was railroaded through the committee, and some color is lent to this statement from the fact that after the report was first submitted to Secretary HUGHES it is said to have been recalled for further consideration.

It appears now that friends of the battleship exercised considerable influence with the Advisory Committee and helped to determine its action. This is unfortunate, if true, because the Navy stands as a prejudiced party when chemical warfare is under consideration. Ever since it was demonstrated last summer that capital ships were likely to prove no match for a combination of chemical warfare and the aviation service, the Navy has shown animosity toward gas warfare. But our objection lies deeper than this. Comparatively speaking, the Navy knows little about chemistry—far less than the Army. The latter has made great strides in the application of chemistry in the solution of its problems and it appreciates chemists and their services. In these two respects the Navy has shown few signs of progress and some evidence of a reactionary spirit. Its chemists are on a per diem basis and are classified with "clerical, drafting, inspection, watchmen and messenger service."

Viewed in this light, it is hardly fair, as reported, that naval influence should be powerful enough with the Advisory Committee to influence its action. We have already expressed our feeling that the Disarmament Conference made a mistake in adopting this resolution, and we still express the hope that when the time comes for ratification of treaties the Senate may be persuaded to dissent.

It may be argued that the Advisory Committee can take refuge in the results of its survey to discover popular opinion on the questions brought before the Disarmament Conference. The statistics are interesting, indeed startling, but in our judgment they are without practical value. They are utterly discordant and irrelevant and show no constructive thought. There is evidence of voting by organizations and societies, many of which may have had predetermined partisan purposes. Thus while only 220,896 actual signatures were received, there was a vote of 1,093,535 for an association of nations. For open sessions of the Conference there were 1,056,499 votes; and we know that open sessions as popularly conceived were impracticable. Only 5,499 thought that Far Eastern questions should be considered, and yet these were of the utmost importance in their influence for war or peace within the next generation. As many as 395,104 votes favored abolition of submarines, but the Conference merely limited their use in warfare and did not abolish them. So we are not impressed with a vote of 366,795 for abolition of gas warfare. The figures merely reflect uninformed opinion on the part of a selected group.

Will the Industries Absorb Chemical Graduates?

IN HIS recent speech before the Chicago Section of the A.C.S., Dr. JOHN JOHNSON of Yale University stated that the electrical industry is the only industry in the United States well supplied with technically trained men in executive positions. While he did not enlarge upon this comparison of the electrical industry with the chemical and process industries, it may be advantageous to study the personnel conditions in each field.

About 20 years ago, when the electrical industry was in the more scientific stage of development and many questions of technology were being settled, involving need for research in physics, electrochemistry and new engineering design, men like STEINMETZ, EDISON and WHITNEY received much publicity about their accomplishments. Electricity was coming into wider use, and construction and operating men were becoming known for their work over the whole country. As a consequence there was a rush on the part of high school graduates to our universities demanding education in this field so fertile for individual progress. When they began to finish courses in electrical engineering the profession was thought to be overcrowded. It was in fact so far as opportunities for pure engineering were concerned, for the standards of design were rapidly being established.

The industrial folks, however, were not found sleeping. Taking cognizance of the situation, such manufacturers as the General Electric Co., the Westinghouse Co. and, in the public utility field, the Cities Service Co., arranged to take graduates into their testing departments where pure engineering with study of apparatus is involved. Here at the rate of hundreds per year they were

gradually educated to appreciate the many phases of the electrical business and finally tempted into production, sales and management. They were allowed to choose the branch most suited to individual temperament.

Not a few remained active in the pure engineering phase of the work, but the majority by reason of birth and home training found a natural taste for the business phases. As a result the industry has become saturated with technically trained men. The manufacturers naturally welcome the final graduation from the manufacturing side and the entry of these men into public utility service as managers and operating chiefs with customer companies. While the manufacturer has turned a deserved business advantage for himself, he has by the same policy performed a great service to the electrical industry.

The chemical industries are now in a position approximating that of the electrical industry when the education of the student for the field was undertaken. Many chemically trained men are coming through the universities each year. The chemical industries, including manufacturers of fine and heavy chemicals, coal-tar products, dyes, explosives, electrochemical products, fertilizers, alcohol, etc., must take these men and turn them into paths where they are greatly needed.

Nor may the manufacturer stop by obtaining men for his own particular work. He should turn out men for his customers, the process industries where chemical control is essential. For the makers of animal products, plant products, soap, sugar, food products, leather, paper, etc., including about twenty major fields, are the customers of the chemical manufacturer and in some cases must be educated to the consideration of technology.

No one is better suited to do this work and can profit more in the doing than the manufacturer of chemicals. The greatest good may come to American business if these graduate chemists be saved from throwing over their profession in disgust.

Coal and Coke In 1921

THE first weekly report on coal production from the United States Geological Survey for this calendar year is of particular interest because it gives preliminary estimates of the production of bituminous coal, anthracite coal and beehive coke for the year 1921. These figures for coal indicate just what one would expect—namely, that the production of bituminous coal has been very low, in fact distinctly lower than any previous year since 1911. This is a natural result of the depressed business conditions of the period, and it would have been possible only under such conditions. As would be expected, the anthracite production has been about the same as for the decade past, since this coal represents principally domestic fuel demands and is largely unaffected by business conditions of the country.

The total coke production of the country is estimated as approximately 26,000,000 tons—in other words, much less than during the previous ten-year period, but a large proportion of the decrease from the years immediately preceding was caused by the decrease in beehive and the relatively small part of the decrease was caused by the diminution in byproduct coke output, large though this latter decrease was.

The most encouraging point in the year's summary is the fact that it was primarily the output of beehive coke which was so much lower than for many years past. In fact it decreased by 74 per cent from the output of 1920, and was only about one-seventh of that of 1916, during which year the beehive coke industry reached "the high point of prosperity." To find a year when production was as low as during 1921 one must go back to 1885, when practically the same quantity of beehive coke was produced—namely, a trifle over 5,000,000 tons.

It is a splendid condition of industry that permits the fluctuation thus to occur almost altogether in the wasteful and inefficient branch of industry and permits the more efficient portion to continue to function at higher rates despite the decrease in total business.

Speaking Of Thrift

THIS week we celebrate the anniversary of BENJAMIN FRANKLIN'S birth, and we are all urged to give consideration to the cultivation of habits of thrift. Why is it that when anybody tells us to save our money we resent it. Of course, we want everybody to understand that we know how to manage our own affairs, whether we do or not, but we are especially sensitive to advice about saving. Indeed, the more we need to save the less we like to hear about it. We like to think, and indeed the less intelligent of our number continually do cry, that to save is a virtue that the very stupidest may practice. Then, when our wits have left us entirely, we like to chuckle over the idea that rules for dullards do not apply to us.

We venture the belief that the fault is in the capsule and not in the medicine. We should save; it is a good thing to do it, and it is bad for us as well as for the general welfare to waste our substance; to throw away uselessly what we have earned. It should not be an offense to urge us to save. It does not offend to urge us to read philosophy or history, for instance. If someone says of SUMNER'S "Folkways," "It is hard reading, but meaty; you will enjoy it," it flatters our vanity; it indicates that we can understand what others cannot. Then why not appeal to vanity or at least to self-respect in urging people to save?

Consider the Hearst newspapers, edited for the lowest orders of intellect that can read at all. And yet the billboards declare that, for instance, the New York *American* is "A Newspaper for Men Who Think." A glance at the physiognomies of the readers of the Hearst newspapers in street cars discourages belief in the statement—but not among the readers. They think they think. Everyone thinks he thinks.

Now the facts about saving do not coincide with the usual advice. The ability to save is not as common as dirt. It takes intelligence to save, and to be able to do so is a gift. Whoever can practice the art may be stupid in regard to descriptive geometry or physical chemistry or the music of such modern composers as MAX REGER, or SCHOENBERG, but he is not feeble minded in regard to saving. We are all feeble minded in one respect or another, but the all-round feeble-minded person cannot save. And yet so much emphasis has been laid on the thrifty dunderhead that the impression has gained ground that only the imbecile are provident.

The idea is totally wrong. The half-wit may hoard a few dollars from some remaining instinct that he cannot explain, but in ninety-nine cases out of a hundred it is soon wasted. It takes long-range vision to save. It does not call for self-denial or Pollyanna goodness. It calls for a look ahead long enough to see between a

present fancy and a greater purpose. It calls for ability and character and a certain sporty quality to stick to a purpose. If we want to refer to persons who work with their hands or who do not wear expensive clothes as "the plain people," why not discriminate between those who can save and those who cannot? They are different. The savers are better and more able in this respect, and they deserve credit for it. Why not give it to them? They will respond, and many of them will even read "Folkways." Then, when they have read that book, they will not read yellow newspapers that strive to make their readers angry in order to keep their attention. The savers will prefer constructive literature that induces human progress.

The Distribution Of Steel Consumption

A STUDY of the greatly varying rate at which steel has been produced in the past 13 or 14 months and of the accumulation and liquidation of stocks of steel and of manufactured goods made from steel indicates that there has probably been but slight variation in the rate of actual ultimate consumption of steel since the collapse of the high-pressure demand in the steel market late in 1920. Such a conclusion is reassuring both to the steel-making industry and to business generally. When, last July, the production of steel ingots dropped to a rate just one-fourth the average rate in the first 9 months of 1920, the steel makers were more or less alarmed. Before the war there had been a tradition, supported by actual experience, that the "hard times" or irreducible minimum of steel demand was fairly definite, commonly designated as 50 per cent of capacity.

Without going into details, it may be stated that without any strain of the imagination it can be conceived that the ultimate consumption of steel and steel products has been fairly uniform since late in 1920. The steel consumed is represented by a steel ingot production at the rate of 22,000,000 tons a year, which is the rate at which steel was produced during the last 3 months of 1921. The theory before the war was that it required a certain amount of steel simply to keep the country going, while whenever the country was expanding its facilities, a great deal more steel would be required, for almost any kind of industrial or commercial expansion involves putting steel into employment, chiefly in what is called "investment construction."

Unfortunately it is impossible, except by an amount of work that nobody seems willing to undertake, to make an exact analysis, either for a year or a period of years, of where the steel we make actually goes for the purpose of performing its ultimate service, but rough approximations are by no means difficult. Certain lines of consumption are seen to be relatively stable. Judged by present prospects and by the actual record of the past half dozen years, the largest steady customer of the steel industry is the oil trade. For maintaining the production of petroleum about a million gross tons annually of steel tubular goods is required, with considerable quantities of other steel, particularly of plates for storage tanks. Apparently insignificant from the tonnage standpoint, tin plate can be counted upon to involve about one and a half million gross tons. There have been two "off" years recently in tin plate—1919 on account of stocks of about 8,000,000 boxes on Nov. 1; 1918 a safeguard in connection with the war, and 1921 on account of stocks of prepared goods which the public would not buy at the prices originally asked. The automobile industry is a steadier consumer of steel than is commonly supposed. It is not generally realized that beginning with 1916 the production of passenger automobiles other than Fords has not varied very greatly and has not materially increased. The production of Fords has increased sharply. The consumption of rolled steel in automobile building is, however, scarcely 750,000 gross tons a year, so this is a minor item compared with tin plate or the steel used by the petroleum industry.

The cases mentioned above are of regular consumption, merely that the country may keep going. In many lines both upkeep and expansion are involved. In railroading, for instance, it requires about 1,500,000 tons of rails a year for replacements, while additional rails are required when new track is laid.

The year 1921 furnished a crucial test. There was very little steel consumed that did not absolutely have to be consumed, and the steel industry is now furnished with a measure of the amount of backlog business it can count on with practical certainty, this to be added to by such expansion and progress as financial and commercial conditions may warrant from time to time.

Omnia Mutantur Nos et Mutamur in Illis

LATELY we saw a note made by Dr. CHARLES BASKERVILLE in his diary at the Pittsburgh meeting of the American Chemical Society in 1902. Dr. IRA REMSEN was in the chair as president, and Dr. THEODORE W. RICHARDS had presented a paper on "The Compressibility of the Atom." As soon as he sat down "a very well-dressed chap arose and said, 'I have a machine here with which you may see the millions of atoms in rapid motion.' REMSEN promptly declared, 'There being no discussion of the paper, I shall call on —— [the author of the next paper on the program] for his communication.' The individual referred to slapped the top down, picked up his books, jammed his hat upon his head, and marched off in a huff. REMSEN then remarked: 'I must apologize to the Society for my abrupt method of shutting off discussion of Professor RICHARDS' excellent paper, but subsequent events apparently have verified my diagnosis.' "

In the margin was a note made by the diarist many years afterward: "Could this have been an ultra-microscope, and was R's mind closed to such a conception?" Maybe so; maybe so. But were not the minds of most of us closed to such a conception—only 19 years ago? We should also like to know who the "well-dressed chap" was. We can think of one who might have been he who thought he had a machine in which he could see atoms—and may really have had it—but the fact that the person was well dressed rules out our candidate.

Without question we are living in darkness even today. What is, then, the specific feature of our ignorance that hides the light from us? Is it because we know so little of isotopes? Is it because we lack the shepherd's art of herding electrons? Or because our sense of positive electric charges is so hazy? Will IRVING LANGMUIR rob us of our benzene ring?

Without a doubt both you and I
Will be regarded, by and by,
As very odd and very queer
By all the people living here.

Old and archaic we shall be;
They'll say we lived so curiously.
They'll wonder at our negligence
And why we hadn't better sense.

Perkin Medal Is Presented to William M. Burton

The Discoverer of the Burton Process of Cracking Petroleum Distillates Receives the Fifteenth Award of the Society of Chemical Industry—Addresses by Officers and Prominent Members of the Society—Presentation by C. F. Chandler and Acceptance Address of William M. Burton

PRESENTATION of the fifteenth Perkin Medal to be awarded by the American Section of the Society of Chemical Industry for meritorious accomplishments in applied chemistry took place in Rumford Hall, New York City, on Friday, Jan. 13. The medalist was William M. Burton, president of the Standard Oil Co. of Indiana and famous for the discovery and large-scale development of the Burton process of cracking petroleum distillates. Seldom, if ever, in the history of the Society has the Perkin Medal been awarded under such auspicious circumstances nor to an investigator whose work has so profoundly affected one of the country's great industries.

In the course of his introductory remarks the chairman, Sumner R. Church, called attention to the distinguished presence of all of the four past presidents of the American section. With considerable regret, however, he announced that Dr. R. F. Ruttan, present head of the Society of Chemical Industry, had been prevented from attending the presentation meeting because of a severe physical disability.

Reminiscences by Dr. Remsen

The first speaker to be introduced was Prof. Ira Remsen, often called the "father of chemistry in America." In his characteristic manner he gave a most interesting and intimate insight into the life and work of Dr. Burton. He recounted many personal reminiscences of his early association with his former student who was then continuing his graduate studies in the laboratories of Johns Hopkins. The investigations at that time were into the realms of pure science and, with his usual good-natured humor, Dr. Remsen chided the medalist for deserting the rôle of the scientist and entering into the executive side of industry.

The formal addresses of the other speakers are presented, either in full or in abstracted form, in the following pages.

The Personal Side of Dr. Burton

By Charles H. Herty

The charm of biography persists always. The results of a successful man's work are set forth in the public record, whether it be in the form of scientific publications, of official status, of some great engineering feat, of the size of his income tax, or what not. Back of the life accomplishment, however, is the personality of a human being who, following the bent of his own genius, has triumphed over the difficulties which beset us all.

What manner of man did it? That is the question which kindles a different kind of interest from that due to a knowledge of what the accomplishment is. For out of such studies of many types of men we gain here and there suggestions, self-applicable, which help us over our own rough spots and give us hope.

In the case of Dr. Burton, or "'Billy," as he was called by us in student days at Johns Hopkins University, there is added another to the long list of successful men who were born in the country and passed their early days entirely ignorant of cement sidewalks. What a pity we couldn't all have persuaded our parents to move out to the country before we were born. At any rate, it was Billy's good luck to enter the world under such favoring circumstances in the year 1865. In 1886 he was graduated from Western Reserve University, receiving the A.B. degree. The next 3 years were spent at Johns Hopkins University, from which institution in 1889 he received the Ph.D. degree.

A Normal Individual

It is peculiarly fitting that the Perkin Medal should be awarded to him in this the first year of President Harding's administration, for right well does he represent the return to normalcy, all of his friends to whom I have written emphasizing the fact that from boyhood to the present time he has always been a normal individual. He has cultivated no particular hobby, considered by many to be essential to distinction, but has carried through life a love of experiment and an ardent zest for the lathe and mechanical tools. It is easy to understand, therefore, that in the environment in which he has worked he not only succeeded in cracking oil but carried the work on to a successful large-scale application.

He plays no outdoor games, not even golf. This sounds abnormal, but to offset it he recently obtained keenest satisfaction in installing in his home under his personal direction a radiator system at one-fifth the estimate furnished by a contractor, and who wouldn't rejoice at getting the best of a plumber? I insist he is normal.

The Significance of His Success

Steadily he has been advanced in that company with which he began work after completing his university training, until today he occupies the presidency. Throughout this advancement he has remained the same sincere, sympathetic, level-headed man to whom his friends and associates come with their problems for his sound advice.

That he has worthily won this great honor from his associates in business all agree, that throughout it all he has preserved his unaffected selflessness all will rejoice; but there is another aspect of his success which deserves not only record here but wide heralding at this stage in the development of American chemical industries. The industry with which he is connected is one of our early and now thoroughly stabilized industries, and it is peculiarly worthy of note that the Standard Oil Company of Indiana has chosen for its chief executive the chemist. Not all chemists are qualified to be executives, but certainly our chemical industries will be placed on a much sounder basis when the chemist of proper qualifications is given opportunity to share in the determination of corporate policies. Billy Burton's record may yet prove the harbinger of a new day.

The Chemist in Industry

Dr. Burton's monumental work in the oil industry was fittingly reviewed by one of his associates, Russell Wiles, patent adviser of the Standard Oil Company of Indiana, who chose for the subject of his address "The Chemist in Industry." It is only within the last few years, he declared, that the chemist has contributed his proper share to industrial progress. "Much has been done in chemistry as a pure science, but it is within comparatively recent years that the chemist has emerged from his laboratory and that industry, as a whole, has felt the need of close co-operation with him. Where 10 years ago big practical applications of chemistry were rare or confined to a few specialized industries, today there is scarcely an industry which has not been more or less affected by the progress of chemical science. Chemical inventions, at least as exemplified in my own practice, are at least ten times as numerous as they were a decade ago.

"The work of Dr. Burton, which is being so fittingly recognized, may well be regarded as rather an early example of the great things the chemist is to accomplish in the future than as an achievement which is to be unique in history. Bringing a thoroughly scientific point of view and applying to his problems the methods of pure science, with his great natural ability and indefatigable industry, it was entirely unavoidable that Dr. Burton should profoundly affect the petroleum industry in one way if not in another. No man has ever had a more promising field—an enormous industry dealing with problems which ought to be handled in an essentially chemical manner and having no chemists at all. Dr. Burton would be the first to recognize his splendid opportunity, and it is characteristic of him that his opportunity never was neglected.

Production on a Scientific Basis

"But Dr. Burton alone never could have accomplished what has been done by the Standard Oil Co. of Indiana. There has been much discussion in big corporations as to the best method of correlating the scientific force with the manufacturing force. All sorts of experiments have been attempted and all sorts of systems have been devised. The system worked out by the Standard Oil Co. of Indiana, largely at the instigation of Dr. Burton and of recent years under his guidance, is unique and amazingly successful. None but a scientifically trained man would have dreamed of such a system and the operations of the Indiana company are the best demonstration of the industrial value of scientific training.

"The system of this company is founded on the premise that a scientifically trained man is a good man for any job; the scientific staff does not co-operate with the manufacturing staff—it has become the manufacturing staff. The practice, so far as concerns chemists, has been to take on trained men for the laboratory force precisely as in many other plants. After brief association with the laboratory, during which the newcomer can become familiar with the peculiar problems of the works and particularly of some special department to whose problems he is assigned, he leaves the laboratory and goes into the works in some subordinate capacity. It then becomes his prime duty to test, on a practical scale, whatever improvements may fall within the sphere of his department. Having once become established in the works, it has been found that almost without exception the technical men become excellent executives and their promotion is rapid.

"The result is that the manufacturing department of the Standard Oil Co. not only maintains an excellent research department, but that the whole manufacturing organization from top to bottom is largely dominated and controlled by men of scientific training. The Standard Oil Co. of Indiana is unique in this regard, and the tremendous success of its manufacturing department must be very largely attributed to the superb organization which Dr. Burton conceived and has built."

The Burton Process

After showing how thoroughly this system has been applied in the Whiting refinery, which is the largest plant of the company, Mr. Wiles turned his attention to the industrial significance of the Burton process.

"No industry was ever so profoundly modified by any process as the oil business has been modified by this process. How profoundly the Burton process has affected the refining practice in plants where it is in full operation can never be thoroughly comprehended by one outside of the industry. There are, however, some points which might be overlooked which are illustrative.

"The Burton process has more than doubled the yield of gasoline from a given quantity of crude run. Practically, this means that a given quantity of crude oil supplies twice as many engines with fuel. But these engines have to be lubricated, the cars they propel have to be provided with grease, and the very road surfaces upon which they run have to be provided with asphalt. The increased supply of gasoline has enormously increased the demand for these other products, and, at the same time, the normal increase in demand for other petroleum products, such as wax, petroleum jelly, etc., has been greatly augmented, as might be expected with the increase in population.

"The problem of finding the increased supplies of all these commodities, when more than twice as much of the crude oil run is going into gasoline, has been extremely serious. Indeed, at times, some oil refineries have been essentially on a lubricant basis—i.e., the amount of crude run was determined primarily by the lubricants demand instead of the gasoline demand, but the ingenuity of the scientific staff has proved itself entirely equal to the problem. Running methods throughout the plants have become modified in one way and another to produce all the needed products in quantities so balanced as to meet the market demands, but the practical working out of the Burton process by no means has consisted in setting up the Burton stills and running them as a side line or excrescence of the refinery. The entire operation of the refinery has had to be readjusted fundamentally to co-operate with the pressure still plant.

"And it may be added that the profound shift in the ratio in which products are being produced and the practical withdrawal by the Standard Oil Co. of Indiana of gas and fuel oil from the market has very profoundly modified marketing methods. The full extent to which the changes in marketing methods, largely caused by the existence of the Burton process, may affect this and other industries in the future is problematical. The new problem was met satisfactorily but in a manner which may have far-reaching future consequences."

In concluding his address, Mr. Wiles paid tribute to his associate in the following words: "In extending to William M. Burton this highest honor in your power, you honor one who has brought honor and credit to your profession, a scientist of scholarly ideals and high at-

tainments, an organizer of broad vision and confident faith in the future, an efficient and successful executive and, perhaps greatest of all, a leader of men. Dr. Burton asks nothing of his men which he is not capable of doing himself. His greatest tribute, greater far than any award for scientific attainments, is the affectionate regard of those with whom he has worked for so many years and who know him best. Our greatest rewards are not degrees, or diplomas, medals or decorations, but the esteem and affection of our associates. These Dr. Burton has long had in abundant measure.

"But in honoring him you celebrate a great achievement of your own great profession. May this be only one of a host of like achievements which you have reason to recognize. May these awards, from year to year, mark equally great gifts to human knowledge and human comfort. The day of the chemist is here. You hold the future of industry."

Presentation Address

BY C. F. CHANDLER

It is my privilege and very pleasant duty, as senior past-president of the Society of Chemical Industry residing in this country, to present to William Meriam Burton, A.B. and Ph.D., this fifteenth impression of the Perkin Medal, in recognition of his most original and valuable work in applied chemistry.

Dr. Burton was born at Cleveland, Ohio, on Nov. 17, 1865. He was graduated at the Western Reserve University in 1886 with the degree of A.B. Subsequently he attended the Johns Hopkins University, taking the major course in chemistry under Prof. Ira Remsen, receiving the degree of Ph.D. in 1889. His papers published at this time in the *American Chemical Journal* attracted favorable attention in scientific circles.

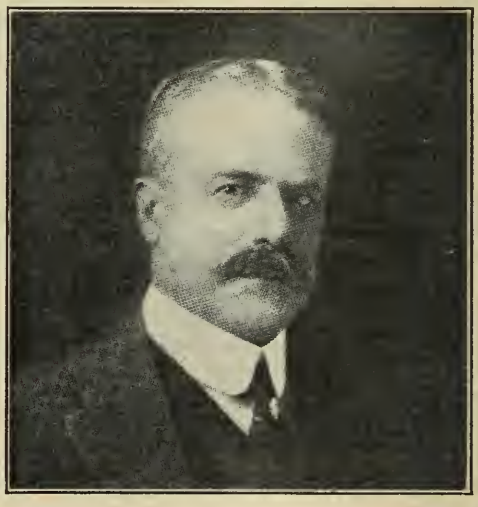
Soon after graduating he was engaged as chemist, in 1889, by the Standard Oil Co. at Cleveland, Ohio, to assist in a process for refining the sulphur-bearing petroleum from the neighborhood of Lima, Ohio. In 1890 he was transferred to the Standard Oil Co. of Indiana, where he served as chemist. In 1892 he was appointed assistant superintendent of the works, serving in this capacity until 1895, when he was made general superintendent. In 1911 he was elected director, in 1915 vice-president, and in 1918 president, which latter position he still holds.

My acquaintance with Dr. Burton began in November, 1895. At that time there was a rumor in Germany that the Standard Oil Co. reserved the pure Pennsylvania oil for the American market and sent the foul-smelling, sulphur-bearing oil from Ohio, Illinois and Indiana to Germany. It was further rumored that the German Government was contemplating forbidding the importation of this oil.

It was quite true that this Ohio oil contained from ¾ to 1 per cent of sulphur, and that when it was fractioned in the usual way, the fractions all carried portions of this sulphur and were offensive and unsuitable for the customary purposes. This was also true of the Canadian petroleum. But Herman Frash began the search for practical methods of removing this sulphur in 1885, at his Empire Company refinery at London, Ont., applying for his first patent in 1887, and by the end of 1894 had applied for twenty patents in this connection. His oxide of copper treatment applied to the usual fractions was a complete success and came promptly into use. So that the Ohio oil was in every way fully equal in purity and value to the Pennsylvania oil.

Fearing that the German Government might adopt some adverse legislation which it might be difficult to get repealed, the Standard Oil Co. requested me to go to Berlin and convince the government that there was no objection whatever to Ohio oil. In order to be thoroughly informed, I visited and carefully inspected several of the refineries of the company—namely, Olean, Lima and Philadelphia. I found Dr. Burton in charge of the Lima works, and spent a day with him. He interested me so much that I proposed that he should go with me to Berlin, to confer with the government officers.

Late in November we sailed for England and made our way to Bremen, where we consulted with the German representatives of the Standard Oil Co. We then went to Berlin and consulted with representatives of the company there. Our interview with Count Posidowski, the Imperial Minister of the Interior, was entirely satisfactory. He willingly accepted the evidence we presented and all danger of adverse legislation disappeared. For the purpose of strengthening our position we then visited the Imperial Health Department, and the two petroleum experts, Professor Engler in



WILLIAM MERIAM BURTON

Carlsruhe and Professor Louge in Zurich. We had no difficulty in satisfying all these authorities that Ohio oil was in no way inferior to Pennsylvania oil.

Thus I had the pleasure of associating with Dr. Burton on the most intimate terms for nearly 2 months and we became the best of friends. Ever since he became connected with the Standard Oil Co. in 1889 he has devoted his attention to the improvement of methods and means for converting the crude oil into the most valuable products, in the most economical manner, but his methods have rarely appeared in print.

His Great Invention

Dr. Burton's great invention, which ranks with the manufacture of oil from coal, the boring into the earth for oil by Colonel Drake, the elimination of sulphur from the Canadian and Ohio oils by Frash, was his process for distilling the heavy, high-boiling fuel and gas oil fraction and lubricating oils under high pressure, at a high temperature, in order to convert them into light, low-boiling gasoline.

In the earlier years the production of light oils, gasoline, naphtha, etc., in the fractioning of crude petro-

leum, exceeded the demand. Fifty years ago the wholesale price of refined burning oil was 25c. per gal., while the light oil, under the name of naphtha, was offered at 5c. a gal. Unscrupulous retailers bought both, and mixing them, facilitated "kerosene accidents." The last year before this condition of the oil trade was made public through the New York City Board of Health, there were fifty-two deaths, chiefly of women and children, in New York City caused by kerosene accidents. But with the introduction of the internal combustion engine and the appearance of automobiles, motor cars, trucks, etc., the demand for gasoline has far outstripped the supply.

Dr. Burton promptly attacked this problem of increasing the supply by converting the heavy, high-boiling oils into gasoline, by distilling them under great pressure at a very high temperature. It really seemed an impossible problem on account of the dangers of explosion. But Dr. Burton triumphed, and at the present time very large quantities of gasoline are supplied by this process, and the quantity may be largely increased as the process is more extensively adopted.

I have not gone into details with regard to the process, because I am to be followed by the inventor himself. Incidentally I may add that a valuable variety of asphalt is produced as a byproduct from the cracking of the distillates of the crude petroleum, used in Burton's process of cracking into gasoline.

Dr. Burton received the Willard Gibbs Medal,[1] May 17, 1918, at the meeting of the Chicago Section of the American Chemical Society, in recognition of his distinguished work in petroleum chemistry.

The following articles were published by Dr. Burton, in the *American Chemical Journal,* vol. 11, 1889:

"On the Crystal Form of Metallic Zinc," by George H. Williams and William M. Burton, page 219.

"On the Action of Dilute Acids on Benzoic Sulphinide and the Analysis of Commercial Saccharin," by Ira Remsen and William M. Burton, page 403.

"A Rapid Method for the Estimation of Sulphur in Organic Compounds," by William M. Burton, page 472.

In the *American Chemical Journal,* vol. 12, 1890, were published:

"A Method for the Detection and Estimation of Petroleum in Oil of Turpentine, by William M. Burton, page 102.

"The Atomic Weight of Magnesium, as Determined by the Composition of Its Oxide," by William M. Burton and L. D. Vorce, page 219.

U. S. PATENTS ISSUED TO DR. BURTON

Date of Application	Date of Issue	Number	Title
1904, Aug. 12	1904, Oct. 11	772,129	Process of making hydroxy stearic acid
1912, July 3	1913, Jan. 7	1,049,667	Manufacture of gasoline
1912, Sept. 23	1913, Mar. 11	1,055,707	Process of producing asphalt
1913, Aug. 25	1914, Aug. 4	1,105,961	Manufacture of gasoline
1914, Jan. 21	1914, Sept. 29	1,112,113	Process for producing wax from other hydrocarbons
1915, Jan. 23	1915, Nov. 16	1,160,689	Method of safeguarding stills
1915, Feb. 20	1916, Jan. 11	1,167,384	Petroleum products
1916, Nov. 28*	1920, June 15	1,343,674	Distillation of petroleum oils

* Humphreys and Burton.

Conferring the Medal

William Meriam Burton, Bachelor of Arts and Doctor of Philosophy: It gives me the greatest pleasure, as the representative of the Affiliated Chemical and Electrochemical Societies of America, to place in your hands this beautiful Perkin Medal, as a token of the appreciation and affection of your fellow chemists.

[1] See Met. & Chem. Eng., vol. 18, No. 12, p. 647, June 15, 1918.

Address of Acceptance

By William M. Burton

The notification from your secretary, Dr. Rogers, that I had been appointed as a recipient of the Perkin Medal came to me as a most unexpected but happy surprise. The awarding of the Willard Gibbs Medal to me in 1918 would seem to be sufficient recognition, on the part of American chemists, of the industrial work that has been done under my direction; and now comes this additional honor and distinction. I appreciate in the highest degree the compliment this medal conveys, and I hasten to express my most sincere thanks to the members of the awarding committee and to the societies they represent.

The work done under my direction which has perhaps attracted the most attention was carried on principally in the laboratory and refinery of the Standard Oil Co. at Whiting, Ind., a suburb of Chicago, and consisted in devising ways and means for the practical conversion of high-boiling fractions of petroleum into low-boiling fractions in such a way as to insure substantial yields of suitable products with a minimum loss and at a reasonable expense.

The Problem of Motor Fuel

The problem became imperative with the advent of the internal combustion engine about 15 years ago. The most commonly known example of such an engine is, of course, the automobile motor, which, as constructed today, requires a fuel that evaporates at comparatively low temperature, has a high heat value expressed in British thermal units, burns without leaving objectionable residues, does not possess an objectionable odor, is low priced and can be produced in large quantities. Benzene, toluene and alcohol are fairly well suited for the purpose, but their cost and their small volume of production render them largely unavailable.

The low-boiling fractions of petroleum naturally come into use for this purpose, and up to about 1910 the supply of this fuel was sufficient to meet the demand. In fact, the automobile provided an outlet for the sale of these products, which to some extent had been a drug on the market in the oil world. The older refiners in the country will remember when these so-called naphtha products were thrown away and permitted to run down the streams adjacent to the refineries, thereby causing a willful waste and a fire menace to the neighborhood.

Prior to 1910 the average yield of naphtha or gasoline products from crude oil in the United States was about 11 per cent. This yield represented only the amount of such products (of the quality desired at that time) normally present in the crude petroleum and capable of being separated by ordinary methods of distillation at atmospheric pressure. Furthermore, this small yield was sufficient to furnish all that was needed for gasoline stoves and other industrial purposes prior to the use of the internal combustion engine for transportation purposes.

When the automobile came into general use, however, it was perfectly clear that the normal yield of naphtha products suitable for fuel in self-propelled vehicles would not be nearly enough. At that time our refineries were selling about 40 per cent of the products of crude oil for use as fuel and for gas-making purposes in lieu of coal. The remaining 60 per cent represented the normal yield of naphtha and gasoline, illuminating and lubricating oils.

The above-mentioned 40 per cent fuel and gas oil comprised fractions boiling between 225 and 375 deg. C. These oils could, if necessary, be withdrawn from the market, and our problem was to convert them so far as possible into fractions boiling between 40 and 200 deg. C., the product to be equal in quality to normal naphtha products and the yield and operating expense to be commercially feasible.

Our first experiments were directed toward making a suitable product by superheating the high-boiling vapors as such, but without pressure, somewhat along the practice observed in making pintsch gas. We soon found, however, that this so-called "cracking" in the vapor phase required a temperature so high that the aliphatic hydrocarbons contained in the petroleum were largely converted into cyclic and aromatic bodies and fixed gases—unsuited for our purpose. The yield was poor and the quality most undesirable. Obviously our problem included the proposition of reducing the molecular weight without changing the general structure.

We next tried the use of various reagents and catalyzers, such as aluminum chloride and ferric oxide. Anhydrous aluminum chloride, indeed, produced some rather remarkable results. The yield and quality of naphtha products were fairly satisfactory, but there was a substantial loss of oil in the operations and the first cost of the anhydrous aluminum chloride, as well as the difficulty in recovering it from the residues, rendered this plan unattractive.

Nearly 30 years ago Sir Boverton Redwood and Professor Dewar in England had patented a pressure-distilling process for the purpose of increasing the yield of kerosene oil from the residues of Russian crude petroleum, but it never was applied industrially. It had been known, therefore, for some years that distilling petroleum under pressure served to break down the high-boiling fractions into low-boiling fractions but, as far as we could learn, no one had ever done it on a large scale and, in fact, such a proposition could not commend itself to a practical refiner because of the obvious dangers from explosions and fires that would be present in handling large stills under such conditions.

Experiments With 100-Gal. Still

But having tried everything else that suggested itself, we attacked the problem of distilling petroleum in considerable quantities (8,000 to 12,000 gal.) under pressure of about five atmospheres. The first still we built was of a welded design and was planned to handle 100 gal. of the high-boiling fractions. Obviously, the raw material first to be tried consisted of the so-called fuel oil, or reduced crude, meaning the residue of crude oil after the more valuable products had been removed. We soon found that we could not work profitably with this product; when distilled with or without pressure it produced quantities of coke that deposited on the bottom of the still and caused a red hot bottom that would not stand any rise in pressure. The next proposition comprised the use of high-boiling distillates from the crude —viz., oils boiling from 225 deg. C. upward. By using these oils as raw materials we obtained our first encouraging results. We distilled these distillates at a pressure of about five atmospheres and were thereby able to hold down the temperature to a moderate figure, the cracking being done in the so-called liquid phase. By doing the work in this way we found to our intense gratification that the low-boiling fractions produced belonged mostly to the aliphatic or paraffine series, which were easily deodorized and finished into products suitable for sale. Further, the yield of salable liquid was good and the production of fixed gases and coke small.

The First Commercial Pressure Still

Experimentally, therefore, our work was successful. But the big problem remained to be solved. Could we build large equipment that would, in a practical way, obtain the desired results and at the same time be durable and reasonably free from the fire hazard that always attends operations in an oil refinery? Some of our practical men said we could, but more of them said we couldn't. In this case, however, the majority was overruled and we immediately prepared plans and specifications for a still 8 ft. in diameter and 20 ft. long built of ½-in. mild steel plates, and holding a charge of 6,000 gal. of raw material. It had a safety factor of 5, the working pressure to be 100 lb., and the bursting pressure 500 lb.

The still was built and charged, with many misgivings on the part of the doubters, but with boldness and confidence exhibited by the rest of us. So soon as we had the still hot and pressure began to develop, we encountered our first difficulty. The still was built in a workmanlike manner and would have made a good steam boiler, but we found rivets and seams leaked badly under oil pressure where they would not under steam pressure. It was difficult to induce boilermakers to calk the leaks while the still was hot and under pressure, but we found men bold enough to do it and the first run was sufficiently encouraging to induce us to proceed further. But the leaks persisted until Nature came to our aid and the minute portions of oil in the leaks gradually carbonized and they closed without our aid.

The experiments with the large still proved our results with the small one—viz., the yield of suitable gasoline fractions was good; the loss was trifling; the cost was reasonable, and the fire hazard under close caution and supervision was not excessive. In addition, we were astonished to find that the residue remaining in the still contained substantial quantities of asphaltine actually created (from a distillate containing none of it) by distillation under pressure.

Minor Difficulties to Be Overcome

We learned early in the work that operating at moderate pressure required a substantial dephlegmating system that would return to the still the fractions boiling too high for our purpose, and permit the others to pass on. A suitable safety valve that would operate properly with oil vapors at high temperature had to be devised. It would require much more time than I have at my disposal this evening to give a full account of the many difficulties that arose. We had solved the big points, but there were many smaller ones. For successful results we must operate with the oil at temperatures from 370 to 400 deg. C. in the still. At 450 deg. C. steel begins to lose its tensile strength and its capacity to withstand pressure. It is clear, therefore, that with this narrow margin great caution must be exercised to prevent overheating. The human element enters here, as it does in every feature of pressure-still operation, but we operated over 8 years with hundreds of these stills in daily use, and manufactured millions of barrels of gasoline by this method before we had a fatal accident.

After making a number of runs with our 8 x 20 still, and in view of the fact that the demand for gasoline

was increasing at a rapid rate, we asked for an appropriation of $1,000,000 to build sixty pressure stills 8 ft. in diameter and 30 ft. long, each charging 8,000 gal. of raw material. It required considerable argument to convince any of our directors that such a revolutionary proposition could possibly be successful, but finally they voted in favor of it, and we went ahead.

The Problems of Today

From the humble beginning of the 100-gal. still in our experimental laboratory, the Standard Oil Co. of Indiana has in operation today over 800 pressure stills having a gross charging capacity of 8,000,000 gal., and licensees under our patents are operating as many more, giving a daily production of 2,000,000 gal. of gasoline out of the total of about 12,500,000 gal. produced daily in the United States and Canada.

This amount of gasoline makes possible the use of two millions of motor vehicles more than could otherwise have been supplied from a given consumption of crude petroleum, and as a corollary of that proposition and assuming 20 per cent of gasoline as a normal average yield from crude oil, the pressure-still process is conserving for future consumption an amount of crude oil equal to nearly one hundred million barrels per year.

The consumption of gasoline by internal combustion engines during the past decade has increased at a terrific rate. In 1910 the United States consumed approximately 700 million gallons, while for 1920 the Bureau of Mines statistics show a total gasoline production of 4 billion 600 million gallons, of which 850 million were made from natural gas, something over 3 billion gallons made by straight crude oil distillation and 750 million gallons made by the cracking process. Further, statistics show that while the increase in crude oil production during the past decade has been 142 per cent, the increase in gasoline production has been over 700 per cent, and although some of this gasoline has been exported, the larger portion has been consumed by the ever-increasing number of automotive vehicles in this country.

The increase in production of crude oil has not been commensurate with the increased demand for its products, and the pressure-still process filled at least part of the gap. Naturally, one is inclined to speculate on what the future will be regarding an adequate supply of these important commodities. One suggestion would be that some of the large amounts of oil now being used for fuel and gas-making purposes be replaced with coal and substantial portions of the oil used for making gasoline, the coal consumption, in turn, to be replaced in part by the development of hydro-electric power.

The American people are notoriously wasteful in the use of natural resources with which they are so highly endowed. It is hoped the work outlined above will be considered a slight contribution toward the curtailment of such waste.

Acknowledgment

It would be obviously unfair and unjust to close this paper without duly acknowledging the work done by my associates in successfully establishing the pressure-still process. Our patent attorneys, represented by Russell Wiles, contributed many useful and practical suggestions, and if it had not been for the invaluable assistance of R. E. Humphreys, E. M. Clark, T. S. Cooke and many others connected with the Standard Oil Co. of Indiana, satisfactory results would never have been obtained.

Tungsten in the United States

Conditions affecting the production of tungsten in the Boulder County, Col., district are outlined in a report just issued by the United States Bureau of Mines.

It was not until 1900, after the Caribou and Boulder County silver mines had been operated for 30 years, that the heavy dark mineral found as "float" and known to the miners as "heavy iron," "black iron" and "barren silver" was recognized as an ore of tungsten. There was no development of importance, however, until 1914 when the war-time demand for high-speed tool steel, of which tungsten is usually a component, became so great as to cause feverish activity among the owners of the known Boulder County deposits.[1] In the tungsten mining camps the high prices brought about a boom similar to the booms caused by important gold discoveries. The price of tungsten rose to unheard of heights, $75 a unit or more being the quotation for nearly 2 months, and at least one lot is known to have been sold for $105 a unit. Such high prices caused the large users to import tungsten ores from South America, and later China, as these foreign ores could be laid down in this country very cheaply. As a result of these importations the market broke rapidly, and during the later part of 1916, 1917 and nearly all of 1918 the price was fairly steady at about $25 a unit. The small demand, upon the signing of the armistice, together with the large importations and stocks held by dealers, forced the price down so much that early in 1919 all of the Boulder County producers were forced to suspend operations.

Besides the well-known uses of tungsten for high-speed tool steel and incandescent lamp filaments it has been used for replacing platinum and platinum-iridium alloys for contact points in spark coils, voltage regulators, telegraph instruments and other electrical devices; wrought-tungsten targets for X-ray tubes; finely divided tungsten as catalytic agent in the production of ammonia from nitrogen and hydrogen; permanent magnets made by heating and quenching a steel containing 4 to 5 per cent tungsten and 0.5 to 0.7 per cent carbon; and in gas engine parts, such as valves.

Exports of Vanadium From Peru

Consul Claude E. Guyant of Lima reports in the Jan. 2, 1922, issue of *Commerce Reports* that during the calendar year 1920 198,760 sacks of vanadium ore, aggregating in weight 10,534 metric tons, were exported from Peru, all shipped to New York, the value of the ore being 2,474,562 soles, which was equivalent to $1,237,281 (sole = $0.50)—i.e., 234.90 soles ($117.45) per ton.

In the first 6 months of 1921 there have been only four shipments of vanadium ore, aggregating 44,562 sacks with a total weight of 2,362 metric tons, valued also at $117.45 per ton, despite the fact that Peruvian exchange has been more than 20 per cent below par during the year.

The local office of the corporation that has been the principal exporter of this ore advises that the maximum vanadio-acid content of the Peruvian product during the past 2 years has been 26 per cent, the average being 20 per cent.

[1] The development of milling practice in Boulder County, the ore-dressing methods in use and the local manufacture of ferro-tungsten and tungstic oxide are described in Bulletin 187, "Treatment of the Tungsten Ores of Boulder County, Colorado," by J. P. Bonardi and J. C. Williams, which may be obtained on application to the Director of the Bureau of Mines, Washington, D. C.

What Are the Universities and Technical Schools Doing to Train Their Undergraduates in Industrial Relations?*

The Engineering School Curriculum Should Contain Courses in the Principles of Industrial Organization, Cost Finding, Wage System and the General Economics of Industry — Study of Human Relations Important—Student Should Be Prepared to Build a Better Industrial World

BY DEXTER S. KIMBALL
Dean, College of Engineering, Cornell University, Ithaca, N. Y.

THE question, "What are the universities and technical schools doing to train their undergraduates in industrial relations?" is very closely tied up with the question, "What *can* universities and technical schools do along these lines?" and a consideration of the latter question is in a measure an answer to the former. Both questions involve a consideration of the basic function of such institutions.

One of the most important developments of recent years is the popular recognition of the efficiency of engineering methods. A few years ago the word "engineering" was used almost exclusively to denote activities connected with the design, construction and operation of machinery, the construction of highways and bridges and similar undertakings. Today we hear of "Industrial Engineering," "Efficiency Engineering," "Financial Engineering," "Human Engineering," and others of similar portent. At first sight some of these terms may seem unwarranted, but they have been coined for lack of better nomenclature. They simply indicate the gradual passing of the old empirical and speculative methods of attacking the problems of industry and the steady growth of the more scientific methods that have become identified with the work of the engineer and scientist.

Existence of Engineering Type of Mind Must Be Recognized

Not less important is the recognition of the existence of the engineering type of mind just as we have long recognized the legal type of mind. Natural talents differ, one man being well suited for the study of law and another for the study of engineering or some other calling. The engineering mind is the result of a fairly definite training of an intellect fitted for such work, and the same is true of law or medicine. And it should be carefully noted that this training is fairly well defined in both quantity and content. If this were not so, it would be possible to develop lawyers on some other basis than is now employed and doctors could no doubt be trained without studying medicine. Any course of technical study, therefore, that involves a marked weakening of the fundamentals of engineering education cannot be expected to produce men with engineering minds, and this should be kept constantly in view in discussing the possibilities of the engineer in any portion of the industrial field.

Now the engineer has found an ever-increasing field of usefulness in recent years. Viewed originally as a technical adviser of industry, he has been gradually drawn over into the administrative field, from the very necessities of the case. As industry has become more technical and more complex it has been found imperative to employ technically trained men to supervise industry of many kinds. And the technically trained man, bringing his own peculiar methods to bear on problems of administration, has already made an assured place for himself as an executive. There can be little doubt that the near future will see the engineer a dominant figure in the administrative side of industry. This must necessarily be so in a civilization such as ours, which depends so largely upon engineering for its existence. As a result of these extended activities, there has grown an increasing demand from practicing engineers and employers that engineering students be given some instruction in economics and such allied studies as refer to the problems of management. And hence practically all good engineering schools in this country include in their curriculum more or less instruction along these lines.

Study of the Human Factor in Industry

But this closer contact with the administrative side of industry has brought the engineer face to face with the greatest problem of all ages—namely, the status of the human factor in industry. Whether he wills it or not, he must face this problem and make an effort to solve it. Others have tried with little success and it remains to be seen whether the engineer with his more scientific methods of attacking industrial problems will succeed in solving this most ancient of all industrial problems.

A recognition of this further extension of the engineer's activities has brought an insistent demand that the curriculum of engineering schools be still further modified to include instruction and study in human relations. The demand is logical and deserves very careful consideration on the part of those who are responsible for technical education. As yet no marked modification of this kind has been made except in a few isolated instances.

While the *character* of the modifications desirable in engineering curricula is well defined, the *degree* to which it is permissible to carry these modifications is not so obvious. Every technical school in the land is beset by urgent requests, in some cases amounting to a demand, that the course of instruction be modified to suit some peculiar industry or the opinion of some particular group of people. Financiers and bankers wish to have their particular field more fully represented. The advocates of the many forms of efficiency engineering have their own peculiar modifications, and those interested in uplift work are advocating complete courses in "human engi-

*Reprinted from the *Proceedings* of the Academy of Political Science, Kent Hall, Columbia University, New York City, vol. 9, No. 4, January, 1922, on "Constructive Experiments in Industrial Co-operation Between Employers and Employees."

neering" (which expression I detest) to replace in a large measure the courses of instruction now in use.

The tendency of the overenthusiastic teacher is to answer these many and conflicting demands by organizing highly specialized courses of instruction that will prepare the student admirably for a definite and narrow portion of the industrial field at the expense of a broad and solid foundation for his life's work. As a consequence there are now appearing in answer to these demands some narrow and highly specialized courses of instruction such as are suggested in the foregoing. We find elaborate shop organizations for teaching the details of scientific management, so called, and several varieties of special courses in administrative engineering; and some courses have already been established in human engineering, whatever that may be.

Highly Specialized Courses Demanded by the Industrial Manager Not Desirable

Now without doubt there are some places where special courses of the kinds mentioned are justifiable in the higher technical schools just as specialized trade schools are often justifiable in the lower grades of educational activity. But these special courses do not solve the general problem and there are certain grave objections to these highly specialized courses so strongly demanded by the industrial manager. It should not be forgotten that the *primary* reason why the engineer has been found useful in managerial work is his knowledge of the fundamentals of engineering design and construction and the trained mind that he brings to the consideration of problems of management and organization. That is, aside from personal qualifications that are inherent and cannot be acquired, the technical graduate is good material from which to make an executive simply because he is primarily an engineer by training.

The character of engineering fundamentals and the amount of time that should be spent upon each one is fairly well agreed upon by educators and engineers who have given this matter careful thought. And the constant pressure that has been exerted for many years upon the technical colleges by the advocates of special training of many kinds has resulted in reducing these fundamentals to a minimum. This in itself has been a beneficial influence, but it must not be extended too far. It is not claimed, of course, that the content of these fundamentals, or the methods of presenting them are all that is to be desired. There is much more work to be done along these lines than some of us may be aware of. But at the most these fundamentals can only be concentrated and made more presentable; they cannot be eliminated as some would have us do and still prepare men who will possess the engineering mind. In engineering colleges that require the equivalent of a high school training at entrance it takes about three years to teach the average student the fundamentals of engineering, leaving one year in which to give him some practical applications of these fundamentals in some particular portion of engineering practice. This year of application is not necessarily the senior year, but may be spread out over one or more of the last years of college life. This amount of academic time is also available, therefore, for special instruction in economic and humanistic studies for those who wish to pursue an administrative career.

There is of course the alternative so often and so naturally advocated of lengthening the college course to five or even six years as has been done to some extent in law and other courses. A discussion of this solution is beyond the limitations of this article. This solution has been tried in several places but so far as the writer is aware there is little reason to believe that such a lengthening of the course will become universal in the near future, and there is no reason to believe that the arguments that resulted in lengthening the course in law are fully applicable to engineering. This discussion will be confined therefore to standard four-year courses which normally send the graduate into the practical field at about twenty-three or twenty-four years of age. In general, the writer believes that this is about as late in life as a young man should begin actual service in the industrial field.

Educational Content of a Four-Year Course

The particular problem under discussion reduces itself, therefore, to the selection of an educational content that can be incorporated into the ordinary four-year course of instruction that will give all students in the college some instruction in the fundamental principles of organization and management, some instruction in basic economic theory and as much instruction as possible in subjects dealing with human relations in industry. This content, so far as industrial organization and economic theory are concerned, is not difficult to find. Thus all engineers should receive instruction in the elementary principles of industrial organization, cost finding, etc., wage system, time and motion study and the general economics of industry. If possible, these subjects should be given before the senior year so that in the senior year the student who so desires may specialize as far along the lines of industrial organization as other students can in such lines of study as gas-engine and steam-engine design, electrical engineering, etc. Space forbids a more detailed statement of such a plan, but actual experience has already shown that such a course will give the student a sound engineering foundation and a good grasp on the fundamentals of economics and industrial organization and management. It will not develop specialists in this or any other line of work nor will it necessarily develop the peculiar personal qualities so often demanded by industrial managers who have peculiar managerial problems to solve.

Content of a Course in Human Relations in Industry Difficult to Define

The educational content of a course in human relations in industry is not so easy to define despite the very large amount of literature that has appeared on this subject. Of course a considerable discussion of human relations in industry is necessarily involved in any discussion of industrial management. But the entire subject of human relations is controversial, to say the least, at present, and the teacher can find little in the industrial field itself that will aid him in drawing accurate conclusions. Certainly the average industrial manager can throw little light upon the most important matter if the results one sees in the industrial field are any indication. Of course there is a considerable literature of the "uplift" kind and there have been many experiments along the line of welfare work, so called, which, because of their failures or successes, indicate that certain efforts may be desirable or undesirable. But a sound philosophy of what human relations in industry should be has not as yet been formulated—at least none that goes beyond a general advocacy of the Golden Rule. Perhaps all that the teacher can do is to call the attention of the student

to this field and direct his thoughts to this, the greatest of all problems. This in itself is something, as it should stimulate the thoughts of these future industrial managers to think of these matters at an early age and long before the age at which most men begin to appreciate this problem. And most certainly everything possible should be done to keep the human element in industry before him and thus offset as far as possible the somewhat detached and materialistic attitude of mind that is so often found in those who concentrate their attention on pure and applied science.

It is not asserted that a training such as is outlined in the foregoing is essential for all industrial managers. We are discussing only the training of high-grade technical men who may be expected to become industrial leaders in a large way. There can be no doubt that many of the proposed courses of training that contain little or no science and engineering will be found of great value in training certain types of men. Schools of commerce have long been successful in training men for business with very little science, pure or applied, in their curriculum; and such courses modified by the introduction of a limited amount of pure and applied science should be of great value to a large number of prospective industrial workers. But such courses do not produce the engineering type of mind. They are not courses in engineering at all, but are often attempts to produce this type of mind by using other educational content and at the same time giving considerable attention to the practical aspects of industrial organization and management. If this can be done, then, as previously stated, lawyers can be trained without studying much law. And those who now so strongly advocate modifications in the engineering courses and the substitutions of large amounts of instruction in industrial relations would be the first to discover that the product of such curricula was not what they had expected.

Closer Co-operation Needed on the Part of Industry

And the industrial manager must learn that he has duties to perform which up to the present he has shirked or performed but poorly. For after the college has done all it can do for the prospective industrial worker he still is merely good material from which the industrial manager may, if he will, mold an efficient and intelligent industrial leader. The average industrial manager expects to receive from the college a full-fledged engineer or manager, while at the same time he would not think of permitting a newly-graduated doctor to remove his appendix. The technical schools should and can teach fundamentals, but the burden of adapting and specializing the graduate to fit any particular industry should rest squarely upon the shoulders of the industrial manager and of the industry where it rightly belongs. It should be said in all fairness that many progressive industrial managers have already recognized the truth of this statement as is shown by the special provisions now made by industrial concerns to adapt the college graduate to suit their specific needs. Closer co-operation is much needed along these lines.

Furthermore, these considerations are not the only ones to which the colleges must give heed. The primary object of the technical schools was to send out men who would be *useful to the industries*. Most of the technical colleges have not got far beyond this strictly utilitarian viewpoint and the demands of industry tend to keep this viewpoint constantly before them. Our national ideals, however, have changed greatly since technical colleges were first organized. A new industrial day has dawned in which profits, as such, are not the most important consideration, and industry is coming to be looked upon as a means of supporting human existence, not as a means of corporate profit. We have become more interested in men than in machines.

The Kind of Industrial Efficiency to Be Developed

Industrial efficiency we must develop, but the fruits of this efficiency must be for all if we adhere to our present national ideals of democracy. An efficiency that benefits the employer and not the employees, or an efficiency that builds up the state at the expense of the individual, is foreign to these ideals. If technical graduates are to take an active part in industrial management, and it seems assured that they will, the colleges will be remiss in their duty if they do not include in their course of instruction such work as will give their students some idea of the modern views of the distribution of the fruits of industry. Here is an educational problem and an educational content to be formulated regarding which little is said in the criticism of the technical graduate, though it is one of the most important of educational problems. "Where there is no vision the people perish," said the prophet of old, and this is as true today as it was thousands of years ago. Efficient industrial managers we must have; but if the republic is to endure we also must have industrial managers whose vision will be great enough to look beyond the petty requirements often laid upon the technical school for the man who, *while useful to his industry*, can also do something to make industry *more useful to all men*.

For after all, ideals and not technical developments move the world. The recent remark of a great industrial leader that if he had his way he would put business men at the headships of our colleges and universities shows a lamentable lack of knowledge of the principal purpose of such institutions. Technical and commercial efficiency we must have, and the problems of production must be solved. But it will avail us nothing if we cannot also solve the problem of human relations. Our business men and financiers cannot lay claim to much progress in solving this last problem. Yet it is the one great problem and one that requires not only industrial knowledge but high idealism and a love for humanity. It has been charged that the colleges and universities are too far removed from industry and the practical things of life. This may or may not be true, but it is sincerely to be hoped that there will always be in this land great institutions of learning that are not dominated solely by industry or industrial ideas, where great teachers will have an opportunity to prepare men not only for the industrial world that now exists, but will also be free to prepare them to build a better industrial world to come.

Michigan Leads U. S. in Paper Mill Growth

Michigan has led all other states of the Union in the growth of the paper industry during the past 5 years, as in this time 27 new mills have been constructed and placed in operation, increasing the number from 39 to 56. There are now 105 paper machines in service, as compared with 89 machines installed in 1917. Kalamazoo and Monroe are the centers of the industry in the state. Kalamazoo leads the country in the manufacture of book papers. Monroe leads in boxboard

Brittleness Developed in Pure Lead by Stress and Corrosion

It Has Been Known That Corrosion Induces Intercrystalline Brittleness—It Is Now Shown That Damage Is Accelerated by Accompanying Stress—A Method Is Noted of Making Large Columnar Crystals or Stalactites of Metal

By HENRY S. RAWDON, ALEXANDER I. KRYNITSKY and JULIUS F. T. BERLINER*

In A previous publication[1] it has been shown that the condition of intercrystalline brittleness sometimes found in lead by which the metal may be changed to the form of a granular powder is the result of selective corrosion of certain portions of the material rather than to an allotropic change, as had been previously stated by some investigators. The results obtained by Thiel[2] confirm those given in the publication referred to above. It was shown further that the readiness with which such intercrystalline brittleness may develop is a function of the purity of the metal and that by a selective corrosive attack of impurities existing as intercrystalline lodgments the change is brought about. By the use of suitable corrosive agents, even very high-grade lead can be made to exhibit intercrystalline brittleness to an appreciable extent.

Simultaneous Action of Tensile Stress and Corrosion

Lead, as cable sheathing and in other similar forms, is sometimes subjected to considerable tensile stress during its service. For this reason a series of experiments to demonstrate the influence of externally applied stress upon embrittlement seemed very desirable.

The material from which the specimens were prepared was of very high purity[3] (99.99 per cent) in order to minimize any effect caused by impurities in the material. It was cold-rolled into rods of $\frac{3}{8}$ in. diameter and then drawn to a 0.164-in. diameter wire. Specimens approximately 10 in. long were cut from the wire and annealed for 2 hours in an oil bath at 216 deg. C.

In the determination of the mechanical properties of lead, the results are influenced in a very marked degree by the conditions under which such properties are determined, particularly by the rate at which the load is applied. The ultimate tensile strength of the material to be used was determined by a "dead weight" loading by the addition of small weights, approximately 4 oz. each, to a container suspended at the free end of a specimen held in a clamp. A period of approximately 10 minutes was required for the addition of sufficient load to break a specimen. The material was found to have an ultimate strength (as determined under these conditions) of 1,705 lb. per sq.in.

The appearance of the fractured ends of a lead wire broken in this way is shown in Fig. 1. In this case, however, the specimen was loaded with a weight of only 710 lb. per sq.in. and a period of 12 days was required to cause fracture. In addition to the sharp "necking-down," a characteristic roughening of the surface for some distance back of the break occurred. The specimen also showed a trace of what appeared to be intercrystalline fissures,[4] in the roughened portion.

For demonstrating the effect of the simultaneous action of tensile stress and corrosion, a cylindrical glass container was fitted around the central portion of each specimen. The solutions used and the applied loads are summarized in Table I. In each case the corroding solution surrounded the lead specimen for a distance of approximately 1 in., and the surface of the liquid was covered with a thin layer of sperm oil to prevent excessive evaporation and also to minimize the accelerating effect of atmospheric oxidation. The loads applied to the specimens were arbitrarily chosen, one-tenth, one-fourth and one-third of the ultimate strength in tension, as previously determined, being used. The

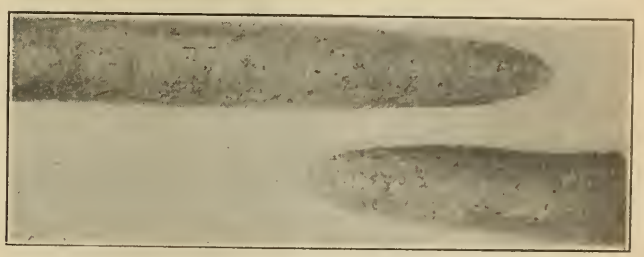


FIG. 1. PURE LEAD BROKEN AFTER HOLDING 710 LB. PER SQ.IN. FOR 12 DAYS. × 3

attempt was made to employ a maximum load of one-half the ultimate tensile strength of the material, but it was found impossible to use such a load on account of the flowing of the metal and subsequent breaking in the grips.

From the results summarized in Table I it will be seen that many of the specimens which were surrounded by the mildly corroding liquids failed from various causes before the completion of the test. In some cases fracture occurred in the grips on account of the gradual flowing of the metal at these points under a larger stress at these portions caused by the flattening of the material. The ability of lead to flow gradually under the continued application of a load which may be very much less than the "tensile strength" of the material is very characteristic and also well known.

In most of the specimens for which the test period was rather long, considerable localized corrosion occurred just above the oil layer. On account of the disturbance of the rack on which all the weighted specimens were hung, by reason of the breaking of specimens at different intervals and from accidental

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*Physicist, Associate Physicist and Laboratory Assistant, respectively, Bureau of Standards.

[1] H. S. Rawdon, "Intercrystalline Brittleness of Lead," Bureau of Standards Sci. Papers 377.

[2] A. Thiel, "The Apparent Allotropy of Lead," *Ber.*, vol. 53B, pp. 1052-66 (1920). Also *Chem. Abs.*, vol. 14, p. 3006.

[3] The material used was the high-grade lead described in Sci. Paper 377.

[4] W. Rosenhain and S. L. Archbutt, "Intercrystalline Fracture of Metals Under Prolonged Application of Stress," *Proc. Roy. Soc. London*, vol. A96 (1919), p. 56.

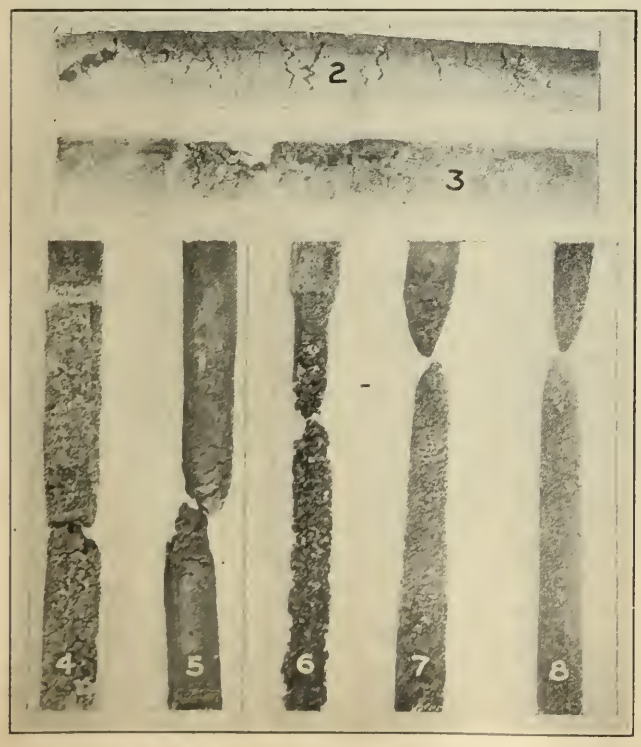
TABLE I. EFFECT OF THE SIMULTANEOUS ACTION OF TENSILE STRESS AND CORROSION UPON LEAD

Specimen No.	Liquid Surrounding Stressed Specimen	Load Applied to Specimen 0.164 In. Diameter, Lb.	Unit Stress Computed, Lb. per Sq.In.	Time Interval Before Fracture Occurred, Days	Remarks
1	Distilled water	3.6	170	...	Specimen intact; no evidence of embrittlement after 340 days.
2	Distilled water	9.0	426	...	Broke in upper grip after approximately 200 days.
3	Distilled water	12.0	568	...	Broke in 83 days—just above oil layer, no evidence of embrittlement.
4	N_2 aqueous lead acetate solution	3.6	170	...	Specimen intact; no evidence of embrittlement after 340 days.
5	N_2 aqueous lead acetate solution	9.0	426	...	Broke in 202 days, just above the layer of oil.
6	N_2 aqueous lead acetate solution	12.0	568	...	Broke early in the test period, record lost. No embrittlement.
7	N aqueous lead acetate	3.6	170	...	Specimen intact after 340 days, embrittlement started, intercrystalline fissures have formed.
8	N aqueous lead acetate	9.0	426	...	Broke in 192 days, just above the lower grip.
9	N aqueous lead acetate	12.0	568	117	
10	N_2 aqueous lead acetate solution + N_2 nitric acid	3.6	170	94	Fig. 4.
11	N_2 aqueous lead acetate solution + N_2 nitric acid	9.0	426	21	Figs. 2 and 3.
12	N_2 aqueous lead acetate solution + N_2 nitric acid	12.0	568	15	Fig. 5.
13	N aqueous lead acetate solution + N nitric acid	3.6	170	13	Fig. 6.
14	N aqueous lead acetate solution + N nitric acid	9.0	426	9	Fig. 7.
15	N aqueous lead acetate solution + N nitric acid	12.0	568	5	Fig. 8.

jarring of the liquid in the cups surrounding the lead samples, some of the specimens became covered with a slightly emulsified layer of lead acetate for a short distance above the surface of the oil layer. The difference in the rate of corrosion along the bar was great enough in two cases as to cause the specimen to fail in the upper part before the portion surrounded by the corroding liquid was appreciably attacked.

The results obtained (Table I) plainly indicate that embrittlement of lead quickly results when the metal is submitted to the simultaneous action of tensile stress and corrosion. Figs. 2 to 8 show the characteristic appearance of specimens after the attack. The fact that the fissures which form are intercrystalline was readily revealed by microscopical examination of longitudinal sections of broken specimens.

In general, the results of the tests indicate that while the application of a tensile stress powerfully accelerates embrittlement of lead, corrosion is of more fundamental importance in causing the embrittlement



FIGS. 2 TO 8. PURE LEAD BROKEN UNDER COMBINED STRESS AND CORROSION, AS NOTED IN TABLE I. × 3

to occur. The regularity in the rate at which failure occurred with respect to the concentration of the corroding solution and also to the magnitude of the applied stress suggests very strongly that after a sufficiently long interval of time the specimens subjected to the action of the very mildly corroding solutions would

FIG. 9. COARSE-GRAINED LEAD AFTER 42 DAYS IN 2N NITRIC ACID PLUS N LEAD ACETATE. NATURAL SIZE

behave in a similar manner if other conditions do not interfere. However, whether lead is sufficiently soluble in distilled water to permit failure by "intercrystalline brittleness" to occur is not apparent and can only be conjectured.

It is not to be concluded that embrittlement of lead always necessitates a corrosive attack of the metal. It has been known for some time by users of lead cables that overhead cables on bridges and similar structures which are subject to vibration must be supported in a special way so as to minimize the vibratory effect on the cable, otherwise embrittlement cracks will develop as a result of the stress conditions. Such cases have recently been described by Archbutt.[5] The intercrystalline character of cracks produced under such conditions, however, is not so evident as when corrosion is one of the factors which bring about their production.

Corrosion of Coarsely Grained Lead

The fact that the corrosive attack of lead is truly intercrystalline is shown in Fig. 9 in a very striking manner by the use of excessively coarsely grained material.[6]

In Fig. 9 is shown a 2-in. section of a lead "stalac-

[5] L. Archbutt, "Failure of Lead Sheathing of Telegraph Cables. Contribution to Synposium on Effect of Prolonged Application of Stress on Metals," *J. Faraday Soc.*, vol. 16, April, 1921.

[6] Some very coarsely crystalline bars in the form of icicles or stalactites were prepared by John R. Freeman, Jr., Associate Physicist, Bureau of Standards, thus: An iron rod was allowed to touch the surface of the molten metal and, after a sufficient amount of lead had solidified upon it, was slowly moved upward at a carefully controlled rate. By properly adjusting the rate at which the rod is moved a bar of lead resembling an icicle in shape may be produced, consisting of a relatively very small number of crystals. In some cases a single crystal may form the entire cross-section of the rod.

tite" after corrosion for 43 days in a nitric acid solution. It will be noted that the crystals, as seen on the end of the corroded specimen, are separated from one another by conspicuous "ditches," the width and depth of which can be readily observed without resorting to the use of the microscope. The chemical analysis of lead used indicated the composition to be as follows: Lead, 99.94 per cent; copper, 0.03 per cent; and antimony, 0.03 per cent. The depth and width of the intercrystalline "ditches" which form during corrosion appear to be related closely to the grain size and to be more prominent than might be expected from the small percentage of impurities in the metal. This suggests that, at least in the case of lead, the intercrystalline impurities may not be entirely responsible for the intercrystalline attack during corrosion.

Summary

The results obtained in the preceding experiments in connection with those previously described in the publication cited in footnote 1 indicate that lead is quite different from the other soft metals in its behavior upon prolonged corrosion. This metal, even of a very high degree of purity, develops intercrystalline brittleness when subjected to a corroding medium, particularly of an acid nature, for a considerable period of time. The application of an externally applied stress while subjected to the action of a corroding solution is a powerful adjunct in producing intercrystalline brittleness, as was exemplified in the case of lead. Specimens broken in tension under such conditions have an appearance characteristic of a brittle material. Examination readily shows, however, that only the "bond" between adjacent crystals has been affected; the grains themselves retained their ductility and other characteristic properties.

Sulphuric Acid Tank Leaks Caused by Wood Borers

By C. E. Cresse*

TANKS for holding sulphuric acid at the Chicago Heights plant of the Armour Fertilizer Works were built from North Carolina pine cut in the winter. The bottom of each tank was formed from 2 x 8-in. planks laid flat, and the sides and ends were made up by laying 2 x 8-in., 2 x 6-in., and 2 x 4-in. planks flat with the 2-in. edge next to the inside of the tank, which was lined with sheet lead about $\frac{1}{8}$ in. thick. Reference to Fig. 6, page 336, Chemical & Metallurgical Engineering, vol. 24, 1921, will give a clear idea of this method of construction.

Holes Not Apparent to the Eye

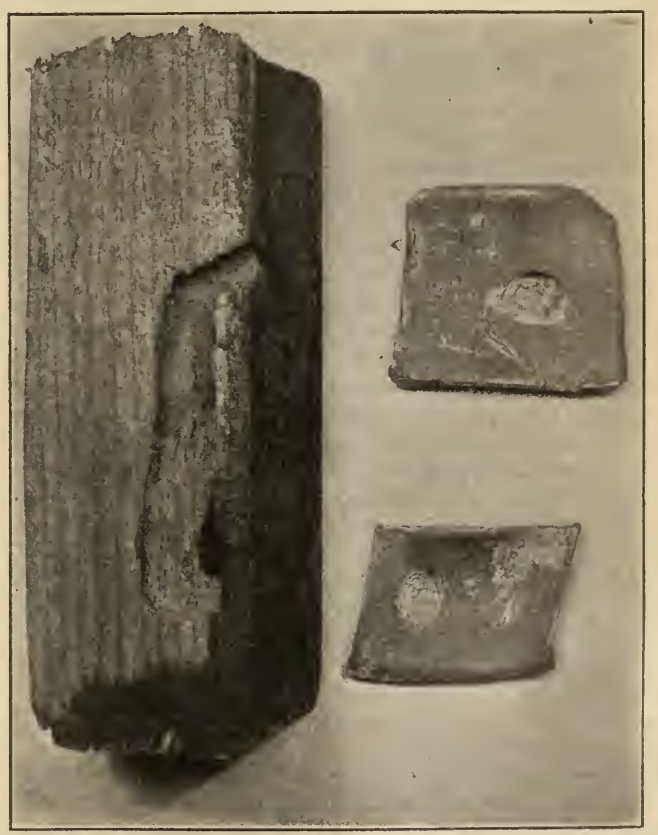
The tanks were filled with 50 per cent sulphuric acid in May, and when 5 weeks later they began leaking, the acid was drawn off and an investigation made. Considerable difficulty was encountered in locating the trouble because no holes were apparent to the eye on the interior lining. The approximate locations of the leaks were determined by the moist spots in the wood on the outside, the lead was cut and curled back and the work of the wood borer disclosed.

Specimens of the beetle were sent to a Washington government department, where it was identified as the Capricorn beetle, more commonly known as the Goat beetle or Sawyer worm. This Southern pine sawyer is named more technically the *Monohammus confusor*. Starting as an egg laid by the female beetle on the surface of the timber, he hatches into a borer. He feeds on the sapwood, weaving back and forth until grown to full size, when he mines deep into the heartwood and back to the surface again. Here he passes through a resting stage and is transformed into a long-horned beetle. Many kinds of forest trees are attacked by the borer with serious damage to the timber.

Timber Contained Many Borers

Evidently the timber from which these tanks were made contained a large number of borers. When they mined to the surface and encountered the lead lining of the tank the "goat" instinct was aroused and they proceeded to dine on the lead. All activity, "goat" and otherwise, ceased, however, when they tapped the sulphuric acid.

In the accompanying illustration are shown on the left the progress of the worm through the timber and the exit where it attacked the lead lining. On the right are photographs of the holes made by the borer on the outer side of the lead lining—i.e., next to the wood. The sharp tooth marks are plainly visible.



PHOTOGRAPH SHOWING PROGRESS OF THE WOOD BORER

On the left is shown the path of the worm through the wood and the exit where it attacked the lead lining. On the right are photographs of the lead lining on the side next to the wood, through which the worm also bored.

The action of wood borers causing leaks in acid tanks and chambers has been known for several years, but preventive measures are usually considered too late. It is recommended by the United States Forest Service that such wood be treated with creosote to kill these pests before it is employed for construction purposes.

*General Superintendent, Armour Fertilizer Works, Chicago Heights, Ill.

American Chemists—A Statistical Study

By Gerald L. Wendt
University of Chicago

THE data given in the edition of "American Men of Science" for 1920 furnish the following facts relative to the distribution and education of the leading American chemists. The chemical profession still leads all others in the number of its representatives listed. Of about 9,500 men listed 1,852, or 19.5 per cent, are chemists, including biological chemists, chemical engineers, industrial chemists, physical chemists, etc. This is about 12 per cent of the 15,000 membership in the American Chemical Society. In point of age and eminence the list is headed by Dr. Charles William Eliot, president emeritus of Harvard University, born on March 20, 1834, who was assistant professor of chemistry at Harvard from 1858 to 1863 and professor of chemistry at the Massachusetts Institute of Technology from 1865 until his election to the presidency of Harvard in 1869.

Of particular interest are the 220 men who are designated with an asterisk in chemistry and are thus among the 1,000 "students of the natural and exact sciences whose work is supposed to be the most important." In the first edition of this compilation, in 1905, chemistry had 175 men among the thousand, or 17.5 per cent, and led all other sciences by a handsome margin. This lead has in the intervening 15 years been increased to 22 per cent. In the following study of these 220 men no individual names are mentioned, since the inclusion or exclusion of any particular name in this list is subject to a large error of personal choice. The statistics based on large numbers, however, are of value.

As would be expected, most of the men are between forty and sixty years of age. Divided into decades, the numbers are as follows: Eighty to ninety years of age, 3; seventy to eighty, 21; sixty to seventy, 37; fifty to sixty, 76; forty to fifty, 59; thirty to forty, 22; below thirty, 1; date of birth not given, 1.

The geographical distribution of these leading chemists shows a great preponderance along the northeastern coast. In the states bordering on the Atlantic from Massachusetts to the District of Columbia are 151, or 68.6 per cent. Listed by states in numerical order the distribution is as follows: New York, 55; Massachusetts, 25; District of Columbia, 21; Pennsylvania, 17; Connecticut, 14; Illinois, 13; California, 12; New Jersey, 10; Ohio, 10; Maryland, 6; Michigan, 5; Wisconsin, 5; Minnesota, 4; Missouri, 4; Kansas, North Carolina, Nebraska, Rhode Island and Virginia, 2 each; Delaware, Indiana, Iowa, Nevada, New Hampshire, South Carolina, Texas, Utah, British Columbia, 1 each. There remain twenty-two states with no leading chemist.

Doctor's Degrees Held by Leading Chemists

Of these 220 chemists seventy have honorary degrees, chiefly Sc.D. and LL.D. Of the 70 recipients of honorary degrees 3 have no other degrees whatever, 11 have a bachelor's or master's degree but no Ph.D., and 56 have both a bachelor's or master's degree and the Ph.D.

Only 149 of the 220 leading chemists have the Ph.D. degree, while 71 do not have it. Of the 149 who have the Ph.D. degree 56, or 37.6 per cent, obtained it in Europe. This is a large fraction, but it is rapidly diminishing. Of the 23 men born since 1880, only 3, or 13 per cent, have a European Ph.D., while of the remaining 126 born in 1880 or before, 53, or 42 per cent have a European Ph.D. The 56 Ph.D.'s granted by European universities are distributed as follows: Leipzig, 18; Göttingen, 15; Heidelberg, 10; Berlin, 3; Munich, 2; Strassburg, 2; Bern, Breslau, Freiburg, Hanover, Jena, and Zurich, 1 each. The 93 men who received the Ph.D. from American universities are distributed as follows: Johns Hopkins, 22; Harvard, 14; Yale, 13; Chicago, 10; Pennsylvania, 6; Columbia, 4; Massachusetts Institute of Technology, 3; Cornell, Illinois Wesleyan, Michigan, North Carolina, Stanford and Wisconsin, 2 each; Brown, California, George Washington, Illinois, Kansas, Lafayette, Minnesota, Ohio (Athens), Princeton, Toronto and Tufts, 1 each. (Two men have 2 Ph.D.'s each.) Thus 73 of 95 degrees were given by the endowed universities, and only 22 by the state universities. Of the 71 chemists who have no Ph.D. degree, 11 have honorary degrees and 42 have bachelor's or master's degrees, 11 have M.D.'s and 18 have no degree whatever.

The fact that one-third of our leading chemists do not have the Ph.D. degree is perhaps surprising. It should be remembered, however, that the list includes industrial chemists and thus a number of heads of large commercial establishments who have not themselves contributed to the science of chemistry. In addition, a number of names are of executive officers in the Chemical Warfare Service, U. S. Army, whose contributions are not strictly chemical. Finally, it should be noted this condition does not apply to younger men. Of the 141 men fifty years of age or over, 53, or 38.6 per cent do not have the doctorate degree; but of the 23 men under forty years of age only 5 do not have the degree. Of these, 2 are Englishmen, educated in England, where this degree is not regular. There remain only 3 men or 13 per cent, who do not have the degree. One of these was a Colonel in the C. W. S., one is an editor and one is a chemical engineer in charge of a large government laboratory.

Distribution of Bachelor's Degrees

The distribution of bachelor's degrees is also of interest. Among this group of 220 chemists 174 have bachelor's degrees, of whom 11 have two each. The 185 degrees are distributed among the universities as follows: Harvard, 22; Yale, 16; Massachusetts Institute of Technology, 15; Michigan, 9; Wisconsin and Columbia, 6 each; Cornell, Johns Hopkins and Pennsylvania, 5 each; Amherst, California, Ohio State, Toronto and Williams, 4 each; College of the City of New York, Kansas, Princeton and Wesleyan, 3 each; Edinburgh, Haverford, Illinois, Lafayette, Nebraska, New York, Rutgers, Stanford, Tufts and Worcester, 2 each; Beloit, Bethany (Kan.), Bowdoin, Brown, Buchtel, Bucknell, Case, Chicago, Cincinnati, Colorado, Dalhousie, Davidson, DePauw, Doane, Earlham, Georgia, Gettysburg, Grinnell, Hamilton, Hanover, Kentucky, Knox, Lehigh, Maine, Middlebury, Minnesota, Muhlenburg, North Carolina, Northwestern, Penn. State, Purdue, Rensselaer, Rhode Island, Swarthmore, Texas, Vanderbilt, Virginia, Washington and Lee, Westminster (Pa.) and Wooster, 1 each.

It is thus apparent that Harvard and Yale stand out both in graduate and in undergraduate work, while Johns Hopkins and Chicago predominate in graduate instruction and Massachusetts Institute of Technology and Michigan show undergraduate strength. Other deductions must be left to individual interest.

The Distillation of Coke-Oven Tar and the Recovery of Some of Its Products

An Outline of Current Practice in the Refining of Coal Tar and Its Principal Products of Commercial Importance—Description of Processes Involved in Recovery of Tar Acids, Naphthalene, Anthracene, Creosote Oils and Pitch

By WILBERT J. HUFF

THE successful results achieved by the use of coke-oven tar as a fuel in open-hearth steel furnaces have led to its extensive consumption in such furnaces, and since the majority of byproduct coke ovens are operated in connection with steel works, much of the tar is utilized as fuel near its point of origin. Coke-oven tar, however, compares very favorably with coal tar of other origin, and is admirably adapted to profitable distillation. This is, of course, very advantageous where all of the tar is available, as in the case of byproduct ovens operated primarily for the production of gas.

Coke-oven tar, or any coal tar, may be the source of a great many chemical products. However, most of these fall outside the province of the tar distiller, who finds it economical to confine his attention to the following chief products: Creosote oil, naphthalene, anthracene, carbolic and cresylic acids and pitch. Small quantities of light oil, ammonia water and pyridine are also recovered.

In the crude tar, these materials are so thoroughly incorporated with one another that it is necessary to have recourse to a process of fractional distillation and chemical treatment in order to separate them. The following fractions are usually separated:

(1) From atmospheric temperatures to 170 deg. C. (338 deg. F.): Products: Light oil, water, some pyridine,[1] some naphthalene.

(2) From 170 deg. to 235 deg. C. (338 deg. F. to 455 deg. F.): Products: Crude phenol, cresylic acid, naphthalene (crude), pyridine, creosote oil.

(3) From 235 deg. to 270 deg. C. (455 deg. F. to 518 deg. F.): Products: Creosote oil, naphthalene (crude).

(4) From 270 deg. to 315 deg. C. (518 deg. F. to 599 deg. F.): Products: Creosote oil, anthracene (crude).

(5) From 315 deg. to 355 deg. C. *supra* (599 deg. F. to 671 deg. F.): Products: Creosote oil, anthracene (crude).

In fraction 1, the water forms an immiscible layer which is readily separated. It contains some ammonia and its compounds, but the recovery of this is rarely undertaken save when the tar distillation plant is near a byproduct coke plant. The light oil may be pumped to the light-oil still of the coke plant to be rectified together with the light oil from the gas. The naphthalene contained in this fraction is thus taken care of in the regular coke-plant operation where the naphthalene appears in the still residues.

When the remaining condensates cool, they each give two phases, one an oil, brown or green in color, the other a solid, partially crystalline. The solid from fraction 2 is crude naphthalene. That from fraction 3 is largely crude naphthalene, although a little crude anthracene may appear. The solids in fractions 4 and 5 are called crude anthracene, although they are really a mixture of crude anthracene, carbazol and phenanthrene, together with a large number of less important hydrocarbons. When the solids have completely separated, the oils are drained off and the solids centrifuged or pressed to remove adhering oil. When sufficient distillate has been removed, the hot liquid pitch remaining is discharged directly into steel tanks or bays, where it is allowed to cool for subsequent handling and transportation.

The temperatures given represent vapor temperatures noted during the distillation and, because the character of a fraction cut from such a complex mixture varies with type of apparatus, these temperatures are only approximate. The practical tar distiller determines his cut points by observing changes in the character of his condensate. This should be remembered in reading the following pages.

Following is the distillation record[2] for a typical tar from a byproduct coke oven:

Fraction No.	Temperature, Deg. C.	Gal. per 1,000 Gal. Tar	Per Cent by Volume Referred to the Original Tar Vol.
1	Atmospheric—170	Oil—14.5	1.45
		Water—15.5	1.55
2	170–235	122	12.2
3	235–270	123	12.3
4	270–315	133	13.3
5	315–355	98	9.8
Residue and losses		494	49.4

Weight of residue, 57 per cent of original tar.

The following products may be obtained from such tar:

	Gal. per 1,000 Gal. Tar	Per Cent by Volume
Ammonia water	14.5 (0.6 lb. NH_3 est.)	...
Light oil[3]	15 (naphthalene not determined)	1.5
Tar acids	26	2.6

Crude Naphthalene	Lb. per 1,000 Gal.	Per Cent by Weight
170 deg.–235 deg. C. fraction	200	2.2
235 deg.–270 deg. C. fraction	48	0.6
Total	248	2.8

Crude Anthracene Cake[4]	Lb. per 1,000 Gal. — Without Chilling	Lb. per 1,000 Gal. — Additional Recovery Due to Chilling	Per Cent in Weight — Without Chilling	Per Cent in Weight — Additional Recovery Due to Chilling
270 deg.–315 deg. C.	46.5	9.4	0.47	0.095
315 deg.–355 deg. C.	93.0	9.4	0.95	0.095
Total	139.5	18.8	1.42	0.19

[1] The pyridine content is small and in this country its recovery is seldom undertaken.

[2] In interpreting tar analyses, it should be remembered that it is not possible to attain in tar analyses the high precision of most chemical analyses. Moreover, from time to time the composition of the tar changes somewhat due to variations in the operating conditions and the coal supply.

[3] The exact composition of these tar acids was not determined. The probable composition is crude phenol approximately 1 part, cresylic acid approximately 2 parts.

[4] The exact per cent anthracene was not determined.

Pure anthracene ($C_{14}H_{10}$) is a solid hydrocarbon which on oxidation gives anthraquinone, whose dihydroxy derivative is alizarine, an extremely important red dye. Anthracene is rarely obtained pure. Phenanthrene, carbazol, acenaphthene, fluorene, methylanthracene, chrysene, pyrene and a great many other hydrocarbons are intimately associated with it and possess so many properties in common with it that the isolation of pure anthracene is rather difficult. The refined anthracene of commerce contains about 80 per cent of anthracene.

Government statistics[5] for 1920 show a total production of almost three million pounds of crude anthracene (25 per cent) and 100,000 lb. of refined anthracene (on the basis of 100 per cent). This is somewhat less than the requirements of the dye industry caused principally by the fact that there is no great demand for hard pitch in the American market; consequently, much of the anthracene is not distilled out of the pitch.

Carbazol [$(C_6H_4)_2NH$] is found intimately associated with anthracene and although always a constituent of crude anthracene cake, it is not generally isolated by the tar distillers. Dye companies purchasing anthracene sometimes insist on a content of anthracene not too high (maximum about 55 per cent), thus insuring a supply of carbazol as a byproduct of the anthracene purification process. Carbazol is the source of some very important dyestuffs, among which are carbazol blue and carbazol yellow.

Naphthalene ($C_{10}H_8$) is the most familiar pure product of the tar distillery. Its uses are many and constantly increasing. In the field of dyes it serves as a starting point for all the phthalein colors, such as eosine, erythrosin, etc., a great many azo colors containing naphthols. The chemical uses for naphthalene have been stimulated in the past few years by the discovery of a catalytic process whereby naphthalene is oxidized by air to valuable intermediate products, chiefly phthalic acid.[6] The deficiency in the supply of anthracene is being made up in part by synthetic anthraquinone prepared from phthalic acid.

While it is probable that these uses for naphthalene will increase, such an increase will probably not absorb the complete production of naphthalene, and studies are in progress to extend the uses. One of the recent developments is the hydrogenation of naphthalene to compounds such as tetra-hydro-naphthalene and deca-hydro-naphthalene. A mixture of these gives a liquid oil which absorbs oxygen and becomes sticky, and is offered as a turpentine substitute.[7]

The possibility of developing a use for naphthalene such as driving internal-combustion engines is of interest. For this purpose it is of course not necessary to purify the commercial recrystallized material, since this is a nearly pure chemical compound of definite boiling point, practically free from gum- and resin-forming materials. To permit easy handling it is formed into balls and is fused just before it enters the engine.

Naphthalene when mixed with pitch serves to lower the melting point and decrease the viscosity. Consumers of liquid fuel oil who wish to obtain this oil by distillation of tar to a very soft pitch may carry the distillation to a harder pitch, thus obtaining more liquid oil, and cut back the pitch to a softer grade again by adding to it crude naphthalene.

Tar Acids. Coal tar contains an extremely important group of compounds which are acidic in nature—i.e. they are capable of forming water-soluble compounds when treated with caustic. They redden litmus paper, are themselves soluble in water to varying degrees, and possess important antiseptic and germicidal properties. The number of these tar acids is probably large, and they appear to some extent in all the fractions, but are at the highest concentration in what is sometimes called the carbolic fraction (i.e., 170 to 235 deg. C.) and this is the only fraction regularly washed for tar acids. This contains chiefly only phenol and cresols, and these two compounds are the only ones separated by the tar distiller, the higher boiling tar acids being permitted to remain in the creosote oil, where they form important agents for the protection of wood.

Perhaps the greatest demand for phenol will come from the manufacture of the synthetic phenol-formaldehyde resins. These resins, which generally resemble hard rubber, have an enormous variety of uses in the technical and industrial world. A very familiar product containing such resins is the phonograph record. These resins can consume an enormous amount of phenol (or cresol), possibly millions of pounds, provided the phenol can be obtained at a favorable price.

Another use which consumes a large quantity of phenol is the manufacture of disinfectants and germicides. Carbolic acid and carbolated products are too well known to require comment. Prior to the introduction of phenolic resins, the chief commercial outlet for phenol rested upon its antiseptic and germicidal properties.

Pure cresol of commerce is a mixture of three isomeric compounds having the formula $C_6H_4OHCH_3$. The tar distiller generally does not endeavor to isolate any one of the cresols pure. However, ortho-cresol may be separated from phenol and the other cresols by fractionation through a good column, and for that reason can be purchased pure. Neither meta- nor para-cresol is regularly offered for sale in its pure form, since it is impossible to separate these by fractionation. Instead a mixture, known as meta-para-cresol, is offered.

The cresols are more efficient bactericides than phenol and at the same time are less poisonous, consequently they are preferred for many uses. The important formaldehyde condensation products known as the synthetic phenolic resins can be prepared from the cresols as well as phenol. The cresols play an important part in the manufacture of certain coal-tar colors and are often prepared pure by the dye manufacturer.

Tar Bases. In contrast with the acidic compounds found in coal tar there exists a group of basic compounds, containing nitrogen, of which the most important are pyridine and its derivatives. These are extracted from certain of the tar oil fractions by washing with dilute sulphuric acid.

Pyridine, however, is rarely isolated pure. Commercial grades generally contain a little water and higher boiling bases. The more volatile fraction of commercial pyridine (115 to 160 deg. C.) is used as denaturing alcohol because of the nauseating taste and

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[5] Census of Dyes and Coal-Tar Chemicals, 1920. U. S. Tariff Commission. (See CHEM. & MET. ENG., vol. 25, No. 4, p. 166, July 27, 1921.)

[6] H. D. Gibbs and C. Conover, U. S. Patent 1,284,888, Nov. 12, 1918. This patent was developed in the Color Laboratory of the U. S. Bureau of Chemistry, and is dedicated to the people of the United States.

[7] *Chem. Zentral.* (1919), vol. 4, p. 688. A number of patents covering the preparation of hydro-naphthalenes have been applied for—e.g., International Specifications 147,474; 147,476; 147,478; 147,580 to G. Schroter, Berlin.

mell which it imparts. The higher fractions are used as solvents in purifying anthracene.

Creosote Oil and Pitch

By far the greater percentage of the compounds in coal tar are not worked up for isolation in the pure state, but are sold as constituents of creosote oil or pitch, and it is in these products that the bulk of the tar distiller's business is done. Accordingly uses for these products are extremely important to the tar distiller.

Creosote Oil. The term creosote is used in a very broad sense in commercial practice and includes many products which do not have their origin in a byproduct coke plant. In this article the term "creosote oil" will be applied to the residual oils obtained after the crystallization of the naphthalene and anthracene and extraction of phenol and cresols. Such oils form high-grade agents for the preservation of wood or almost ideal liquid Diesel fuel.

Certain purchasers require a creosote containing more naphthalene than the above oil contains. This furnishes an additional outlet for the crude naphthalene, which can be added as desired. The demand for creosote the last few years has been so great that much low-grade foreign material has been incorporated with coal-tar distillates. A favorite mixture is coal tar 20 per cent, coal-tar oil 80 per cent. Mixtures containing water-gas tar are also employed.

Pitch. Since the amount of pitch obtained from coal tar is very large (about 50 to 60 per cent by weight of the tar), it is very important to so conduct the distillation that this shall be marketable at its maximum value. For this reason tar distillers generally run to a certain grade of pitch, rather than to a certain percentage of oil, or to a certain vapor temperature.

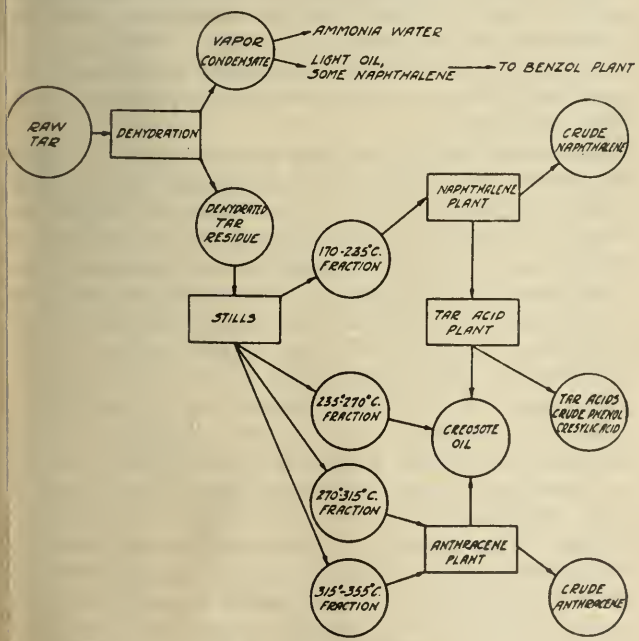

FIG. 1. FLOW DIAGRAM OF THE PROCESS FOR REFINING TAR

Pitch may be graded into three groups: (1) Soft, (2) medium, and (3) hard. These grades of pitch have a great variety of uses, among which may be mentioned:[8]

(*a*) Roofing.—This use is so well known that it requires only passing mention.

(*b*) Waterproofing.—Tunnels, bridges, underground construction in general makes important use of pitch as a waterproof binder.

(*c*) Paving.—Coal-tar pitch has had wide application in the construction of many types of paving. The use of soft pitch as a binder in concrete and tar macadam roads has been extremely important lately. Block and brick pavements use pitch as a filler.

(*d*) Paints and Protective Coatings.—Solutions of pitch in coal-tar solvents are used for iron and steel, for acid-proofing and alkali-proofing, and for waterproofing.

(*e*) Pitch Coke.—A comparatively recent development is the demand for pitch coke as a source of carbon for the electrochemical industries. This promises to furnish an outlet for hard pitch.

(*f*) Miscellaneous.—A great many other uses may be mentioned such as core compounds for casting, as a briquet binder, as a pipe dip, as an insulating medium for electrical purposes and many other purposes.

The exact specifications for the pitches which are to be used for these purposes vary from purchaser to purchaser and are supplied by the purchaser, so they cannot be conveniently given here.

The complete production of pitch may be utilized in the coke plant. A brief discussion of this will be found on a later page.

Processes Involved in the Refining of Tar

The processes involved in the refining of tar take the sequence shown in Fig. 1.

Dehydration. The first process in the distillation of tar is that of dehydration. Thick layers of crude tar if suddenly heated will foam and spatter disastrously because of the explosive formation of steam from water droplets dispersed through the tar probably as in an emulsion. To avoid this, the tar is sometimes dehydrated in special apparatus where only thin films are exposed to the source of heat, which may be indirect. In this, the tar is gradually heated until the vapor temperature reaches 170 deg. C., thereby removing most of the water and free ammonia, together with a little naphthalene and a small amount of tar bases and oil.

In a tar distillery operated in conjunction with a byproduct coke plant, the oil is run to the light oil plant. The naphthalene will of course appear in the still residues from the light oil plant.

The Carbolic Oil Fraction. Naphthalene. The sequence of the operation upon the first or carbolic oil fraction (170 to 235 deg. C.) is indicated in Fig. 2.

The hot dehydrated tar is run to the stills, where it is further heated and the condensate evolved collected in appropriate fractions.[9] The carbolic oil fraction (170 to 235 deg. C.) first appears. This contains the phenol, the cresols and a large part of the naphthalene. Some pyridine is also present in this fraction. Upon cooling to atmospheric temperatures the oil is usually converted into a semi-crystalline mass which does not flow satisfactorily. For that reason it is pumped from the receiver while still warm and forced into the naphthalene crystallizing pans. Here it is allowed to remain at atmospheric temperature for from 3 to 5 days. The oil, generally brown in color, is then drained as completely as possible. The naphthalene crystals still entrain a large amount of oil, so these are shoveled by hand from

[8] Weiss, *J. Ind. Eng. Chem.*, vol. 8 (1916), p. 841.

[9] It is beyond the scope of this paper to consider in detail the construction and operation of the stills.

the crystallizing tanks and wheeled to the centrifuge, where much of the remaining oil is removed. The crude naphthalene is washed upon the centrifuge with a jet of cold water (about 18 deg. C.). It is then sufficiently pure to meet many specifications for crude naphthalene and may be sold as such. It is coarsely crystalline and somewhat oily, and generally possesses a dirty light brown color. Its melting point varies, but is generally well above 60 deg. C. The impurities are water, oil, tar acids and tar bases.

This crude naphthalene is often further purified. The first operation is recrystallization. The naphthalene is melted and again run into shallow pans. After standing for a few days, the crystals are centrifuged and washed with a stream of cold water. This recrystallized naph-

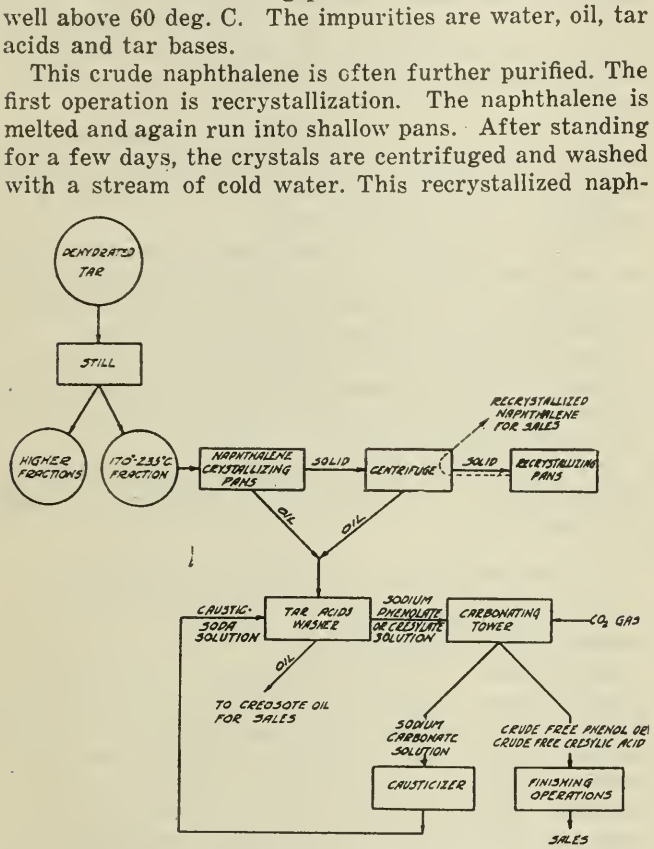

FIG. 2. FLOW DIAGRAM OF THE PROCESS FOR REFINING THE CARBOLIC FRACTION (170 TO 235 DEG. C.) OF TAR

thalene is still brown in color but much lighter than the crude grade described above. The melting point may be raised to 76 deg. C. or higher. The impurities are very much reduced, but still of the same nature as those associated with the crude naphthalene described above.

This recrystallized naphthalene can be converted into pure white naphthalene for balls and flakes by a very simple process. However, most tar distillers do not carry out this final purification, so it will not be described here.

The important control tests are: (1) Dry salt test for determining the content of naphthalene in an oil, (2) melting point tests for the quality of the naphthalene, and (3) distillation of the naphthalene. Water, if present, is also determined.

Recovery of Tar Acids. Many tar distillers do not isolate the tar acids as such, but sell instead the oils containing the tar acid. There are a number of modifications of tar-acid recovery, one of which is as follows:

The drain oil from the naphthalene pans and centrifuge used on the 170 to 235 deg. C. fraction is allowed to stand to settle out any ammonia liquor which it may contain, then is run into a suitable washer equipped with agitators. Here it is brought into intimate contact with a solution of caustic soda having an initial specific gravity of about 1.10 or containing approximately 8 pe cent NaOH. The total amount of caustic required de pends upon the tar-acid content of the oil and is dete mined by shaking a sample with increasing amounts c caustic until the oil volume no longer contracts. Fo tar of the analysis given above, this will not excee 140 gal. of 8 per cent caustic soda per 1,000 gal. c raw tar.

The tar acids consist mainly of phenol and the cresol and it is generally advisable to separate these, for i normal times the phenol is of higher value than th cresols. This separation is accomplished by takin advantage of the fact that phenol is a stronger aci than any of the cresols. In the presence of insufficien alkali the phenol will combine with the alkali, whi the cresols remain free, or if to cresol already combine with caustic (i.e., sodium cresylate), there is added a oil containing phenol, the phenol will drive out th cresol from its combination and form sodium phenolat instead. The process of washing which utilizes th property of competing and exchanging is known a the "interchange" process and is applied somewhat a follows:

Interchange Process for Separating Phenol Fro Cresols. To the charge of fresh oil in the agitator the is added less caustic than is necessary to combine wit all the phenol. (The correct amount can be determine by analysis. The probable ratio is 1 part of phenol t 2 parts of cresol, and the probable caustic use is abou one-third the total requirements.) The water-solub sodium phenolate formed is then drained into the phenc ate storage and a fresh portion of caustic added. Th will combine with some phenol and some cresol and held for "interchange" in the "interchange" storag A third and final portion of the caustic is placed upo the oil. This combines with the remaining cresols a is drained into the cresylate storage. When a secon lot of oil is to be washed, the phenol is extracted wi a portion of the caustic as before and is carried to th phenolate storage.

Meanwhile the chemist has ascertained the compos tion of the tar acids in the interchange storage tank This interchange liquid is run upon the washer a thoroughly agitated, then drained into an interchan storage tank until its composition has been ascertaine If the phenol content has risen to a crystallizing poi of 15½ deg. C., it has been converted into substantial pure phenol and is sent to the phenol storage. If no it is held for further interchange. Meanwhile a thi washing with fresh caustic is under way. The resulti product is reserved in a second interchange stora tank for analysis and is held for interchange or sent the cresylate storage depending upon the chemist's r port. The fourth and last wash is sent to the cresyla storage. The important control test in this process the determination of the crystallizing points of the t acids. Commercial coal-tar phenol crystallizes at 1 deg. C., while coal-tar cresol, substantially free fro phenol, does not solidify at —80 deg. C., so it is n difficult to interpret the test and apply it to the inte change process as described above.

In some tar distilleries phenol and cresylic acid a separated without resort to the interchange proces Less caustic than is necessary to combine with the e tire phenol content is employed for the first was which is of course practically pure phenolate. The r maining tar acids are extracted by a second wash. T

ixture of phenol and cresylic acid subsequently obained from this second wash is distilled through a olumn and the first or phenol fraction collected sepately. However, the interchange process is preferred, specially in the larger tar distilleries.

The washing process demands efficient agitation, for he caustic soda solution is immiscible with and slightly eavier than the oil. The mixture should be kept warm 30 deg. C., for example). If too hot, the extraction is ncomplete; if too cold, naphthalene may separate from he oil and cause trouble, for the tar acids aid in keepng naphthalene in solution and their removal permits he oil to deposit more naphthalene. The agitation is ontinued for from an hour to an hour and a half.

Decomposing the Phenolate and Cresylate.—The henolate or cresylate is then allowed to settle thorughly in order to free it as far as possible from he oil. The aqueous phenolate or cresylate is drawn off ntil an emulsion of oil and water appears in the sight ox. To assist in the further removal of oil, the phenolte or cresylate is allowed to remain in the appropriate torage tanks until needed and care is taken not to mpty these tanks completely when feeding the carbonting tower. An oily layer gradually collects at the urface of the storage and this must, of course, be leaned out at rare intervals.

From the storage tank the phenolate or cresylate is assed to the top of the carbonating tower.[10] Here it neets in counter-current a stream of gas containing arbon dioxide.

Carbon dioxide is a much stronger acid than either henol or the cresols and consequently combines with he sodium compound to form sodium carbonate, at the ame time liberating the phenol or the cresylic acid.

The gas, which is generally high CO_2 flue gas from oke-fired steam boilers, is purified by passing it through dust separator and washer. The washer may be a ower packed with limestone chips over which a stream f water flows counter-current to the gas current. This emoves sulphur dioxide and a little hydrogen sulphide vhich, if not removed, would gradually convert the odium salts to sulphate, which is worthless, since it annot be recausticized.

Often a flue gas of sufficiently high CO_2 content is not vailable. In such cases, it is generally the custom to uild a special coke-fired furnace for the production of he CO_2. The efficiency of the furnace may be increased y adding limestone to the coke charge.

At the bottom of the carbonating tower there is disharged a two-phase mixture consisting of spent liquor an aqueous solution of sodium carbonate) and subtantially insoluble free tar acid. This mixture is passed hrough two separators in series, the spent liquor being rained to the sodium carbonate storage while the phenol nd cresylic acid is run into an appropriate receiver for ettling. Here it is permitted to remain for several ours to remove the entangled spent liquor. From these ettling receivers the tar acid is run in measured quanities to a lead-lined finishing tank to be treated with measured amount of sulphuric acid. (Generally 60 eg. Bé. or 77 deg. sulphuric acid, sp.gr. 1.7, supplied rom an acid tank above.) It is necessary to use this acid because complete decomposition of the sodium phenolate or sodium cresylate does not take place in the carbonating tower. The sulphuric acid also aids in the removal of water. The acid is added carefully until the mixture changes blue litmus paper red. The tar acid is then tested for its water content in the laboratory, and in case the content is found to be greater than 15 per cent more sulphuric acid is added.

When the tar acid is properly finished, it is separated from the waste sulphuric acid layer by draining this through the sight box. The waste sulphuric acid is run into the waste storage. The crude cresylic acid generally contains some phenol, and it is often redistilled. The still is equipped with a good column, since the cut between phenol (b.p. 184 deg. C.) and orthocresol (b.p. 188 to 191 deg. C.) is a close one. A receiver for still residues must be provided, for the still cannot be run completely dry. The still residues are subsequently reworked and may yield as much as 80 per cent cresylic acid, the remainder being pitch and loss. A holder for pitch is also provided. Cresylic acid pitch has no special value and is mixed with the regular coal-tar pitch.

Before shipping cresylic acid, it is submitted to air blowing to "sweeten" it by driving out the hydrogen sulphide which it generally contains. It is then ready for sale.

In order to render this process of extracting tar acids economical, it is necessary to recausticize the sodium carbonate. A high-grade quicklime is used for this purpose. When a special carbon dioxide kiln is used, this produces a lime which can be used in the causticizing.

The oil which has been washed for tar acids is drained free from entangled cresylate solution. It may then be washed for pyridine or again worked up for naphthalene. With naphthalene sales at their present low point, the most economic disposal would probably be to run the drain oil into the creosote and keep the naphthalene in solution by the addition of anthracene drain oils. The 235 to 270 deg. C. fraction generally contains so small an amount of tar acids that it is not worked up for these. It is, however, often worked up for naphthalene. At present, it would probably be pumped into the creosote oil.

Redistillation.—Under certain local conditions it is best to submit the fractions containing tar acids and naphthalene to redistillation in order to concentrate these products before submitting the oils to the crystallizing and washing processes described above.

Anthracene Oils.—The fractions taken above 270 deg. C. (viz., 270, 315 deg. C. and 316 to 355 deg. C. *supra*) deposit crude anthracene upon cooling.[11,12] The process of extracting this is very similar to the crude naphthalene process, save that artificial cooling is sometimes resorted to in order to increase the anthracene recovery.

Crude anthracene is dark green to brown in color and possesses a pasty crystalline form. It generally separates in small crystals which hold considerable oil, the whole giving a buttery appearance very familiar to tar distillers. To separate these crystals from oil is some-

[10]In some tar distilleries the phenolate or cresylate is decomosed by the addition of sulphuric acid. This process, while less xpensive to install and more simple to operate, involves higher roduction costs, since the sodium sulphate produced is practially worthless and must be thrown away, necessitating the purhase of fresh caustic for each washing for tar acids. It is, herefore, generally used only in small recovery plants and will ot be described here.

[11]There is of course no sharp temperature break at which the presence of crude naphthalene ceases and the anthracene solids appear. The oils show a transition in which the content of crude naphthalene progressively declines while the content of the constituents of crude anthracene rises.

[12]The highest temperature attained during distillation varies considerably. The pitch, if overheated, may coke. To obviate this danger, a gas or steam is generally blown through the charge in the last stages and vacuum may be applied.

times difficult. A filter press is generally employed for this purpose.

The pressed crude anthracene cake still contains considerable oil, together with a large amount of other impurities such as carbazol, phenanthrene, acenaphthene, etc., which are solid at ordinary temperatures. The anthracene content is relatively low and may render the product unmarketable as such. It is then necessary to recrystallize it.

This is done by dissolving the first crude anthracene in hot naphthalene drain oil from the 170 to 235 deg. C. fraction. If redistillation of naphthalene oils is practiced, a light, clean redistilled drain oil is used. An excess of the hot oil is mixed with anthracene at a temperature of about 80 deg. C. The proportions sometimes used are 1 ton of pressed anthracene to from 500 to 600 gal. of oil. When all the anthracene has gone into solution in the hot oil, the mixture is permitted to cool to about 20 deg. C. The oil and crystals are then run upon a centrifuge for separation. The crystals are spun until thoroughly dry, washed with cold water, and bagged for shipment. They may contain from 30 to 50 per cent of anthracene. The residual oil is added to the creosote.

With changing local conditions, it is sometimes advisable to depart from the above practice somewhat. There sometimes appears between the naphthalene and anthracene fractions an intermediate fraction whose solids are so impure that they are not worth working up. This fraction is run directly into the creosote. Just above this there may be a fraction which gives a high quality of anthracene (as much as 35 per cent anthracene or higher) merely upon cooling and filtering. This may comprise as much as three-fourths of the remaining anthracene fraction. Still higher there may be a fraction which gives only a low-grade anthracene upon filtering and which must therefore be crystallized from hot naphthalene drain oil in the manner previously described.

Creosote Oil.—The character of the creosote oil ma be controlled to some extent by the omission of certai fractions and the inclusion of others, by the addition o omission of crude naphthalene, or of the carbolic o fractions which have not been treated to remove th tar acids. In this manner it is possible to obtain cre sotes capable of filling many widely different specifica tions.

At the present time fuel oil is abundant and not to expensive. However, the time is not far distant whe our dwindling oil reserves will probably compel th utilization of tar distillates as a source of liquid fuel Indeed, those companies which are at present adva tageously situated in respect to a suitable coal suppl are in a position to obtain such distillates today at price which compares favorably with fuel oil.

Pitch.—The pitch obtained by distilling oil from ta at vapor temperatures higher than 360 deg. C.[13] is ge erally a hard pitch. It is of course a simple matter manufacture a softer grade by stopping the distillatio at an earlier stage, and by careful regulation secu any commercial grade of pitch.

At a coke plant run in conjunction with a steel work it is generally not necessary to depend upon sales fo the disposition of pitch. Thus, with a tar having th analysis given, the distillation may be stopped at th end of the 235 to 270 deg. C. fraction, leaving a so pitch residue which can readily be liquefied by stea heating, and therefore in every way suitable for use a an open-hearth fuel in place of raw tar, provided onl suitable provision for steam preheating be supplie The oils, naphthalene and tar acids recovered by suc a distillation will total about 26 per cent of the volum of raw tar distilled and represent some of the mo valuable products of the tar distillery.

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[13]See footnote 12.

Iron Ore Mined and Shipped in 1921 Estimated by U. S. Geological Survey

The iron ore mined in the United States in 1921, exclusive of that which contained more than 5.5 per cent of manganese, is estimated at 29,547,000 gross tons, a decrease of 56 per cent as compared with the output in 1920. The shipments of ore from the mines in 1921 are estimated at 27,009,000 gross tons, valued at $89,688,000, a decrease in quantity of 61 per cent and in value of nearly 69 per cent as compared with the shipments in 1920. The average value of the ore per gross ton at the mines for the whole United States in 1921 is estimated at $3.32; in 1920 it was $4.11. The stocks of iron ore at the mines, mainly in Michigan and Minnesota, apparently increased from 11,378,794 gross tons in 1920 to 13,872,000 tons in 1921, or 22 per cent.

The output of iron ore in 1921 was the lowest since 1904, when 27,644,330 tons was mined.

The accompanying table shows the quantity and value of the iron ore mined and shipped in the United State by the principal producing districts. The figures fo 1920 are final; those for 1921 are subject to revisio

ESTIMATE OF IRON ORE MINED AND SHIPPED IN THE U. S. IN 1921

District	Ore Mined, Gross Tons		Ore Shipped, Gross Tons		Value	
	1920	1921	1920	1921	1920	1921
Lake Superior	57,945,049	25,394,000	59,677,331	23,155,000	$253,620,578	$81,091,000
Ala., Ga., N. C., Tenn., Va	6,766,794	3,022,000	6,702,730	2,946,000	19,330,818	6,343,000
N. J., N. Y., Pa.	2,085,959	668,000	2,096,321	444,000	10,266,130	1,278,000
Western	740,226	429,000	740,637	429,000	1,460,968	839,000
Conn., Md., Mass., Mo.	66,437	34,000	64,422	35,000	327,833	137,000
Total	67,604,465	29,547,000	$69,281,341	$27,009,000	$285,006,327	$89,688,000

French Production and Supplies of Naval Stores

Latest estimates indicate that the French productio of naval stores has not been as seriously affected by th summer droughts as was previously predicted, accor ing to information from Consul Jaeckel, of Bordeau printed in the Jan. 2, 1922, issue of *Commerce Report* The total production for 1921 is estimated at 31,0 tons of turpentine and 105,000 tons of rosin, pitch, et or 4,000 tons less turpentine and 15,000 tons less ros than in 1920.

Estimated stocks of naval stores held by merchan and distillers in the Bordeaux region total 1,000 to of turpentine and 6,800 tons of dry products. Th estimated amount in France at the close of 1921 wa 7,000 tons of turpentine and 30,800 tons of dry product

Colloidal State in Metals and Alloys. II—Crystallization

Primary Crystallization of Pure Metal Consists of the Coagulation of Very Tiny Crystalline Particles From a Molten Isocolloid—Recrystallization Consists of a Migration of Like Particles Across a Finely Dispersed Solid Mother Liquor Called the Amorphous Phase*

By JEROME ALEXANDER
President, Uniform Adhesive Co., Brooklyn, N. Y.

BEFORE considering the effects of the mechanical and heat treatment of metals and mixtures of metals (alloys), let us first try to follow mentally what happens upon the slow cooling of a hot saturated solution of a crystalloid salt—sodium chloride, for example, since it has no water of crystallization. As the kinetic energy of the system drops and the capacity of the water to maintain the salt molecules (or their ions) in motion diminishes, some salt molecules are extruded as it were from the solution, only to be dissolved again while others are extruded; for there exists a condition, not of static but of kinetic equilibrium, varying with the temperature.

Crystallization of Salt Solutions

If, however, a number of salt molecules are extruded in such a position and so close to one another that they may cohere—i.e., within the radius of molecular attraction—they may form a crystal nucleus, or "crytallogen," which in proportion to its size will tend to take from the cooling solution more extruded molecules than it gives back. Such dominant nuclei tend to form on the relatively cooler walls of the containing vessel or on any added nucleus or foreign surface providing a "rear guard." Quick cooling produces more extruded molecules per unit of time, and agitation tends to bring the extruded molecules into contact; therefore both these factors tend toward the formation of more numerous and smaller crystals. Where large crystals are desired, it is the practice in chemical works to crystallize in large tanks, which are carefully insulated and left undisturbed for weeks.

Extreme care is necessary to grow large perfect crystals from solution, the temperature being controlled within very narrow limits to maintain the slight degree of supersaturation at which no new nuclei or spontaneous crystals will form and yet the seed crystals (or large added nuclei) will grow. R. W. Moore[1] has grown clear, perfectly developed crystals of rochelle salt 3 in. long, the process taking about a month in a thermostat sensitive to about 0.01 deg. C. Of particular interest is his statement that crystals grow faster near the bottom of the crystallizing vessel than at the top, for this is evidence of a gravitational accumulation of molecular groups (nuclei or "crystallogens") at the bottom quite analogous to the separation of the particles in colloidal solutions, as demonstrated by Perrin.

Crystallization continues until there is reached the kinetic equilibrium corresponding to the final temperature; and we have discrete crystals of sodium chloride bathed in a mother liquor containing a residual amount of salt in solution or true crystalloid dispersion. Impurities tend to collect in the mother liquor, and if they are protectors (in the colloidal sense) may inhibit or modify crystallization as they accumulate, as is the case with molasses, for example.

Crystallization of Pure Metal

Even with pure metals under the best conditions, the path of crystallization is not as smooth as is the case with salt solutions, but is beset with complicating factors. There is no foreign restraining solvent, the viscosity is great, the attraction between the closely packed metal molecules is tremendous, and the metal soon forms a hard skin so that the interior crystals are formed under pressure or strain. With some metals there may be formed a geode-like center, where slower cooling and lessened or more equalized strain may result in the formation of large well-developed crystals.

But the metal seldom reaches the crystallization equilibrium, toward which it strives, for the enormous increase in viscosity which accompanies its rapid loss of heat prevents the aggregation tendencies of the metal molecules from entirely establishing themselves, and there results a mass of metallic crystals embedded in a finely dispersed solid metallic "mother liquor," the so-called amorphous phase.

The amorphous phase is colloidal, as its name, appearance and properties indicate, and contains a mixture of submicroscopic crystals or crystal fragments with unoriented or random clusters, possibly in the form of isotropic globulites; for the globulitic form, according to many investigators, seems to be a precursor of the crystalline condition. As stated in the first article in this series, at higher temperatures, before visible crystallization occurs, the whole metal probably exists as an isocolloid. The extent to which this state is altered in the direction of a visibly crystalline mass, embedded in a colloidal matrix, depends largely upon the speed of chilling. In impure metals and in alloys the composition of the phases and the presence of substances which hasten or inhibit crystallization are important factors.

Von Weimarn holds the view, in which the writer does not concur, that all molecules and molecular groups are crystalline, that crystallinity is the only internal state of matter and that in general no amorphous substances exist in nature. This view would give to the words "amorphous" and "crystalline" significations they do not at present possess. Besides the X-ray spectroscope shows[2] that many organic colloids, such as gelatin and starch, and also some inorganic colloids (silicic acid

*Part I, on Molten Metal, appeared in Chemical & Metallurgical Engineering, vol. 26, No. 2, p. 54, Jan. 11, 1922.

The present series of papers was written mainly in the fall of 1919. Reduced to about half their original form, they were read before the Columbus meeting of the American Institute of Mining and Metallurgical Engineers, October, 1920, and will so appear in vol. 64 of its *Proceedings*. They are now given in full, together with some recent additions which are indicated by enclosure within square brackets [].

[1] *J. Am. Chem. Soc.*, vol. 41, p. 1010 (1919).

[2] Scheerer, *Nachr. Ges. Wiss. Göttingen*, vol. 96, p. 100 (1918); *Chem. Abs.*, vol. 13, p. 2624.

and stannic hydrosols) consist of or contain groups of molecules arranged in an unoriented, haphazard or random manner; so that even if the molecules themselves are crystal prototypes, they can and do occur in non-crystalline groups.

Zay Jefferies[3] has shown that with metals, in general, the cohesion of the amorphous phase equals that of the crystalline phase at the lowest recrystallization temperature, which he terms therefore the equicohesive temperature; and based on this he has explained the mechanical behavior of metals at various temperatures. At higher temperatures than the equicohesive point, the cohesion of the amorphous phase decreases more rapidly than that of the crystalline phase—i.e., it becomes relatively softer—whereas at lower temperatures than the equicohesive point its cohesion is greater and increases with much greater rapidity than that of the crystalline phase. Fig. 1, taken from Jeffries' paper, shows these facts diagrammatically.

These differences between the two phases are intelligible from the following considerations: The atoms in the crystalline phase, though arranged in regular layers, are on the average closer packed,[4] and therefore at lower temperatures cannot draw together as much as those of the amorphous phase, which consequently becomes relatively stronger at lower temperatures; whereas at higher temperatures, the molecules of the amorphous phase become separated and mobile more readily than those of the crystalline phase, for they possess initially more potential energy[5] since they are less closely packed—i.e., further apart on the average—and are, therefore, less strongly held to one another by molecular forces; consequently the amorphous phase becomes relatively weaker at higher temperatures. The fact that, even at room temperatures, some of the molecules of some metals possess mobility was demonstrated by Roberts-Austen, who showed that gold and lead when placed in contact diffused into each other after a lapse of years.

Recrystallization

As a result of this preferential softening, the amorphous or colloidal phase, at relatively higher temperatures, acts like a very viscous solvent surrounding and nourishing the more rigid crystals; and as increasing temperature renders this solvent less viscous, the metal strives toward crystallinity, which represents the position of minimum mechanical potential. Some metals, like lead, undergo such molecular readjustment, even at room tempartures. During this process of recrystallization below the melting point it has been observed that, in general, large crystals tend to grow at the expense of the small ones. A similar process is observable in the crystallization of salts, for, as Hulett has shown, finely ground powders are more soluble than a coarse grinding of the same substance. Therefore the smaller metal crystals would preferentially dissolve in the "amorphous" or colloidal phase. Bearing in mind that the growth of a crystal means that there are deposited upon it more molecules or molecular groups (crystallogens) than are dissolved off, the larger masses would naturally get most of these extruded units, just as happens in the cosmic field. The larger crystals have the advantage of exposing to the solvent action of the amorphous or colloidal phase less surface per unit of mass; and when metal molecules or molecular groups deposit on a crystal, they release a certain amount of energy, the heat of crystallization or latent heat of fusion, which helps to make the amorphous or colloidal phase more fluid.

Do the small crystals dissolve molecule by molecule, or in molecular masses or groups as well? It would seem that in some cases at least molecular groups are dissolved off and transported, for in strained metals especially recrystallization is extremely rapid. Thus in sheet aluminum[6], when heated to a suitable temperature, recrystallization takes place like a flash, the originally smooth sheet becoming coarsely granular, suddenly, before one's eyes. The writer has observed[7] ultramicroscopic particles streaming from a crystal of sodium citrate as it went into solution, indicating that initially solution took place, at least partially, in colloidal molecular masses.

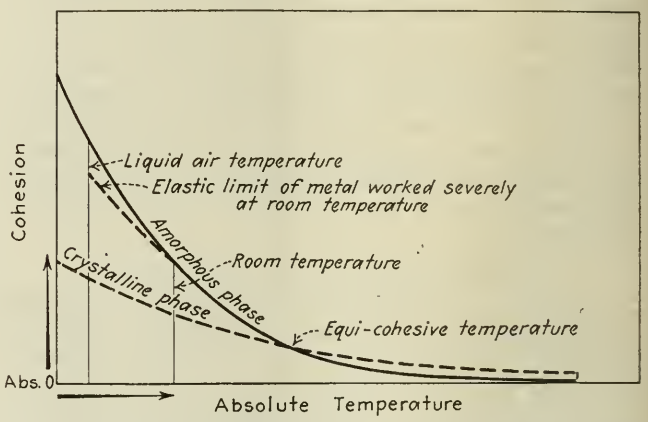

FIG. 1. DIAGRAMS SHOWING CHANGE IN ELASTIC LIMIT AND HENCE DUCTILITY OF A METAL SEVERELY WORKED AT A CERTAIN TEMPERATURE AND TESTED AT AND BELOW THAT TEMPERATURE

The amorphous or colloidal phase becomes, therefore, a medium for the transfer of atoms, molecules or molecular groups from the small to the larger crystals, and also tends to annihilate itself by allowing its constituent oriented and unoriented particles to be incorporated into the huge Juggernaut crystals.

The preceding remarks have been based upon a consideration of *pure* metals, which are practically never met with, for most commercially pure metals contain as impurities several other metals, elements or compounds. Besides, most metals are used in the form of mixtures or alloys—steel, brass, bronze, type-metal, babbitt metal, solder, etc. The introduction into a metal of a single impurity, even in minute percentage, usually produces a very marked change in its properties or behavior—for example, 1 part of carbon in 10,000 of iron, or 1 part of copper in 10,000 of gold—and as it seems to me that in many cases this effect involves, at some stage, the direction, modification or inhibition of the normal crystallization of the metal by a colloidal dispersion of some substance or substances, it is desirable at this point to consider the general question of the effect of colloids upon crystallization.

Most experiments in this field have been made with aqueous solutions or dispersions, and the rule seems to

[3] *J. Am. Inst. Metals*, vol. 11, p. 300 to 324 (1917). See also *J. Inst. Metals*, vol. 20, p. 109 to 140, and *Trans. Am. Inst. Min. Eng.*, Bull. 146, February, 1919.

[4] Pope and Barlow. The intrinsic weakness of the crystal lies in its tendency to rupture along lines of slip or cleavage.

[5] As Graham said, colloids possess energia.

[6] Dr. G. H. Gulliver, *J. Inst. Metals*, vol. 20, p. 158 (1918).

[7] Alexander and Bullowa, "Archives of Pediatrics" (1910).

be that a colloid which is adsorbed by, or which forms an adsorption compound with, the initial colloidal aggregations of the crystallizing substances either prevents the growth of its crystals or groups beyond colloidal dimensions or else forces their growth to assume globulitic or dendritic forms which vary with each substance, each colloid and each set of conditions. Thus gelatin, gum arabic and similar stabilizing or protective colloids, even in small quantity,[8] oppose the aggregation of the gold atoms at the instant of their liberation to such an extent as to yield a highly dispersed hydrosol under conditions that would otherwise yield a coarse blue or black gold suspension. The use of gelatin (about ½ per cent), eggs and similar colloids in ice cream[9] leads to the production and stabilization of very fine or colloidal ice particles, giving the product the desired smooth velvety texture; without colloids the ice cream becomes grainy or sandy, the undesirable roughness being due to large or spicular crystals.

Coming now to substances which form solid crystals at ordinary temperatures, we see in Table I that colloids exert a powerful inhibitory action on the crystallization of plaster of paris,[10] not only preventing the formation of ordinary crystals but delaying or even entirely preventing the "setting."

TABLE I. EFFECT OF GELATIN ON PLASTER OF PARIS

1 Part Plaster to 1 Part Water Containing Gelatin per Cent	Time to Set in Minutes	Microscopic Appearance of Slide
0	40	Characteristic crystals of calcium sulphate.
1/100	50	No crystals, except in a few spots where some colloid-free solution had diffused out.
1/10	260	No crystals.*
1/4	510	No crystals.*
1/2	960	No crystals.*
1	Not set in 48 hr.	No crystals.*
2	Not set in 48 hr.	No crystals.*

*No regular, ordinary crystals, the mass consisting of aborted, modified or sphero-crystals, or of colloidal crystals or other minute unoriented groups, or of a mixture of these.

The effect of colloids on the crystallization of ordinary salts is most remarkable[11] and I hope to be able to publish further results of experiments along this line. Meanwhile I may say that with each salt, each colloid and each set of conditions (concentration, temperature and pressure) there are formed characteristic groupings in which dendrites and spherulites are exceedingly common; also very beautiful and complicated leaf-like, branching and cellular forms, reminding one forcibly of living structures. Indeed it seems evident that the growth and shape of living organisms are largely controlled by the complex interplay of the forces of crystalline growth, as restrained, modified and directed by colloidal substances.

If the amount of colloid is so small that it is all adsorbed by these structures before the salt has entirely crystallized, well-defined crystals of the colloid-free salt may appear. On the other hand, if enough of the colloid is present, ordinary visible crystallization may be entirely prevented; and in intermediate cases abortive attempts at crystallization register themselves in curious formations. The preparation of a few microscopic slides with solutions of NaCl, $MgSO_4$, Na_2So_4 and Na_2CO_3, containing from 0.5 to 50 per cent (figured on the dry salt) of gum arabic or gelatin, will give some idea of these effects[12] and show their striking resemblance to the microstructure of metals. The slides may be made by putting on a drop of the mixture and allowing it to dry without a cover glass. During the drying, changes in temperature and concentration occur within the drop, with the result that the field changes progressively from the center.

Production of Fine Grain

This resemblance led me to comment[13] as follows regarding metals: "Since coarsely crystalline metals are brittle, tending to split along the lines of crystal cleavage, various physical and chemical means are employed in technical practice to obtain a hard, fine-grained structure.[14] Among the physical methods are chilling and rolling, while the chemical methods involve the removal of undesirable constituents (as in the conversion of pig iron into steel), or the addition of desirable constituents (as in case-hardening and the manufacturing of 'chromium steel' and 'nickel steel'). For example, P. Pütz[15] has shown that the predominant effect of vanadium in steel is to decrease the size of the ferrite grains and make the material harder; it renders the ordinary structure due to pearlite fine-grained and homogeneous.[16]

"Now while the question is one of very great complexity, many of the facts at present available seem to indicate that one of the causes favoring the fine-grained structure is the inhibition of crystallization by substances colloidally dissolved in the molten mass. Thus, part of the carbon in iron and steel exists in the graphitic form, and as graphite is slightly soluble in iron[17] some of it will, under proper conditions, be found in colloidal form.[18] Besides, metals may dissolve one another and other substances colloidally, but in the case of ordinary metals this is not easy to demonstrate, although a differential solvent acting in the presence of a protective colloid might leave a colloidal residue."

Amorphous Metal and Cold Work

In conclusion let us consider some of the aspects of the amorphous theory regarding the change of metals under strain, which is stated by one of its principal advocates, Rosenhain, as follows[19]:

"It may be well to state precisely what is understood, in this connection, by the term 'amorphous.' In accordance with Beilby's views and their recent development by the author [Rosenhain] and his collaborators,[20] the amorphous condition is one in which the crystalline arrangement of the molecules is completely broken up, so that the molecules remain in a state of irregular arrangement similar to that which is supposed to exist in the liquid state. In fact, the amorphous phase is re-

[8] Excessively minute quantities may have the contrary effect and actually sensitize. While this condition has not been observed in metals, it evidently forms the basis of the phenomenon known to physicians as anaphylaxis.

[9] J. Alexander, *Koll. Zeit.*, vol. 4, p. 86 (1909).

[10] Jerome Alexander, *J. Soc. Chem. Ind.*, vol. 28, p. 280 (1909).

[11] J. Alexander, *Koll. Zeit.*, vol. 4, p. 86, (1909).

[12] A mixture of Na_2CO_3 and NaCl crystallized in the presence of gelatin may form a "flowering plant," the Na_2CO_3 forming gracefully curved "stems" and the NaCl characteristic four-petaled "flowers."

[13] *J. Soc. Chem. Ind.*, vol. 28, p. 280 (1909).

[14] See P. Longmuir, *J. Iron and Steel Inst.*, September, 1907; *J. Soc. Chem. Ind.*, vol. 26, p. 1064 (1907).

[15] *J. Soc. Chem. Ind.*, vol. 26, p. 614 (1907).

[16] See also Beilby, *Proc. Roy. Soc. A.*, vol. 79, p. 463; *J. Soc. Chem. Ind.*, vol. 26, p. 926 (1907).

[17] See C. Benedicks, *Métallurgie*, vol. 5, p. 41 (1908); *J. Soc. Chem. Ind.*, vol. 27, p. 406 (1908).

[18] Carnegie Research Reports, *J. Soc. Chem. Ind.*, vol. 27, p. 570 (1908); F. Wüst, *J. Soc. Chem. Ind.*, vol. 26, p. 412 (1907); Hersey, *J. Soc. Chem. Ind.*, vol. 27, p. 531 (1908).

[19] "Introduction to Physical Metallurgy," p. 249.

[20] Rosenhain & Ewen, *J. Inst. Metals*, vol. 8, No. 2 (1912) and vol. 10, No. 2 (1913). Rosenhain and Humphrey, *J. Iron and Steel Inst.* 1913, I.

garded as being—from the point of view of the phase doctrine—identical with the liquid phase. Now extremely undercooled liquids are well known in such substances as glass, vitreous silica, etc., and they are hard, brittle bodies devoid of plasticity and of crystalline structure. Amorphous metal is, therefore, to be regarded as being identical in nature with the liquid metal if that could be cooled down to the ordinary temperature without undergoing crystallization. It is admitted that such extreme undercooling of metals has never been actually accomplished, and objections to the whole concept of amorphous metal have been based on that ground. These cannot be discussed here, but they have been fully dealt with by the author [Rosenhain] elsewhere.[21] At the present moment it may well be claimed that the theory of an amorphous phase in metals, produced as a result of mechanical disruption of the crystalline arrangement of the molecules, holds the field as the best working hypothesis available. There are admittedly outstanding difficulties, but these the author regards as being inevitable in a theory whose wide generalizations cover a field which has as yet been but partially explored.[22]

Effect of Plastic Deformation

"The general effect of slowly applied or 'static' plastic deformation may be summarized as follows: The metal in the cast or the annealed state is an aggregate of crystals; when the metal undergoes plastic deformation, the crystals are deformed in the same general sense as the mass of metal. This change of shape of the crystals is accomplished by a process of slip or gliding by which layers of the crystal slide over one another along certain gliding planes. Such slip occurs on a great multitude of planes in each direction and, as a rule, it must occur on at least three sets of planes, but it may occur on a greater number. This slip is accompanied by a certain disturbance of the crystalline arrangement of the molecules on or near the surfaces of the slip. If the deformation has been slight, the disturbed molecules may be able to rearrange themselves in accordance with the crystalline system by which they are surrounded, and the completely crystalline character of the metal will then be unaffected by the deformation. When the deformation is severe and if it is intensely localized, as when a single crystal is bent upon itself, the molecular disturbances at the slip surfaces become larger and permanent layers of amorphous metal are formed on each surface where slip has occurred. Ultimately the metal, as a result of extreme deformation, becomes a mass of crystal fragments embedded in relatively thick layers of amorphous material. This change is accompanied by an increase in the hardness of the metal and —in the majority of metals—by a measurable decrease in density."

This amorphous view stresses particularly the entire absence of regular orientation or crystallization in the so-called amorphous phase, whose molecules are supposed to be in the random and, mainly, isolated state assumed to exist in liquids. I believe, however, that the amorphous phase consists largely, if not entirely, of molecular groups, many of which may be oriented in the form of ultramicroscopic crystals or crystal fragments; and that its properties are due, not to the entire lack of ori entation among its particles, but rather to the fact tha many or the majority of its molecular groups are of col loidal dimensions. Since in metals the molecules are very close together and possess extremely high cohesion o crystallization tendency, it does not seem possible tha the amorphous phase can be composed entirely of isolate molecules, or even entirely of non-crystalline groups With gold hydrosols where the dispersing water exer cises a restraining influence, the X-ray spectroscop shows that the ultramicroscopic, and even that th amicroscopic, gold particles are crystalline. With th most drastically chilled metal, allowing for the high vis cosity and its rapid increase, it does not appear conceiv able that no tiny ultramicroscopic crystals form, or a least that there is no grouping, regular or irregular of the metal molecules. The facts indicate and are i harmony with the conception of amorphous metal as a isocolloid—that is, as a dispersion of colloid crystals crystal fragments or non-crystalline groups in still mor finely dispersed metal—or else a mixture of colloida crystalline and non-crystalline groups, forming a soli gell-like mass. The fineness of its particles and th enormous development of free surface found in all col loids are its critical factors.

The idea here advanced, that metals, in the course o their aggregation, pass through a colloidal stage whic exerts a powerful influence on their structure and prop erties and may even be partly retained in the final prod uct by "protection," adsorption, crystallization or in crease in viscosity due to quenching, is not limited to th field of metallurgy, but may be applied to any substanc or system where a portion or a component becomes col loidal while the remaining portion or components ar outside of the colloidal zone. The case of glass ha been mentioned in the first article of this series, wher some components apparently inhibit the ordinary crys tallization of the others under operating conditions This theory may also account for the fact that under on set of conditions Na_2CO_3 crystallizes with ten molecule of water, while under other conditions it may be crys tallized with seven molecules of water; and the effloresce crystals hold only one molecule of water. Sodium sul phate acts similarly, forming $Na_2SO_4.10H_2O$, $Na_2SO_4.7H_2O$ and the anhydrous salt Na_2SO_4.

Influence of Atomic Groups

Liquids appear to consist largely of atomic or molecu lar groups and solids of still more complex groups, th size and nature of which depend upon conditions[23]; an among these groups those of colloidal dimensions as a rule appear and must then be reckoned with. Th "twinning" of crystals,[24] which is a marked characteristi of γ iron, α brass, and especially of worked or strained metals on annealing, is probably due to colloida influences.

This and many other questions, such as the effect o other metals on iron and steel (so-called alloy steels) and the adsorption of gases at the free metallic inter faces, etc., though germane to this paper, must be lef

[21] Rosenhain, *Engineering*, October, 1913. *Internat. Zeit. Metallographic*, vol. 5, 1914.

[22] Heyn, "Report on Progress of Metallography From 1919 to 1913," Internat. Testing Assoc. N. Y. Congress, 1912. Tammann. *Zeit. Elektrochim.*, vol. 18, July, 1912. Guertler, *Internat. Zeit. Metallographic*, vol. 5, 1914.

[23] W. E. S. Turner ("Molecular Association," p. 99) says: "The formula of a substance shall be recognized as a function of the physical conditions under which it exists, so that the formula for elements is X_n, for compounds $(XY)_n$, where n is to be specified according to the conditions. Although we are far from realizing how n varies for most substances, the adoption of such formula would bring home clearly the fact that both the physical and the chemical behavior of a substance may be closely dependent on the value of n."

[24] [See paper by P. Niggli, *Koll. Zeit.*, vol. 10, p. 268, entitled "Colloid Chemistry and Twin Crystals."]

for future consideration. The work of P. W. Bridgman[25] with high pressure is very suggestive. For example, he found that, whereas cylinders of soft tool steel (1.25 per cent C) and soft chromium-nickel steel (Krupp Special E.C. 60.0) ruptured under the same pressures, whether water or mercury was the pressure-carrying fluid in contact with the metal, the same steels when hardened broke at much lower pressures (about one-third) with mercury than with water. The rupture was due to the amalgamation of the steel, which when once started spreads rapidly under the high hydrostatic pressure.

But even a pressure of 6,500 atmospheres for 12 hours failed to cause the amalgamation of hard or soft steel rods, although the rods were polished with fine emery paper immediately before being plunged into the mercury. On the other hand, hard and soft steels and cast iron (also Al, Ni and Co) were promptly amalgamated on the fresh surfaces formed by breaking the metals under mercury.

Bridgman speaks of "dirt" preventing amalgamation; but from the recent work of W. B. Hardy, on fresh surfaces, and of I. Langmuir and others, on adsorption, it would seem that instantaneous adsorption from the atmosphere, probably of gases, is responsible, although a change in the nature of the surface may have some effect also. Freshly cleaved sheets of mica show a similar effect; their initial coherence is speedily lost. With steel, as with gelatin jellies, the quickly chilled specimens show greater porosity because of the greater total area of the diffusion paths consequent upon finer subdivision.

(Part III, dealing with White Metal and Brass, will appear in a subsequent issue.)

Need for a Scientific System for the Evaluation of Gelatin and Glue

DR. R. H. BOGUE, of the Mellon Institute of Industrial Research, speaking before the New York Section of the American Chemical Society on Jan. 6, stressed the very evident need for a better and more logical system for determining the value of gelatin and glue. Evaluation methods, which have been used in the past and are still adhered to, do not adequately differentiate these products. There are three fundamental reasons for this.

Three Faults of Present System

First, the methods of grading do not at present invariably get at the real property or properties which mean value. They are usually aimed in the right direction, but too often fail in attaining the end desired. A gelatin or glue costing 50c. may, by the present system, be judged inferior in gelatin content or in sticking qualities to one costing 45c. This is not the fault of the manufacturer or the jobber, but is rather a reflection on the chemist for not providing the former with a truly representative system for evaluating his product.

Second, there are so many systems now in use for designating quality—in fact, nearly every glue house in the country uses somewhat different methods—that it becomes almost hopeless to attempt to specify a desired product by any symbol and be certain that a product of the desired properties will be obtained. The same specifications sent to a number of glue houses will not result in the selection by them of exactly equivalent lots, and the several lots obtained will not be equivalent in binding strength or in gelatin content. The standards for reference are inadequate. A viscosity of 45 in one house may be the equivalent to a viscosity of 100 in another house due to the employment of different instruments, or different temperatures, or different concentrations.

Third, an inevitable consequence of this system, and which reacts to the advantage of the manufacturer, is the confusion of the consumer. It leaves too wide a margin upon which the unscrupulous salesman may play. There being no standard of quality, there can be no standard of price that is sufficiently conspicuous to the consumer to make impossible the "putting over" on him of questionable deals.

It should be possible to establish specifications in gelatin and glue that are comprehensive and intelligible, and every such effort should be given careful consideration. From among the many suggestions, a competent committee of chemists should select one, or some combination, that shall be established as a standard.

Proposes Viscosity as Basis for Primary Evaluation

Dr. Bogue has studied the fundamental relations between gelatin content and adhesive strength on the one hand, and jelly strength, viscosity and melting point on the other hand. He has found that a differentiation by noting the melting points is also expressive of the differentiation in the gelatin content and the adhesive strength. The gelatin content is a fundamental property and the adhesive strength is the most important practical property of glues. Since these are not easily determined, but are found to be proportional to the melting point, the latter is a satisfactory test upon which to base grade.

But the melting point test is tedious and not well adapted to control work in a large plant. It was found that the viscosity at a temperature of 32 deg. C. and a concentration of 20 per cent made by the MacMichael viscosimeter differentiated gelatins and glues in the same order as the melting point, and was especially well adapted to plant control work. The instrument is a standard one and obtainable from any chemical supply house; its readings may be expressed, without any calculation, in absolute degrees or centipoises. Thus we have a specification in a universal language, upon a standard instrument, that is representative of actual quality, and that is readily adaptable to plant practice. This, according to Bogue, should constitute the primary basis for evaluation.

Secondary tests, also expressed in some standard language, may be made to determine the adaptability of the product to a given service. These include the customary tests for foam, grease, reaction, etc. A test for hydrogen-ion concentration should be added, as the properties of the product vary with this factor.

The designation of grade may well be expressed in terms of the viscosity in centipoises (or more conveniently in centipoises divided by ten) of the material as shown in the test outlined above. This number could be used as a subscript to a letter referring to the origin of the material. Thus products designated as H_{13} and B_{16} would refer respectively to a material from hide having a viscosity lying between 130 and 139 centipoises and to a material from bone having a viscosity between 160 and 169 centipoises.

[25] See "The Action of Mercury on Steel at High Pressure," *Proc. Am. Acad. of Arts & Sciences*, vol. 46, pp. 325-341 (1911); also subsequent papers.

The Bucher Process for the Fixation of Nitrogen*

An Account of Small- and Large-Scale Experiments in the Production of Sodium Cyanide From Soda Ash, Carbon and Iron—Comparison of Results With Those of Other Investigators—Details of Furnace Design

By M. deKAY THOMPSON

THE fixation of nitrogen by means of the reaction $NA_2CO_3 + 4C + N_2 = 2NaCN + 3CO - 138{,}500$ calories in the presence of iron as catalyzer and at a temperature of about 1,000 deg. C. was discovered by Lewis Thompson in 1839, but on account of the extensive research carried out by Prof. John E. Bucher[1] in recent years on this reaction it is commonly known as the Bucher process.

During the war a plant was built by the government at Saltville for the purpose of making cyanide by this reaction.[2] The briquetted mixture of soda ash, carbon and iron was heated in ferrochromium tubes 9 in. in diameter by means of gas, and the charge was passed continuously through these pipes. The plant was not running at full capacity at any time and was shut down when the armistice was declared. As far as is known, there is at present no plant operating commercially according to this process. Besides the article by Bucher referred to above, shortly after the present work was begun there appeared an article by Ferguson and Manning[3] in which it was shown that the reaction is reversible and the quantity of cyanide formed depends on the amount of carbon monoxide in the nitrogen-carbon monoxide mixture in contact with the solid substances of this reaction. Bucher states in his paper that just as good results are obtained with air which has been passed over hot carbon as with pure nitrogen. This statement is evidently incorrect. It was also found that for a given percentage of carbon monoxide in the gas a higher cyanide yield was obtained at 1,000 deg. C. than at 940 deg., which is of course a necessary consequence of the fact that heat is absorbed in the formation of cyanide. Two other articles on the Bucher process may be mentioned. Posnjak and Merwin[4] find some nitrogen compound other than sodium cyanide in the crude technical product, and confirm Bucher's reaction given above. Morimoto[5] easily obtains yields of 75 per cent, using iron turnings and charcoal at 820 to 950 deg. C.

It was found necessary in the course of this work to do a considerable number of experiments on a small scale on account of the unsatisfactory yields of cyanide obtained in the first experiments when the mixture was made from metallurgical coke and iron flour. These were supposed at the time to be the proper materials. Furthermore, the briquets in many cases became very soft or fell to powder on the treatment with nitrogen, and it was necessary to find some way of preventing this disintegration. These experiments will be described first.

Procedure in Small-Scale Experiments

The briquetting was carried out in a meat chopper as described by Bucher after mixing hot in a Werner & Pfleiderer mixer and the briquets were dried in covered iron pots, heated by a bunsen burner. A few experiments were made with briquets of $\frac{3}{16}$ in. diameter, the majority with briquets of $\frac{5}{16}$ in. diameter, but the diameter was not found to have any effect on the result. The heating in nitrogen was done in vertical tubes. In the preliminary experiments a steel tube of 1.25 in. inside diameter and 2 ft. in length was heated by a resistance coil which was insulated from the tube by a sheet of asbestos, and also heat-insulated on the outside. In later experiments iron pipes of $1\frac{3}{8}$ in. inside diameter, $1\frac{11}{16}$ in. outside diameter and 5.5 ft. long were used, holding about 600 g. of briquets. These were heated by passing an alternating current through the pipe. The lowest voltage available was 10 volts, which gave 2,400 amp. when the pipe was cold and 1,600 amp. when hot. The temperature was regulated by opening and closing the circuit at short intervals approximately of 1 minute duration. This was equivalent to a continuous input of about 2 kw.

These pipes were heat-insulated with asbestos pipe covering somewhat too large to fit the pipe, and the space between the pipe and the covering was filled with loose asbestos-magnesia mixture. The temperature of the outside of the pipe was taken at regular intervals at five points along the tube by a platinum-platinum rhodium thermoelectric couple protected by silica tubes. These tubes were inserted through the asbestos pipe covering and carried in direct contact with the iron tube. Repeated comparisons between the indications of the couple and of an optical pyrometer showed that the couple read about 80 deg. lower than the temperature of the pipe. All readings were corrected accordingly. The temperature of the briquets inside the iron tube may have been a few degrees below the temperature of the tube itself, but no comparison was made. The briquets were held up by an iron gauze placed inside the tube. The nitrogen was taken from a tank of highest grade nitrogen, and was measured by an ordinary house dry gas meter. The tube was filled with briquets through that portion of its length which was heat insulated, then with nitrogen, and the current applied. The exit gas was lighted, and when the flame would no longer burn (in later experiments analyses for carbon monoxide were made until the absence of the gas showed the reaction was complete) the pipe covering was removed, and the tube permitted to cool

*This research was carried out for the U. S. Smelting, Refining & Mining Co. The author wishes to express his thanks to this company for permission to publish these results.

[1] *J. Ind. Eng. Chem.*, vol. 9, pp. 233-252 (1917).

[2] Brown, *J. Ind. Eng. Chem.*, vol. 11, pp. 1010-1013 (1919).

[3] *J. Ind. Eng. Chem.*, vol. 11, pp. 946-950 (1919).

[4] Eugen Posnjak and H. E. Merwin, "Notes on the Bucher Cyanide Process for the Fixation of Nitrogen," *J. Wash. Acad. Sci.*, vol. 9, p. 28 (1919), abstracted in *Chem. Abs.*, vol. 13, p. 891 (1919).

[5] Y. Morimoto, "The Fixation of Nitrogen as Cyanide," *Kogyo-Kwagaku Zasshi (J. Chem. Ind. Japan)*, vol. 21, p. 881 (1918), abstracted in *Chem. Abs.*, vol. 13, p. 363 (1919).

with a small current of nitrogen passing through it. The charge was removed when cool, divided into a top, middle, bottom and average portion, ground, and analyzed for cyanide by titrating with nickel sulphate,[4] and for total alkali by titrating with sulphuric acid, using methyl orange as indicator.

The temperature of the pipe was usually between 940 and 1,040 deg. C. In some pipes there was excessive local heating, and in this case the pipe was rejected.

It may now be interesting to compare some of Bucher's results with those obtained in these experiments.

Comparison With Bucher's Results

In Bucher's experiments, No. 5, made with graphite, iron and sodium carbonate, the flame was colorless, while in No. 4, where the iron was omitted, the flame was yellow colored. Bucher takes this as evidence "showing that no sodium was formed when iron was present." In the present experiments, where iron was always present, the cool top of the tube frequently had an incrustation which contained metallic sodium. On throwing it into water it reacted violently and sometimes took fire. At the same time the flame was colorless, consequently a colorless flame is no evidence that small amounts of sodium are not produced at the same time that cyanide is formed.

TABLE I. EFFECT OF GRINDING PETROLEUM COKE AND IRON

(Iron flour contained 91 per cent iron. Analysis of dried briquets: 21.3 per cent iron, 29.5 per cent soda ash. Duration of each experiment: one hour.)

No.	Hours Grinding	Deg. C.	Per Cent of Cyanide	Average Conversion in per Cent
15	11	950–1,050	2.7	20.5
16	57	950–1,050	12.2	47.0
17	72	950–1,050	16.0	61.5
18	15	950–1,050	7.0	41.5
19	23	1,050	12.0	53.6
20	30	1,050	7.4	51.0
21	30	1,050	8.7	*49.2
22	70	1,050	8.4	39.0

* Duplicate of No. 20.

Bucher does not discuss the question as to what composition produces a hard briquet after treating with nitrogen. In the present experiments it was found that the briquets increased in hardness when the content in alkali and iron was increased at the expense of the carbon. Briquets which after heating analyzed about 80 per cent iron plus total alkali (with the iron and alkali in about equal amounts) were hard, while if this sum was only 70 per cent, the briquets were nearly always soft. This would correspond to about 24 per cent iron as Fe_2O_3 and 29 per cent soda ash in the dried briquets before the run.

The percentage of sodium converted to cyanide is one of the most important factors in this process. The results obtained on this point may be stated in a very few words: (1) The finer the particles of iron and carbon the higher the conversion of the sodium to cyanide (or the "purity," as Bucher calls it), and (2) the highest results were obtained with those forms of carbon that had very little ash, such as petroleum coke, lampblack, graphite, gas carbon and charcoal. Coke with 10 per cent ash gave very poor results, as shown below. The effects of prolonged grinding in a ball mill are shown in Table I.

These results are apparently contradictory, for in Nos. 15 to 17 there is a continued increase in conversion with the duration of the grinding, while in Nos. 18 to 22 the conversion first increases and then decreases. The only difference in the procedure in the two series was that in the first a small ball mill of about 2 liters total capacity was used, in the second a large one about 2 ft. in diameter. Steel balls were used in both mills. This question was not pursued further, for better results were obtained without excessive milling.

The conversion in these runs was decidedly low, and it was evident no better could be obtained with this iron.

Experiments With Different Forms of Iron

The experiments tabulated in Table II show the effect of using different kinds of iron, including precipitated iron oxide, which is the finest form obtainable. The iron oxide was prepared by dissolving iron sulphate and precipitating this with a solution of soda ash. The precipitate was washed free from sulphate, dried and ground a few hours with carbon in a ball mill. Soda ash was then added and the grinding continued half an hour.

The important result of small-scale experiments was that the best conversion with iron flour was about 60 per cent, with iron scale as high as 76 per cent was obtained, both at the expense of very long milling, and with precipitated iron oxide (which was of course reduced to finely divided iron in the furnace) 90 per cent conversion was reached. Coke containing 10 per cent ash gave low conversion (No. 32).

Before it was found that mechanically strong briquets could be made without a binder, sodium aluminate (No. 28) and anthracite ashes (No. 29) were tried as binders. The ashes had very little binding quality, and both were harmful. Gas carbon (No. 54), graphite (No. 71) and charcoal (No. 73) were all tried and gave excellent results when used with precipitated iron oxide. A final lot of briquets made from charcoal for the purpose of testing the product for leaching purposes gave the following analysis: Sodium cyanide 34.5 per cent, conversion 92.5 per cent, iron 41.9 per cent. These briquets were more than sufficiently hard.

TABLE II. EXPERIMENTS WITH DIFFERENT FORMS OF IRON

(Duration, 1 hour)

No.	Sample	Per Cent of Iron	Form of Carbon	Soda Ash (per Cent)	Hours Grinding	Temp. (Deg.C.)	Ave. Content of Cyanide (In per Cent)	Per Cent Conversion	Remarks
4	Iron oxalate	23.0	Lampblack	27.0	...	1,035 to 1,060	18.0	73.0	.....
12	Iron oxalate	23.0	Lampblack	27.0	...	950	13.3	76.8	.....
14	Iron oxide (c.p.)	20.0	Petroleum coke	....	...	1,050	16.5	80	.....
23	Iron scale	21.3	Petroleum coke	30.6	42	1,050 to 955	15.0	76.5	.....
25	Iron scale	21.3	Petroleum coke	30.6	42	1,040 to 880	18.1	73	.....
26	Iron scale	21.3	Petroleum coke	30.6	42	1,040 to 890	15.8	72.1	.....
28	Iron scale	21.3	Petroleum coke	32	24	950 to 1,040	18.6	60.0	5% $NaAlO_2$ contained as binder
29	Iron scale	21.3	Petroleum coke	30.6	42	1,060 to 870	14.2	61.5	Contained 5% anthracite ashes as binder
32	Iron scale	20.1	Coke with 10% ash	31.0	41	1,040 to 990	5.6	24.5	.....
34	Precipitated iron oxide	21.3	Petroleum coke	32.6	7.5	1,040 to 880	16.3	79.0	45 min. duration.
50	Precipitated iron oxide	21.8	Petroleum coke	24.8	...	995 to 855	25.2	85.0	35 min.
55	Precipitated iron oxide	24.0	Petroleum coke	25.0	...	1,020 to 930	19.2	90.0	40 min.
70	Precipitated iron oxide	24.0	Petroleum coke	29.0	...	1,040 to 900	32.1	84.2	74 min.
71	Precipitated iron oxide	22.0	Graphite	29.0	...	950 to 1,040	20.6	59.8	96 min.
73	Precipitated iron oxide	20.2	Charcoal	28.2	...	1,040 to 940	35.1	87 5	72 min.

In heating a mass of properly prepared briquets for

[4] Lundell and Bridgman, *J. Ind. Eng. Chem.*, vol. 6, p. 554 (1914).

the purpose of producing cyanide, it is essential to have a temperature between 900 and 1,500 deg. C. throughout the whole mass. Too low a temperature to produce cyanide may still be high enough to cause a continuous evolution of carbon monoxide from the action of carbon dioxide dissociated from the soda ash on the carbon of the briquets. This will prevent getting good results. The lining of the furnace must be neutral or basic so as not to be attacked by the charge, and must not contain any oxides reducible under the furnace conditions, otherwise there would be carbon monoxide from this source.

These briquets are not good enough conductors of electricity to heat from a cold state by applying any reasonable voltage, and in order to accomplish this result it was planned to mix them with gas carbon passed through rolls $\frac{1}{32}$ in. apart and sifted free from the powder. The granules of gas carbon were of small size so that they could be separated from the briquets by sifting after treatment with nitrogen. It was found subsequently that a similar plan had been patented by Shoeld,[7] the only difference being that in this patent the conducting material is about the same size as the nonconducting material mixed with it.

Design of Furnace

A furnace was designed and built according to Fig. 1. It consisted in cylindrical iron shell divided into two halves by a plane passing through its axis. The edges were flanged so the two halves could be bolted together. It was supported on trunnions with a worm and gear attachment for dumping the charge. The first lining consisted of magnesite bricks, which were built into the two halves separately. The temperature inside could be taken by inserting a thermoelectric couple into any of three steel tubes running through the furnace perpendicular to the axis, at the top, at the bottom and at the center.

It is evident from considerations of heat flow that in order to get a fairly uniform temperature through a section of the furnace perpendicular to the axis of the cylinder it would be necessary to have a lining with a much lower heat conductivity than that of the charge. The first experiment showed that the magnesite brick lining did not meet this requirement, for it was found that the temperature of the charge next the walls was only 600 deg. while that at the center was 1,000 deg. It was also found that with one or two exceptions the temperature at the bottom was much less than at the top. The cause of this was unquestionably the lower resistance of the lower part of the charge due to the pressure of that resting on it. In a continuous furnace where the charge would pass through both the hot and the cool parts, this second difficulty would disappear, but where a lot of briquets are heated and then dumped, either of these faults would prevent the efficient formation of cyanide. The results of some of the runs in the large furnace with magnesite brick lining are given in Table III.

[7] U. S. Pat. 1,317,327 (Sept. 30, 1919).

Discussion of Results

This table shows that some cyanide was made when a fairly uniform temperature was reached by means of a layer of gas carbon placed as an annular layer between the charge and the lining. (See experiments 58, 61 and 62.) The heat was generated in this layer; and at first the outer layer of briquets was hotter than the center. Later, when the briquets began to conduct, the center became somewhat warmer than the outer layer of briquets. The experiments were made merely to see what could be done with the furnace as it stood; it

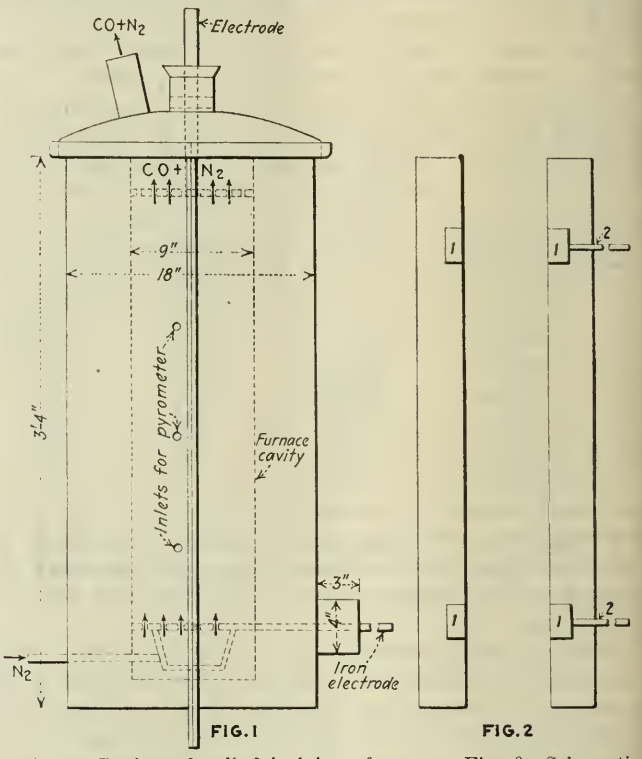

Fig. 1—Design of cylindrical iron furnace. Fig. 2—Schematic design of a continuous electric furnace. 1, Circular carbon electrodes imbedded in furnace walls. 2, Iron rods for electrical contact with carbon electrodes.

TABLE III. EXPERIMENTS IN LARGE FURNACE WITH MAGNESITE BRICK LINING

No.	—Per Cent— of Iron Initial	Final	Soda Ash, in per Cent	—Temperature Deg. C.— Top	Middle	Bottom	— Per Cent of — Cyanide Top	Middle	Bottom	Conversion in per Cent Top	Middle	Bottom	Duration, Minutes	Grams of Cyanide Produced	Weight of Charge in Grams Initial	Final	Remarks
53	17.8	22.6	25.3	1,350	1,020 to 580	960 to 600	2.0	1.7	14.0	10.5	8.2	7.5	180	138	8,150	5,650	.....
57	24.0	....	25.3	1,040 to 700	...	830	1.1	....	....	4.5	....	....	35	...	3,500	....	Thin layer of gas carbon surrounding charge.
58	24.0	....	25.0	.....	1,040 to 665	.....	13.4	4.4	13.3	42.4	15.2	43.9	90	209	5,000	....	½-in. layer of gas carbon surrounding charge.
61	24.0	....	25.0	780 to 875	990 to 1,090	1,090 to 1,180	29.6	25.0	26.7	93.5	91.7	86.6	215	315	2,790	.	1-in. layer of gas carbon around briquets. 4-in. column of briquets.
62	24.0	...	25.0	900 to 950	900 to 950	Steel tube melted	25.7	25.8	26.3	73.0	80.8	86.0	216	335	3,060		4-in. col. of briquets.
96	....	...	...	860	930	930	..	....	....	....	..	....	...	...	.	.	Furnace horizontal, for test of uniformity of temperature. Gas carbon only in charge.

would evidently not be possible to operate in this way for production purposes.

In experiment 62 the bottom happened to be hotter than any other part of the furnace. This must have been due to some unevenness in the charging; perhaps there was a smaller proportion of gas carbon at the bottom than elsewhere.

These experiments showed that a better heat insulation in the furnace walls would be necessary. The magnesia inner lining should be retained on account of its basic properties, but a thin layer of this should be surrounded with the best heat insulator obtainable. Unfortunately a magnesia pipe of the proper size could not be obtained. An ordinary fireclay pipe was tried surrounded with a special infusorial earth. It was found that this material was not perfectly dry and when used as a lining moisture continued to come off for hours. In order to save time it was then thoroughly dried in a reverberatory furnace, and tried again with only gas carbon as a charge. The reverberatory furnace had eliminated the moisture, and there was very good temperature distribution from the center to the clay pipe, but the exit gas still showed the presence of carbon monoxide. In order to get a high enough temperature at the bottom, the resistance was increased by placing inverted Denver crucibles in piles of two or three deep on the bottom electrode. These, as well as the clay pipe lining were badly attacked by the carbon, giving the evolution of carbon monoxide mentioned. The crucibles produced the result desired, of bringing up the temperature of the bottom part of the furnace. It was found that if the furnace were tilted in a horizontal position, the bottom heated up as much as the top without the crucibles. (Experiment 96.)

The results of the experiments with this furnace show (1) that if used the "batch" method the furnace would have to be tilted on its side to get a uniform temperature throughout its length, and (2) that a lining with at least as low a thermal conductivity as infusional earth must be used for a furnace of this diameter (8 in.), and of still lower for a larger diameter.

Suggested Alterations in Furnace Design

A continuous furnace might be made by imbedding two carbon electrodes in the walls of the furnace as in Fig. 2, where the feeding and discharge mechanism are left out. It is probable that there would be no difficulty on the score of different temperatures at the top and bottom, for the entire charge would pass the hottest part.

It is also possible that after warming up the furnace, cold briquets fed in at the top would be sufficiently warmed by the time they reached the electric circuit to be conducting, without the admixture of gas carbon. This would reqquire less power and avoid sifting. These were points, however, which would require extensive alterations in the furnace to verify.

It seems that simply enlarging the scale of the experiments with iron pipes has a great deal to recommend it. If steel tubes of the right dimensions were well lagged and protected from the action of the air, connected in series with a transformer, and each tube connected with a hopper and a discharge arrangement, it is not easy to see where any difficulty would come in operating.

It would be well worth while trying either or both of these furnaces on a full-size scale.

The following table gives the results of the calculation of power required per pound of cyanide.

Power required—	Kw.-Hr.
For the reaction	0.75
To raise 5 lb. of briquets to 900 deg. C.	0.60
Radiation loss (assumed the same per pound of cyanide as in the large experimental furnace, the charge requiring three hours to pass)	0.65
For heating nitrogen	0.10
Total	2.10

Cost, at 0.5c. per kw.-hr. = 1.1c.

If an equal amount of granular carbon had to be added this would require an additional 0.86 kw.-hr. Assuming that 35 tons of briquets are to be treated a day, producing 7 tons of cyanide, and that each tube could deliver 7 charges a day, 600 ft. of 8-in. pipe would have the required capacity. A cubic foot of briquets weighs about 50 lb. Assuming these pipes to be made of the same kind of iron as the pipes used in these experiments and the walls 1 cm. thick, the resistance of the 600 ft. would be 0.047 ohm when hot. This would correspond to a current of 5,100 amp. at 240 volts.

The cost of raw materials per pound of sodium cyanide would be approximately as follows:

	Theoretical, Lb.	Actual, Lb.	Cost, Cents
Soda ash	1.1	1.5	4.1
Carbon	0.5	0.6	0.75
Cu.ft. nitrogen	3.6	11.0	0.2
Total cost of raw materials			5.
Cost of power			1.1
Cost of power and materials			6.1

It is possible that the total cost would be not less than twice this, or 12c. a pound.

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Production of Mineral Oil in the Dutch East Indies

The following table, given in the Jan. 2, 1922. issue of *Commerce Reports*, shows the production of mineral oil in the Dutch East Indies, by districts, during the past four calendar years:

PRODUCTION OF OIL, IN METRIC TONS OF 1,000 LITERS EACH, 1917, 1918, 1919 AND 1920.

Districts	1917 Metric Tons	1918 Metric Tons	1919 Metric Tons	1920 Metric Tons
North Sumatra	175,839	194,213	176,458	194,440
North Palembang	82,917	121,561	148,295	138,315
South Palembang	222,321	204,215	197,003	203,727
Total of Sumatra	481,277	519,989	521,756	536,482
Semarang Residency	16,790	12,466	7,200	33,818
Rembang Residency	180,827	172,759	194,329	259,371
Soerabaya Residency	55,104	55,952	56,986	59,260
Madura	94	35	140	25
Total of Java and Madura	252,815	241,212	258,655	352,474
Dutch North Borneo	251,939	333,693	602,031	711,108
North Koetei	22	140	64	
South Koetei	617,301	665,733	602,278	744,119
Total Dutch Borneo	869,262	999,426	1,372,140	1,455,227
Island of Ceram	2,256	3,574	7,311	21,137
Grand total for Dutch East Indies	1,605,610	1,764,201	2,159,862	2,365,320

Note—1 United States barrel = 159 liters.

Glass Industry Expanding in Australia

Three glass-manufacturing companies have been registered in Melbourne recently. These are the Victorian Glass Bottle Works Proprietary, Ltd., South Yarra, authorized capital £5,000; the Crystal Glass Manufacturing Co., of Western Australia, Ltd., authorized capital £50,000; and the Zetland Glass Bottle Works, Ltd., authorized capital £150,000.

Electrolytic Iron a Commercial Product*

Manufacture of Boiler Tubes of Electrolytic Iron at Grenoble, France—Briquetted Forms of Pulverized Electrolytic Iron Made Into Magnet Cores at Hawthorne, Ill.—Remarks on Leaching Iron From Sulphide Ores With Subsequent Electrolysis

BY BRADLEY STOUGHTON
Consulting Metallurgical Engineer, New York City

FOR more than 50 years attempts have been made to produce pure iron on an industrial scale by means of electrolysis, which modern metallurgy recognizes as the "tonnage production" method for metals in a pure form and which is the established process since a number of years for pure copper, gold, silver, aluminum, lead, zinc, etc. The combination of unexcelled cheapness with unexcelled utility for many purposes, possessed by *impure* iron, has diverted attention from the superior utility of the *pure* metal over pure copper, aluminum, etc., at a fraction of the price. We now know that pure iron is at least as soft and has better cold-working or drawing qualities than either pure copper or aluminum, besides having great advantages for household and machine purposes in respect of price, durability, maintenance of a bright surface, resistance to corrosion or tarnishing, to heat, etc.

Process of the Société "Le Fer"

The Société "Le Fer," which numbers among its directors the eminent metallurgist Dr. Léon Guillet, controls the patents of Anthèlme Boucher, which were under laboratory investigation for several years prior to 1915, when the first industrial installation was made at the iron and boiler works of MM. Bouchayer and Viallet at Grenoble, France, using electricity from hydro-electric plants in the Swiss Alps.[1]

The electrolyte is ferrous chloride; the anode is iron in the form of cast iron; the cathode is a revolving mandrel upon which the pure iron (containing about 99.97 per cent Fe) is deposited in the form of a tube, which is annealed to eliminate the embrittling hydrogen, stripped and used as a boiler tube, either with or without drawing through a die.

The metal is so soft that no inner "ball" is used in the drawing operation. The 0.03 per cent of impurity is made up of the metalloids of the cast iron—namely, traces of carbon, silicon, sulphur and phosphorus. Hydrogen, which deposits with the metal, is completely eliminated by heat, as indicated by chemical analysis and physical properties, which will be described later. From the commercial viewpoint the Boucher process gains by avoiding the following operations in the making of a boiler tube: Purifying the pig iron; rolling and piercing the billet; annealing and roughshaping the tube. The costly items are as follows: Cast iron for anodes;[2] loss of about 20 per cent in slimes due to the use of a soluble anode; and the use of electricity, which amounts to about one-quarter to one-third of a horsepower-year per ton of tubes produced.

In the matter of purity the Boucher tubes excel any other industrial product, and the process has the great advantage that a thin tube, which is the most costly to make by the prevailing boiler tube process, is the cheapest to make by the electrolytic process. M. Bouchayer says that he is able to meet all commercial competition in producing thin tubes, and he plans the construction of a second plant relatively near Grenoble, which would have double the capacity of the present plant.

Process of the Western Electric Company

The research departments of the American Telephone & Telegraph Co. and the Western Electric Co., in seeking a commercial process for the manufacture of pure iron in a pulverized form, employed the very ingenious expedient of utilizing the hardness and brittleness of electrolytic iron from which the hydrogen had not been eliminated, in order to get the material into a finely powdered form and compress it into magnet cores which would have high electrical resistance because the particles were not soft enough to crush together into a unit mass. When these operations were concluded, the compressed cores were baked to remove the hydrogen, leaving pure iron particles.

This process proved cheaper and better than reducing the iron powder by hydrogen from the oxide. A commercial electrolytic iron plant was therefore equipped at Hawthorne, Ill., with a capacity of about 2 tons of iron per day.[3] This method of securing pure iron proved to be relatively inexpensive and to afford a ready means of controlling the quality of the material.

The cores of the loading coils which are introduced at regular intervals to increase the inductance of a telephone circuit are now made of this material. The electrolyte is of ferrous sulphate and chloride and ammonium sulphate; the anode is mild steel; the cathode of polished sheets of steel, from which the deposited metal is stripped when it has reached a thickness of $\frac{1}{8}$ to $\frac{1}{4}$ in.; the current density is about 12 amp. per sq.ft

Electrolytic Iron Direct From Ore

The deposition of iron by electrolysis is from the electrolyte directly on to the cathode. The use of a soluble anode is only a means of keeping the electrolyte supplied with iron. Any other means of accomplishing the same result would give the same depositions, electrical efficiency, etc. For example, the circulation of the electrolyte, always maintaining it up to the desired standard of iron content, would effect the electrolytic action and avoid some disadvantageous features, such

*Reprinted from the Jan. 5, 1922, issue of *Iron Age*. Slightly condensed.

[1]The process and works have been so well described and illustrated in the technical press, and especially by Guillet in *Revue de Métallurgie*, Mémoires, 1915, February, page 82, and by Jean Escard in *Le Génie Civil*, 1919, Aug. 23 and following issues, that details may be omitted here.

[2]Furthermore, a very impure cast iron must not be used, because some of the metalloids will migrate to the cathode.

[3]A brief description of the plant and process is given in the *Journal* of the American Institute of Electrical Engineers, July 1921, pp. 598, 599, 608 and 609. The magnetic and electrical properties of the material and the completed cores are described on pp. 600 to 608.

as the economic waste due to the loss in slimes with the soluble anode, the migration of impurities from anode to cathode, etc.

This is the novelty introduced by Frederick A. Eustis and Charles P. Perin in patents issued the former and developed jointly by them. This process has passed through the laboratory stage and commercial installation is under way. The solution of iron ore is the means of keeping the electrolyte enriched in iron in proportion as it is impoverished by the electrolytic deposition. The electrolyte is ferrous chloride; the anode is of some insoluble material such as graphite; the current density is 50 amp. per sq.ft. The cathode may be a revolving mandrel on which the iron is deposited in the form of a tube, or it may be in the form of a sheet, or a traveling belt from which the crumbs are removed continuously by mechanical means.

The process thus resembles the copper leaching and deposition process so successfully carried out at Ajo, Ariz., and elsewhere, and the established process of electrolytic zinc production. It faces the necessity of producing a metal which must sell in competition at a price lower than that of copper or zinc, but has the advantage of much lower price for ore and absence of some of the chemical difficulties encountered in the leaching and electrolysis of zinc. It may also be employed in localities where iron ore and a market for iron and steel exist, but where solid fuel for smelting is costly. It differs from the usual "direct process" in that it can deliver a product in finished form, ready for market, instead of a "sponge" which is commercially equivalent

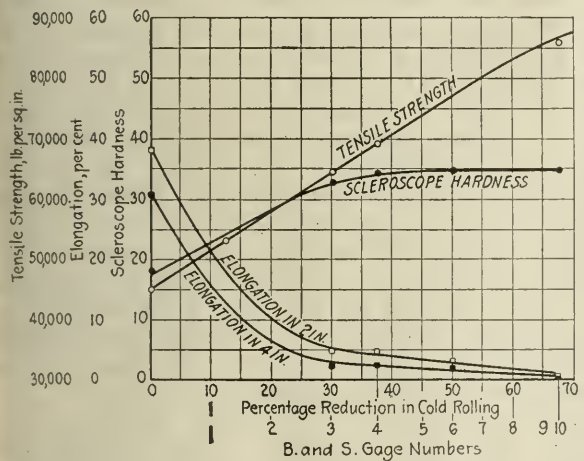

FIG. 1. CHARACTERISTIC CURVES OF ELECTROLYTIC IRON

a poor grade of steel scrap and must be submitted to several processes before it has industrial usefulness. It differs from the electric smelting of iron in that it will produce a very pure product without the use of any flux.

Obviously, it can be applied to any iron ore capable of solution, but its cheapest raw material is the abundant sulphide ores which occur in many parts of the world and which sell at a low price, because, first, of their abundance, and second, their inapplicability to blast-furnace smelting until after a process of complete roasting. Such ores also yield their sulphur content as a byproduct, at a price which more than covers both the cost of sulphur production and the total cost of the ore itself.

The present projected application of the Eustis process is to an iron sulphide ore containing a small amount of copper, and the operations will deliver in marketable form the iron, the sulphur and the copper in one short series of processes.

Pure iron is deposited on the cathode and the ferric chloride formed in the anode compartment is used over again for leaching, thus making the process cyclical. Sulphur is recovered as brimstone and copper is precipitated out on scrap iron. The speed of leaching depends on the fineness of pulverization of the ore, but presents no difficulties whatever after extended laboratory tests, although it is important to avoid unnecessary use of chlorine by mechanically separating such oxides as lime and magnesia before solution. Leaching is assisted by the circumstance that the reaction is

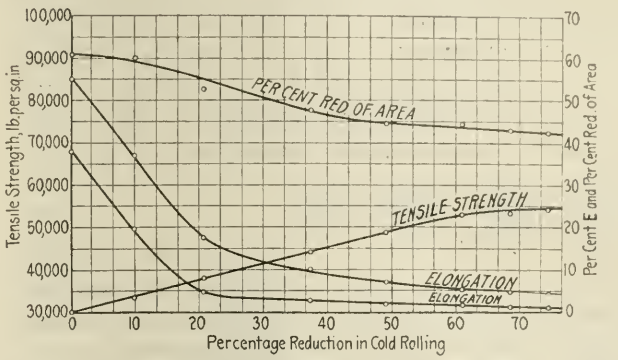
Tensile Strength, lb. per sq. in.
Per Cent E and Per Cent Red. of Area
PER CENT RED. OF AREA
TENSILE STRENGTH
ELONGATION
ELONGATION
Percentage Reduction in Cold Rolling

FIG. 2. CHARACTERISTIC CURVE OF ELECTROLYTIC COPPER

This curve represents the change in physical properties which accompanies cold work on the metal. The abscissas represent percentage in cold rolling.

exothermic. Counter-current extraction has resulted in delivering 97 per cent of the iron and 90 per cent of the sulphur content of the ore.

It is unique in metallurgy for one brief cycle of operations to deliver in marketable form more than 90 per cent of any ore. In the electrolytic vats the electrolyte is circulated vigorously, resulting in smooth, compact deposits being obtained; the cathode current efficiency is 90 per cent and over. With proper control no chlorine is lost, or other noxious gases given off. Each step of the process uses standard apparatus which has been developed after years of commercial operation, so that the transition from laboratory to full-scale industrial operation involves no costly experiments.

Purity of Electrolytic Iron

The only serious impurity in electrolytic iron is hydrogen, and this may be entirely removed by baking at a moderate temperature. Traces of other elements may be present by inclusion during deposition, but no great precautions are necessary to produce metal assaying 99.9 per cent and higher. Tubes made at Grenoble and analyzed in America showed 99.97 per cent Fe, and tubes made by the Eustis process assayed 99.99 per cent. It is noteworthy that it costs no more to make the very pure material than to deposit metal of inferior grade, depending upon the process employed.

Mechanical Qualities of Almost Pure Iron

The mechanical qualities of pure iron are greatly affected by heat-treatment and cold-working; furthermore, the presence of hydrogen, due either to original deposition or to absorption at a red heat (for some persons, through inexperience, have "annealed" the metal in hydrogen gas and then tested it tensilely) destroys its strength and renders it both hard and brittle as well. The crystalline structure of the deposited

metal is fairly coarse and well defined. It is refined on appropriate annealing, and, on rolling or drawing in the cold state, it takes a beautiful fine structure and brilliant polish, which is more than ordinarily durable on exposure to the atmosphere, dampness, etc. Naturally this refining of the structure is accompanied by increase of strength.

An average of tests made by the National Tube Co. on tubes made at Grenoble, in the condition in which they were received, showed tensile strength in the direction of rolling 62,000 lb. per sq.in. and elongation of 12 per cent in 8 in.; the average of three tests of similar material, redrawn and annealed at 900 deg. C. for 20 minutes gave 39,000 lb. per sq.in. tensile strength and 30 per cent elongation in 8 in. (See tests 4 and 6 in the table.) The bursting strength of a Grenoble tube 4 in.

TABLE OF TENSILE TESTS OF ELECTROLYTIC IRON TUBES
(Made at Grenoble, France)
(See also the physical tests in "Characteristic Curve," Fig. 1)

Ultimate Strength, Lb. per Sq.In.	Yield Point, Lb. per Sq.In.	Elongation Per Cent	In.	Red. of Area, Per Cent	
72,600	.....	1.0	2	..	Cold-rolled; tested in direction of rolling.*
78,500	.....	8.0	4	..	As received; tested in direction of drawing.†
57,800	.....	0.5	2	..	Cold-rolled; tested in direction of rolling.*
62,000	52,000	12.0	8	50	As received; average.‡
38,300	.....	0.5	1	..	Cold-rolled; tested across direction of rolling.*
39,000	27,000	30.0	8	60	Annealed; average of three results.‡
41,800	.....	35.0	4	..	Annealed; tested in direction of drawing.†

*Tests made at Columbia University. †Tests made by General Electric Co.
‡Tests made by National Tube Co.

in diameter and 0.03 in. thick, reported by Escard in the *Génie Civil* article cited above, was 1,110 lb., corresponding to a fiber stress of 73,500 lb. per sq.in. It is very probable that pure iron, like very soft steel, would increase greatly in tensile strength without losing much in ductility by subjection to a double heat-treatment.

Cold-Working Properties

In *Le Génie Civil* monograph tests are described and photographs given showing the extraordinary softness and cold workability of the Grenoble tubes. Escard says it is the regular practice at Grenoble to draw five

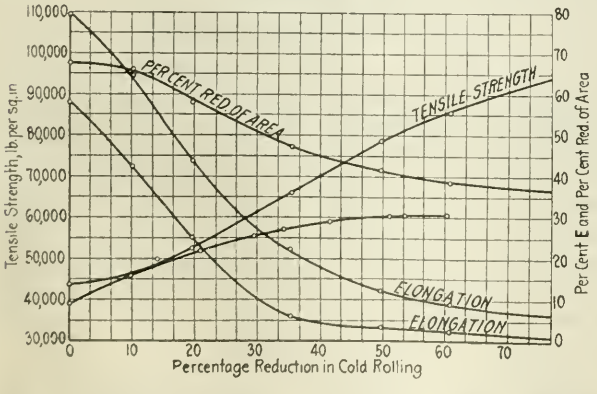

FIG. 3. CHARACTERISTIC CURVES OF TUBING METAL

times through a die without annealing, as compared with the customary practice with soft steel to anneal before each draft. This statement is corroborated by tests made in America, at the plant of the Stanford Steel Products Co., of iron made at Grenoble and iron made by the Eustis process. Tests of cold-rolling, deep stamping after cold-rolling and without annealing, cold-rolling and beading, threading, etc., showed that the electrolytic iron would undergo work with much less frequent annealing than soft, open-hearth steel, and would endure more cold deformation without cracking than ingot iron, Toncan metal, and, in some instances, electrolytic copper.

This softness and ductility open a wide field of usefulness, because the saving in cost of annealings alone (which is an expensive item in cold-rolling work) is an important economic feature, besides the greater ease of working and lessened defective articles. Additional light on the cold-working qualities of pure iron is shown by Fig. 1, "characteristic curve," with which are compared electrolytic copper (Fig. 2) and "tubing metal" (Cu 75 per cent; Zn 25 per cent). The latter is given because its qualities so much resemble those of pure iron.

Resistance to Corrosion

A test made at the Massachusetts Institute of Technology by Prof. Carle R. Hayward showed that a piece of Byer's wrought-iron pipe corroded nearly twice as much, and Shelby steel tubing 2.6 times as much in the atmosphere as electrolytic iron made by the Eustis process. According to the same authority, an immersion test of 22 hours in 5 per cent sulphuric acid gave a ratio of loss of weight per unit of area:

For electrolytic iron	1.00
For steel	4.25
For wrought iron	18.50

Fields of Usefulness

There are many articles whose value is dependent more upon their quality or upon the amount of labor expended on their fashioning than upon the cost of the material of which they are composed. Stamped and beaded articles, like threaded caps, can be made with less annealing and less defective material. The possibility of greater thinness would find its advantage wherever heat conductivity is important, as, for instance, boiler tubes; and even the cook knows that tin cooking utensils bake quicker than aluminum, because they are thinner. The beautiful polish assumed by pure iron after cold-rolling, and its resistance to corrosion, may result in cooking utensils being made without tin, and so perhaps avoiding the color which tinned articles assume after heating and which is the great selling argument for aluminum and nickel utensils.

Thin boiler tubes is a use already mentioned, and involving enormous quantities. Many articles now stamped of copper, because of its softness, could be stamped of electrolytic iron at a greatly reduced price. Where the advantage of increased resistance to corrosion is valuable, there are many uses, such as eaves troughs; boiler tubes (again); pipes and culverts; containers for water and corrosive liquids; parts of automobiles requiring to be bright, ornamental articles to be nickeled and exposed to the weather, where rust soon attacks ordinary steel through its coating and mars its attractiveness; even galvanized, or tinned and painted goods would be more durable if the body of the material were of a less corrosive nature.

Add to this the economic possibility of making electrolytic iron in districts where solid fuel is now too costly for smelting, and we can visualize the commercial advantage of the new industry to localities which already use, or would use, large quantities of articles whose high price is due more to the labor expended on fashioning them than on the cost of the basic material. We are only beginning to secure the information as

to the kind and amount of such articles. Where purity alone is important, we have material like welding wire, for which a fancy price is now paid for relatively pure material. Iron for magnetic purposes has already been mentioned. It is thought that, as greater quantities of pure iron are available for research, investigation will enlarge this field. Electrical conductivity purposes should be included; and, finally, pure material as the basis for the manufacture of high grade, high priced steel for alloy steels, cutting tools, etc.

The "characteristic curves" of electrolytic iron compared with electrolytic copper shown in Figs. 1 and 2 indicate the use of this material in the form of wire for electrical purposes. It is evident that the wire can be cold-rolled so as to have far better tensile properties as transmission lines than electrolytic copper. It will be noted from the previous tests quoted that electrolytic iron has 10 to 20 per cent greater conductivity than steel. It is therefore about the equivalent of copper-clad steel; or the electrolytic iron may be copper clad, thus increasing its conductivity by another 20 per cent or so, and leaving it still not so soft and ductile as to have the objectionable stretching qualities of copper in transmission lines.

Legal Notes

By Wellington Gustin

Test of Unfair Competition Through Use of Some Natural Names in Business

From the United States Circuit Court of Appeals comes an interesting case (271 Fed., 395). A suit in equity for alleged unfair trade competition was begun by the Walker Bros. Co., of Boston, against W. & H. Walker, Inc., of Pennsylvania. This was not a case in which either of the parties resorted to similitude of names for unfair purposes, or of similitude of labels or markings. Both parties had adopted their natural names in their business and defendant was a much older concern. Neither knew of the existence of the other prior to the alleged unfair competition, yet each had been carrying on its business under the name Walker, without fraud, intentional or unintentional, upon each other, and without any substantial confusion or misleading of the consuming public, until the Boston Walkers discovered that the Pennsylvania Walkers were introducing their goods through jobbers and wholesale dealers.

The position of the Walkers of Boston was that under the circumstances they were entitled to the wholesale field in a particular locality, because they were first in that field under the Walker name.

On this proposition the court says such affirmance would interfere with the fundamental rights of reasonable trade competition and with reasonable and commendable purposes of trade enterprise through expansion. However, it is true that business expansion, through instrumentalities in the wholesale and jobbing fields, might be under such circumstances of bad faith, with or without involving deceptive devices, such as similar trade-marks and names, as to make the competition unfair. But none was found in this case.

In some cases of unfair competition the question depends on the purpose or on the good faith or bad faith of the dealers, while in others the question is whether the situation in and of itself, without regard to good or bad faith, is calculated to deceive the public; but the test is always whether trade is being unfairly interfered with, and whether the public is being cheated into buying or paying for something which it is not in fact getting.

Rights After Expiration of Patent Design

In the case of Lenox, Inc., vs. Jones, McDuffee & Stratton Corporation (271 Fed., 511), the Lenox company brought suit upon a design patent, No. 50,064, which had been issued Dec. 19, 1916, under an express term limiting it to 3½ years. The designer was Frank G. Holmes, who assigned his rights to plaintiff.

The design was intended for the face of certain high-grade chinaware. The article was put upon the market as one of great merit, and the sales ran into hundreds of thousands of dollars within a single year.

The court said the chief difficulty of the plaintiff's case was that the patent expired before the menace of infringement claimed by the Lenox company. So the question of unfair competition of the defendants with plaintiff's business became the only serious question involved.

The rights of monopoly, under patents based upon machines, instrumentalities, designs, etc., expire at the end of the term expressed in the patent, and things covered by the patent become public property—provided they are reasonably marked by the name of the manufacturer who adopts them, and are reasonably and properly designated as something made by one, other than the original patentee or producer or manufacturer, by giving the true name of the one who makes them and puts them into the trade, except perhaps in cases exactly like, or perhaps something in very close similitude of, the original in bad faith, to the end that purchasers shall not be deceived into buying a particular thing as an original when it is not.

Case Hinged on Markings

From this law the court said the chief question presented was whether the articles of English manufacture which Jones, McDuffee & Stratton think they may put into their trade are suitably and properly designated as another and as an English product, to the end that they shall reasonably differentiate themselves from the Lenox "Ming." The court found there were considerable differences in the design and coloring in the English and American product, the English ware being of much cheaper grade, selling for one-fifth the price of the American, and the markings on the bottom of the English wares were distinctly different, having the name of the manufacturer and the word "England."

"Patent monopoly," said the court, "was intended by the framers, in the primal sense, among other things to advance science and to encourage invention in respect to instrumentalities, to stimulate original and attractive designs in the field of art, through granting exclusive control to inventors and designers for a limited period. Yet it still remains that it is quite as true, in the broader and more important sense, that there was an intent in the interest of the general public, to the end that the public at large, after the limited monopoly had had its run, should receive the benefits of developments which the government had encouraged through giving exclusive monopoly to inventors and designers for a limited period."

Exclusive control in the Lenox patent had expired by its express terms. Therefore, if there was no wrongful

purpose, the Lenox design, except as to limited qualifications, is open to others. And the court said that if the English product, which the defendant company proposed to use, was suitably marked and designated as English product, so that purchasers would not be led to believe that they were getting the original Lenox "Ming" when in fact they were getting something else, there was no wrong.

Hence the suit against the English company was dismissed.

Protecting Iron With Paint Against Atmospheric Corrosion

SOME experiments in the protection of iron with paint against atmospheric corrosion were described recently to the Iron and Steel Institute (British) by Dr. J. Newton Friend, Carnegie Gold Medalist. These experiments consisted in exposing, for a period of 5 years, a series of plates of steel coated with various paint mixtures, and determining their loss in weight due to corrosion.

These plates measured 2 ft. x 1 ft. x 0.03 in. thick (No. 22, B.w.g.), and were made of open-hearth steel, cold-rolled and charcoal-annealed. They were cleaned by immersion in dilute sulphuric acid, then washed and placed for a few minutes in dilute caustic soda solution to remove any traces of acid. After again washing and drying, the plates were finally polished with emery paper. After weighing and painting, the plates were suspended on a specially constructed wooden fence erected on a low bank running almost due north and south in the valley of the Severn River.

In order that the results might be as reliable as possible and relatively independent of the effects of minor variations in chemical and physical properties from which iron plates are so likely to suffer, five plates were used in each test. Unfortunately, during the absence of Dr. Friend on military service, some of the plates were blown down during gales and damaged. This accounts for the gaps in the table of results.

After 5 years' exposure to the atmosphere the plates were removed, soaked in caustic soda solution to remove the paint, washed, dried and any adherent rust gently rubbed off by scraping and polishing with emery paper.

The oils used in these experiments were:

No. 1. Pure Calcutta raw linseed oil.

No. 2. Same oil as No. 1, heated for 16 hours to a maximum temperature of 305 deg. C. No drier.

No. 3. Oil No. 1, heated for 4 hours with 0.5 per cent Cyprus umber up to 305 deg. C.

No. 4. Oil No. 1, heated for 2 hours with 1.5 per cent manganese hydroxide to 150 deg. C.

No. 5. Oil No. 1, heated for 4 hours with 1 per cent litharge to 205 deg. C.

Dr. Friend has already demonstrated the superiority of polymerized linseed or litho oils over the raw oil for the protection of iron against atmospheric corrosion. This is attributable in part to their diminished permeability toward water, but mainly to their greater stability, polymerization resulting in the saturation of the double bonds, thus rendering the oils less liable to oxidation and disintegration upon exposure.

On the other hand, an ordinary boiled oil is partially oxidized in the process, and, particularly if a drier be present, a marked increase in the rate of setting is observed when the oil is spread as a paint film on a suitable surface. One of the main objects of the "boiling," indeed, is to increase the rate of setting. But the same catalysts which accelerate the setting or initial oxidation also accelerate the disintegration or show further oxidation upon prolonged exposure to air. Hence, in contradistinction to litho oils, ordinary boiled oils will not as a rule offer as good protection to iron as the raw oil. This is shown clearly in the results in Series *A*, *B*, *C*, *D* in the table.

Not only do two coats of paint protect iron from atmospheric corrosion more efficiently than one thinner coat, but they are even slightly more efficient than one thick coat containing the same weight of paint as the two together.

It is important to remember that this applies only to atmospheric corrosion, for Dr. Friend has shown that a precisely opposite effect is obtained by prolonged immersion of iron plates in water. The amount of corrosion under these conditions actually increases with the number of coats or thickness of the paint.

TABLE I—RESULTS OF EXPOSURE TESTS

All weights are expressed in grams. Period of exposure, 5 years.

Series	Composition of Paint by Weight	Wt. of Paint on Each Side	Loss in Wt.	Mean Loss
A	60 red lead / 40 oil No. 1	15	3.35 5.95 3.05 3.50 2.30	3.63
B	60 red lead / 40 oil No. 2	15	.... 5.25 5.82 3.55	4.87
C	60 red lead / 40 oil No. 4	15	7.20 .... 6.62	6.91
D	60 red lead / 40 oil No. 5	15	3.80 6.58 7.10 4.30	5.45
E	First coat: 60 Venetian red / 40 oil No. 3	12	2.25 2.48	2.66
	Second coat: 30 Venetian red / 70 oil No. 3	12	.... 3.25	....
F	First coat: 30 Venetian red / 70 oil No. 3	12	1.35 1.80	1.30
	Second coat: 60 Venetian red / 40 oil No. 3	12	.... 0.75	
G	Two coats: 45 Venetian red / 55 oil No. 3	12 Each	.... 2.28 1.45 2.65	2.13

The question now arises as to whether or not the method of mixing and applying paint to iron may not influence the results. To determine this a series of plates were given two coats of paint, viz:

Series *E*. One coat of 60 per cent Venetian red paint, followed by one of 30 per cent.

Series *F*. One coat of 30 per cent Venetian red paint, followed by one of 60 per cent.

Series *G*. Two coats of 45 per cent Venetian red paint.

It will be observed that the total weight of both pigment and oil on each plate in the three series is the same, but the results are strikingly different. Series *F* yields by far the best results, the thin coat apparently clinging tenaciously to the surface of the metal, while the outer coat, containing a high pigment and low oil percentage, protects the inner by reason of its greater resistance to permeability by moisture and to mechanical erosion.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Dye Investigation Likely to Be Postponed as Sub-Committee Continues to Dwindle

With the announcement by Senator Reed of Missouri that it will be impossible for him to serve on the sub-committee selected to conduct the investigation of the dye situation, Senator Knute Nelson of Minnesota fears that it may be impossible to conduct the investigation at this time. Senator Borah of Idaho, another member of the sub-committee, previously had announced that he could not serve. Thus Senator Shortridge of California, chairman of the sub-committee, is the only member left of the original committee named.

Some of those who were very anxious that this investigation be conducted seem to have lost their enthusiasm since the resolution was broadened to include a probe into the practices of importers and representatives of the German dye interests. On the other hand, the domestic chemical industry appears to be more anxious than ever that the investigation proceed. It is stated that evidence has been uncovered which will reflect unfavorably upon the practices of certain textile concerns and other consumers of dyes. Since the adoption of the Frelinghuysen amendment which extended the scope of the probe to include the importers, some very active work has been done by the domestic chemical industry, with the result that enough already has been disclosed "to hang some of them," as one representative of the chemical industry put it. If this evidence can be brought out before the Senate acts on the tariff, it is expected that it will do more than any other one thing to aid the fight for an embargo.

Licensing of Professional Engineers Subject of Live Debate in Engineering Circles

At the recent meeting of the American Engineering Council of the Federated American Engineering Societies in Washington, a lengthy discussion arose as to the sentiment of the Council regarding the licensing or registering of engineers. Prof. Donald Derickson of Louisiana was the chief advocate of the system, asserting that the experience of his state had been such as to justify the conclusion that the licensing statute had been beneficial alike to the public and the engineer. The Council finally decided to direct the appointment of a committee to make a thorough study of the question.

The Engineers' Club of Baltimore, Md., also recently considered this question and after a thorough discussion of the subject went on record as strongly opposed to any form of state legislation requiring the registration or licensing of professional engineers in Maryland. The opponents of the system, while conceding it would be an excellent thing if it were practically possible for any board to grade each engineer according to his true qualifications and ability, asserted that engineering work is more varied and diversified by far than any other profession and thus it is not to be expected that any state-appointed board could handle the proper grading of individual engineers.

E. F. Smith Addresses Rochester Section, A.C.S.

Dr. Edgar F. Smith, president of the American Chemical Society, addressed the last meeting of the Rochester Section, A.C.S., Dec. 19 at Kodak Park. Choosing as his topic "A Glance at Early Organic Chemistry," Dr. Smith outlined the history of the science and called particular attention to the work of Americans in developing ether, chloroform, synthetic indigo and camphor.

Following this address, motion pictures showing the manufacture of motion picture film at Kodak Park were shown.

Elaborate Program Planned for Meeting of American Ceramic Society

As previously announced, the American Ceramic Society's twenty-fourth annual convention will be held at the Hotel Statler, St. Louis, Mo., Feb. 27 to March 3 inclusive. Three days will be devoted to presentation and discussion of papers on manufacturing problems; two days of open house will be held at industrial plants and seven divisions will meet simultaneously. In addition to the smoker and banquet, exhibits of equipment will be encouraged. The general chairman of the local committee is J. L. Green, 1673 Railway Exchange Building, St. Louis, Mo.

Among the forty papers announced to date are the following:

"The Testing of Silica Brick," K. Endell, Charlottenburg, Germany.

"A New Method of Measuring the Porosity of Brick," E. W. Washburn and E. N. Bunting.

"The Products of the Calcination of Flint and Chalcedony," E. W. Washburn and Louis Navias.

"Refractories Engineering," W. E. Dornbach, Baltimore, Md.

"Comparison of Hot and Cold Modulus of Rupture for Silica Brick," E. N. McGee, Syracuse, N. Y.

"Refractories for Zinc Smelting," George C. Stone, New York City.

"Possibilities of Terra Cotta Casting," R. F. Geller.

"The Cost System as an Aid to Efficient Plant Control," D. T. Farnham.

"The Permeability and Diffusion of Gases Through Refractories," H. W. Douda, Columbus, Ohio.

A number of subjects of timely interest are being prepared for round-table discussion.

Commonwealth Edison Co. Opens New 250,000-Hp. Plant in Chicago

The Commonwealth Edison Co. of Chicago has thrown into operation a new $10,000,000 power plant located in South Chicago on the Calumet River near 100th St. for supplying the industrial district. When this station is eventually completed as planned, it will generate 250,000 hp. With the new plant the capacity of the plants of the Commonwealth Edison Co. now exceeds 800,000 hp. It is planned later to build another 250,000-hp. station on the shores of Lake Michigan at Waukegan with the Public Service Co. of Northern Illinois, which will fit into a scheme of electric superpower development of Wisconsin, Illinois and Indiana. The Chicago system has become the hub of a network of interconnected electric transmission lines in the upper Mississippi Valley which spreads nearly to Minneapolis on the north, southwest to the Mississippi River, and south to the coal fields of Kentucky. The development of power generation on this huge scale is indicative of the industrial growth of this section of the Middle West.

Laboratory Tests for Molding Sand to Be Standardized

A committee, organized by the National Research Council and American Foundrymen's Association, has reached agreement on six tests which will show the properties that are most indicative of satisfactory working conditions of the sand in almost all lines of foundry practice. The "fineness" test and "cohesiveness" test should be given first consideration. Tests for permeability, water content, thermal properties and rational and chemical analyses should also be considered in a general study of molding sands. Information is now being acquired preparatory to drawing up specifications for the proper methods of making such tests.

American Engineering Council Holds First Annual Meeting

The American Engineering Council of the Federated American Engineering Societies held its first annual meeting in Washington, D. C., on Jan. 5 and 6. A leading event of the meeting was a dinner in honor of Secretary of Commerce Hoover at which Mr. Hoover commended the Council's work for the elimination of waste in industry, declaring this to be the most fundamental of all problems with which the nation must deal. He urged the development of methods for effecting economies in manufacture, transportation and distribution and suggested that the problem of national electrification be taken up in the form of a waste survey.

The Council voted to continue support of the legislation for the relief of the U. S. Patent Office as embodied in the Lambert bill. Steps were also taken to co-operate with the Department of Commerce in the movement to prepare for cyclical industrial depressions and unemployment by resort to public works projects. An unqualified indorsement of an embargo on dyes was voted by the Council.

Officers for the year are as follows: president, Dean Mortimer E. Cooley, of the University of Michigan; vice-presidents, D. S. Kimball of Cornell University and J. Parke Channing of New York; treasurer, W. W. Varney of New York; executive secretary, L. W. Wallace.

Steady Business Improvement Indicated by Increased Production in Industries

Ceramic. The five general ware potteries at Sebring, Ohio, are now working at practically full time and expect to maintain production at this status for at least 6 months to come. The different plants are the Sebring China Co., Limoges China Co., Royal China Co., Worcester China Co. and the Saxon China Co.

The Crip Pressed Brick Co., Ennis, Tex., has resumed production at its plant under an operating schedule of about 20,000 bricks per day.

The Haws Refractories Co., Hawstone, near Lewistown, Pa., has resumed operations at its plant after a shutdown for a number of months. Production will be maintained on a basis of 50 per cent for the present.

The majority of potteries at Wellsville, Steubenville and East Liverpool, Ohio, devoted to the production of general ware, have resumed production on a full-time schedule, following a shutdown through the holiday week for inventory and other purposes.

Chemical. The National Aniline & Chemical Co., Wilmington, Del., has added a number of permanent workers to the operating force at its local plant.

Rubber. The Goodyear Rubber Co. is planning for the early resumption of operations at its local plant, following a 2 weeks' shutdown. A wage reduction from 10 to 25 per cent for male operatives at the plant has been announced.

The Goodyear Tire & Rubber Co., Akron, Ohio, has added about 1,000 employees to the working force at its local mills since the middle of December. It is expected to increase the number of present workers soon.

Glass. Practically all of the glass plants in the Wheeling, W. Va., district are now in operation, with production varying from 80 per cent to full capacity.

Glass factory at Sisterville, W. Va., will resume operations Feb. 1 after being idle over a year.

Oil. The Standard Oil Co. has increased the working force at its Bayway refinery, Elizabeth, N. J., to more than 4,100 men, the largest number which has been employed at any one time since last May. The plant is operating on full time.

Paper. The New York & Pennsylvania Co., Johnsonburg, Pa., operating a local paper mill, has increased production to close to capacity.

The Charles Boldt Paper Co., New Iberia, La., manufacturer of paper products, has placed its recently completed mill in operation.

The Trinity Paper Mills, Commerce, Tex., manufacturer of paper pulp from cotton linters, has placed its new mill in operation.

Iron and Steel. The Tennessee Coal, Iron & Railroad Co. and the American Steel & Wire Co., both subsidiary to the United States Steel Corp., are operating their plants in the Birmingham, Ala., district in excess of 60 per cent of normal.

The E. & G. Brooke Iron Co., Birdsboro, Pa., has blown in its local furnace, which has been idle for about 10 months past. Employment will be given to about 130 men.

The Reading Iron Co., Reading, Pa., has resumed operations at its Oley St. mills on a full-time schedule. Plans are under way to place the puddle mills on Ninth St. in service at an early date.

The Allegheny Steel Co., Brackenbridge, Pa., has resumed operations at its plant after a shutdown of a number of weeks. A group of ten sheet mills at the works, now idle, will be placed in service before the close of the month.

The Altoona Iron Co., Altoona, Pa., has resumed production at its local plant after being idle through the greater part of the past year.

The Trumbull Cliffs Furnace Co., Warren, Ohio, will soon blow in its local blast furnace, rated at 600 tons. The plant has been completed at a cost said to be about $3,000,000, and operations have been held in abeyance for some time past owing to conditions.

Outlawing of Chemical Warfare Not Likely to Stop Gas Research by U. S.

Influence on the part of friends of the capital naval ship is said in Washington to have been an important factor in the decision of the Arms Conference to outlaw chemical warfare. When the Chemical Warfare Service demonstrated last summer, in the tests in the lower Chesapeake Bay, that gas could be used effectively against ships, it was not realized, some point out, that it was paving the way for its own destruction. From the date of those tests there has been an increasing animosity to gas in naval circles. This is not confined to the United States, but it applies equally well to many of the advocates of the superbattleship in other countries.

The idea of outlawing chemical warfare had its inception and its chief impetus in the advisory committee to the American delegation. The advisory committee was a sort of afterthought of the conference idea. The committee was selected at the last minute and no advance notice was given those who were appointed to serve. Most of its members took the appointment as complimentary, but a few of those designated took the matter seriously and insisted on advising, much to the embarrassment of certain officials. Senator Sutherland, chairman of the advisory committee, Secretary of Commerce Hoover and John M. Parker, Governor of Louisiana, outstanding members of the committee, are known to have been of the opinion that it would be just as practicable to agree to outlaw war itself. Since Secretary Hoover and Governor Parker are busy men, they devoted very little time to the affairs of the advisory committee. Certain members of the committee, sensing the approval which would follow this course from that portion of the public which had not looked into the subject deep enough to know that chemical warfare is the most humane, efficient and least expensive of all the modern weapons, pressed their report with utmost vigor, it is declared. There has been no explanation as to how General Pershing was induced to reverse himself on the subject. His testimony before the House Committee on Military Affairs just prior to the establishment of chemical warfare as a separate service of the army was an indorsement of a positive character.

Representatives in Washington of the chemical industry point out that the conference would not have thought of concluding an agreement as to the reduction of naval armament unless England, the chief naval power, were to be a party to it. There was no hesitation, however, in attempting chemical disarmament by decree, and Germany, still armed to the teeth chemically, was in nowise considered.

Insufficient time has elapsed to allow any arrangement of details, but since England made the expressed reservation that it would be necessary to keep abreast with chemical development, to guard against the use of gas by an outlaw nation, it is assumed that the United States will not abandon the research work on gas which it now has well under way.

Catalysis and Photomicrography Subjects at New Jersey Chemical Society

Large attendance marked the regular monthly meeting of the New Jersey Chemical Society on Jan. 9, 1922, in Newark, N. J. H. S. Taylor, of Princeton, spoke on "Auto-Catalysis," describing several reactions in which one of the products of the reaction apparently acts as a catalytic agent. Dr. Taylor described some recent experiments on the reduction of cupric oxide by hydrogen and on the efflorescence of cadmium sulphate crystals in support of his contention that in this type of reaction it is only at an interface, where a molecule of the substance is in contact with a molecule of one of the products of its decomposition, that the reaction proceeds.

Charles P. Titus, consulting microscopist, New York, gave a profusely illustrated talk on fabrics, outlining methods of manufacture and showing photomicrographs of numerous textiles.

New York Section of A.C.S. Hears Papers on Glues and Gelatins

The subject at the regular monthly meeting of the New York Section of the American Chemical Society on Jan. 6, 1922, was "Glue and Gelatin." The speakers were R. H. Bogue, Mellon Institute, S. E. Shepherd, Eastman Kodak Co., and E. T. Oakes, National Biscuit Co. Dr. Bogue's paper dealt with the classification of glues and gelatins and is reported in more detail on page 123 of this issue. Dr. Shepherd's paper discussed photographic gelatin, describing the protective action of the gelatin in delaying precipitation, its important effect on the coating operation due to its varying viscosity and the sensitizing or desensitizing effect of gelatin on the emulsion due to the presence of small quantities of metallic impurities, sulphides, grease and organic reducing agents. The talk was illustrated with slides showing curves, photomicrographs of emulsion grains and photographs of instruments used in the Eastman laboratory for determining the setting point, jelly strength and swelling of gelatin.

Potash Producers Hopeful for Adoption of Five-Year Protective Duty

Sufficient sympathy for the domestic potash industry has been manifested by members of the Senate Finance Committee to lead to the belief that agricultural potash will not be returned to the free list. The chances are thought to favor the adoption of the rates contained in the House bill which prescribe a duty of 2½c. per lb. on actual potash for the first 2 years; 2c. per lb. for the third year; 1½c. per lb. for the fourth year; 1c. per lb. for the fifth year, agricultural potash thereafter to be on the free list.

The opposition to this duty came mainly from H. A. Huston, American representative of the German potash syndicate, and from the National Fertilizer Association, represented by S. D. Crenshaw, vice-president of the Virginia-Carolina Chemical Co.

Mr. Huston was frank in his admission that he had been connected with the German potash syndicate for 19 years. He declared that the syndicate had been much maligned and that it is not a monopoly even in Germany. He emphasized the fact that the German law prohibits, under heavy automatic penalties, the sale of potash for export at less than the price offered for potash for distribution within Germany. He argued that it would be to the great economic advantage of the United States to use many times the amount of potash now consumed.

Mr. Crenshaw stated that American producers, in spite of the monopoly given them by the war, had never produced more than 54,000 tons of actual potash in any one year, and that there is no reason to expect that they can produce the normal American requirements at present prices, plus the proposed tariff. He also stated that certain forms of potash much used and desired in the United States cannot be produced in this country. Another difficulty facing American producers is that freight rates alone are nearly as much as the cost of foreign potash delivered at American ports.

Wilbur LaRoe, an attorney, appeared for the United States Potash Producers' Association. He cited the Federal Trade Commission as authority for statements that the Virginia-Carolina Chemical Co. is financially interested in certain German potash enterprises and that it has important holdings in the German potash mines. He declared that the fertilizer interests are leaving the impression, in stating that they have contracted in Germany for only 75 per cent of their requirements, that the remaining 25 per cent may be purchased of American producers. He declared that this is not a fact and that within the last few weeks contracts have been made with Alsatian producers for the remaining 25 per cent of the requirements of the thirty-four companies which entered into the German contract. It was brought out in the hearing that these thirty-four manufacturers produce at least 60 per cent of the country's fertilizer output.

Mr. LaRoe also took exception to the statement by the representative of the fertilizer manufacturers relative to prohibitory freight rates, mentioning the practicability of shipment by water and the promising potash fields in New Jersey as a source of supply for Eastern markets. The domestic supply of potash, he told the committee, is sufficient to meet domestic needs for an indefinite time. The reserve at Searles Lake alone amounts to 20,000,000 tons, he said. Already the solar method of evaporation is being used there with great success and by extending it and providing for increased efficiencies, Mr. LaRoe predicted that the United States within the 5-year period could produce potash at a less cost than can Germany. While all the American plants are closed at present, Mr. LaRoe stated that they have an annual capacity of 100,000 tons and will reopen if the duty is allowed. He estimates American requirements at 240,000 tons. Statements were presented from the State Chemists of the more important fertilizer using states to sustain his contention that California potash is now free of borax. The duty requested, it was stated, will give the federal treasury $10,000,000 annually during the first 2 years. Mr. LaRoe declared that domestic producers are ready to start up their plants if they can be assured of receiving as much as $1.10 for their output.

Short Course in Ceramic Engineering at Illinois University

As previously announced, the short course in ceramic engineering at Illinois University will be conducted this year from Jan. 23 to Feb. 4. This course, as is well known to members of the American Ceramic Society, is designed to meet the requirements of practical men. It deals with the principles underlying the work of managers, superintendents, foremen, burners and others who may be concerned with the manufacture of ceramic products. Those companies who have sent their employees in previous years have been amply repaid for the time and money expended.

The courses this year will be very much on the same basis as in last year's program with some different lecturers and the addition of lectures in business law, boiler water and glass technology. Prof. Charles F. Binns, formerly secretary of the American Ceramic Society, will deliver the lectures on glazes.

National Association of Cost Accountants Conducts Membership Drive

The National Association of Cost Accountants has recently begun a drive for 400 new members by March 1. This organization is national in scope and has members in practically every state in the Union in addition to some in Canada, Mexico and Europe.

There are local chapters in most of the principal cities of the United States. These chapters meet monthly to hear various messages by reputable cost authorities on cost and accounting problems. These local chapters are the clearing houses where cost data and plans are exchanged by representative cost men and accountants.

All those interested in cost accounting are invited to investigate the merits of the organization with a view to becoming active members. S. C. McLeod, 130 West 42nd St., New York City, is the national secretary and business agent.

Ford Muscle Shoals Offer to Be Submitted to Congress by Secretary of War

Secretary of War Weeks, after a conference on Jan. 13, 1922, among Henry Ford, Secretary Hoover and himself, announced that the Ford offer for the Muscle Shoals plant, in the form of a contract, would be transmitted to Congress for action. He declined to make public the nature of his comments on the proposal.

The National Fertilizer Association has undertaken the publication of an analysis of the Ford offer and a survey of the situation surrounding the project, under the caption of "Truth About Muscle Shoals." It is stated therein that Mr. Ford proposes to make two kinds of payments—interest and amortization. The interest payments are a partial reimbursement to the government for the interest which the taxpayers must pay on the money invested in the water power and amount to a total of $161,040,000 over the 100 years' lease. The government, however, must pay interest on $57,000,000 new money invested, which at 4 per cent would amount to $2,280,000 per year. As will readily be seen, this creates a deficit of $600,000 or more every year.

C. W. Goodale Honored for Safety and Welfare Work by Mining and Metallurgical Society

Charles W. Goodale, of Butte, Mont., was awarded the gold medal of the Mining and Metallurgical Society of America at its annual meeting, Jan. 10, for conspicuous services in safety and welfare work. In 1898 Mr. Goodale was appointed general manager of the Boston & Montana Consolidated Copper & Silver Mining Co., operating the richest copper mines in Butte and a large smelter at Great Falls, about 200 miles northeast, a position he filled with great success up to the time of the absorption of that company by the Anaconda Copper Mining Co. Since that time he has been chairman of the Bureau of Safety for all the Montana operations. Those same qualities which have always brought him the affectionate regard of his numberless acquaintances in mining and metallurgical circles have enabled him to enlist that sincere co-operation of all the foremen and workmen so necessary for the success of safety and welfare measures.

Summary of Newly Organized Chemical Firms

During the month of December a total of twenty-six companies was organized to manufacture chemicals, dyes, drugs and affiliated products, with individual capitalization of $50,000 or more. The total indicated capital aggregates $3,595,000. This compares with the formation of thirty-five companies in November, with total authorized capitalization of $6,300,000.

The total for the year 1921 shows an indicated capitalization for new companies organized of $108,410,900, as compared with a capital of $487,148,000 for new concerns in the industry formed in 1920.

Business Paper Editors to Meet

The National Conference of Business Paper Editors will hold a meeting in Washington, D. C., on Jan. 23. After luncheon, the afternoon will be devoted to a conference with the Chamber of Commerce of the U. S., at which will be discussed the railroad situation, tariff legislation, soldier bonus and the hardwood decision of the Supreme Court. The program of the day also includes the regular dinner with Secretary of Commerce Hoover, at which problems of interest will be discussed.

American Ceramic Society Moves Headquarters

Official announcement has been made that the headquarters of the American Ceramic Society have now been transferred from Alfred University, Alfred, N. Y., to Lord Hall, Ohio State University, Columbus, Ohio. Organizing Secretary Ross V. Purdy has automatically, with the coming of the new year, been made general secretary of the society, and his headquarters are at the above address. Charles F. Binns, who has for many years served the society faithfully and well, retired from active participation in the work.

Personal

Dr. Clarence W. Balke, chief metallurgist of the Fansteel Products Co., North Chicago, recently spoke before the American Institute of Mining and Metallurgical Engineers at the rooms of the Western Society of Engineers, Chicago, on "The Story of Tungsten."

S. M. Barnet has been elected president of the Barnet Leather Co., New York, succeeding his father, the late Morris S. Barnet. Sigmund Rothschild was elected vice-president of the company.

C. A. Bigelow, formerly general manager of the Aetna Explosives Co., became assistant general manager of the Hercules Powder Co. on Jan. 1, in charge of the high explosives division. On the same date L. N. Bent became assistant general manager in charge of naval stores, fulminate and caps, and nitrocotton divisions.

R. A. Bull, a consulting engineer of Sewickley, Pa., has moved his headquarters to Spondly Building, 638 Diversey Parkway, Chicago, Ill.

O. S. Delaney, E. I. du Pont de Nemours & Co., Wilmington, Del., gave an interesting address on the subject of the manufacture of explosives at a recent meeting of the Olympia Chemical Club, Tacoma, Wash.

Robert W. Hilton, vice--president of the Ault & Wyborg Co., Cincinnati, Ohio, has announced his withdrawal from the company after 25 years of service. Mr. Hilton started with the company as a chemist and was in charge of the laboratory for 6 years, after which, for 9 years, he was superintendent of the company's plants, and for the last 10 years has been in charge of the development and manufacture of products. After a short vacation he will enter business for himself.

F. Kniffen has resigned as production manager of the cellulose products manufacturing department of E. I. du Pont de Nemours & Co. He will continue to serve that department in an advisory capacity.

Dr. S. K. Loy, chief chemist of the Standard Oil Co.'s (formerly the Midwest Refining Co.) refinery at Casper, Wyo., has been appointed consulting chemist of the Bureau of Mines in connection with oil-shale work.

Thomas O. Marvin has been designated by President Harding to become chairman of the United States Tariff Commission, succeeding Thomas Walker Page, who recently resigned. Commissioner William S. Culbertson has been named vice-chairman.

Ralph H. McKee spoke before the Franklin Institute on Jan. 12, on "Gasoline From Oil Shale."

J. V. Mowe, general sales manager of the Kelly-Springfield Tire Co., Akron, Ohio, has been elected a vice-president of the company.

G. N. Norman, chemical director, and R. S. McKinney, purchasing agent, for the Hercules Powder Co., expect to sail for Europe on Feb. 7. They will be abroad for about 3 months and will visit the principal continental countries.

C. Olin North, C. W. Bedford, R. C. Hartong and C. N. Hand, all formerly connected with the development department of the Goodyear Tire & Rubber Co., have left that organization and incorporated the Rubber Service Laboratories Co. Mr. Bedford is the present chairman of the Rubber Division of the American Chemical Society.

A. L. Pitman has been appointed assistant director of the Bangor station of the Massachusetts Institute of Technology's School of Chemical Engineering Practice.

N. P. Rood, vice-president of the Hercules Powder Co., expects to make a business trip to Chile in the near future.

C. J. Snyder has accepted a position as technical director of the Newman Ice Cream Co. of York, Pa. He was formerly in the chemical department of E. I. du Pont de Nemours & Co. at Parlin, N. J.

Herbert Talley will leave the service of the Hercules Powder Co. on Feb. 1 to go with the U. S. Powder Co.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

The Uneven Fall in the Prices of Basic Commodities

One of the conspicuous obstacles in the path toward better times in business is the maladjustment in the wholesale prices of the principal domestic commodities. The general process of deflation appears to have run an uneven course, so that there exists at the present time an unusual disparity between the great groups of basic materials. The spread between the prices of farm products and other primary materials, on the one hand, and the prices of manufactured goods, labor and transportation, on the other is an obstruction to progress. Substantial revival of business cannot be effected as long as such unbalanced relations continue, and it therefore behooves business to study these fundamental conditions in order that means may be provided for their correction.

Inequality in Recession From War-Time Peaks

Babson's analysis of 78 leading articles of commerce indicates that 39 are from 50 to 100 per cent and 18 from 2 to 25 per cent above the pre-war level. On the other hand, 21 are from 0 to 82 per cent under the 1904-1913 average. This maladjustment of prices is further shown in the price indexes of the U. S. Bureau of Labor Statistics, which are shown in the accompanying table. From the 1920 maximum to the figure reported for November, 1921, these groups have shown the following percentage decreases: farm products 53.7, metals and metal products 39.0, foods 50.5, chemicals and drugs 27.0, fuel and lighting 34.5, and building materials 42.2.

The Collapse of Agricultural Prices

Almost at the bottom of the whole situation is the severe agricultural depression. The farmers produced a bumper crop during 1921, but according to official estimates of the government, their produce had a market value eight billion dollars less than the value of the crop of 1919 and three and a half billion less than in 1920.

The farmer has been forced to shoulder tremendous losses, for practically every farm product is selling for less than the actual cost of production. Furthermore, his purchasing power has been reduced correspondingly and this has necessarily had its effect on practically every branch of industry. It has been estimated by reliable authorities that the farmer's dollar purchases less goods now than it has at any time during the past 30 years.

Chemical and Metallurgical Prices

Metals and metal products have had the next most conspicuous decline of prices. In the index numbers of the Bureau of Labor Statistics this group stands at 119 for November, 1921, in comparison with 114 for farm products and 149 for all commodities. This represents a fall of practically 40 per cent from the peak reached in 1920. Practically every non-ferrous metal is selling at prices which are equal to or lower than the pre-war level.

Chemicals and drugs, according to the Labor Department statistics, are at a somewhat higher level, although still not greatly above the average for all commodities. It is significant to note that the chemical group reached a low of 161 in August of this year and in the three succeeding months for which figures are presented has shown a very slight increase.

The disparity between this figure for chemicals and drugs and the CHEM. & MET. Weighted Index of Chemical Prices perhaps needs some explanation. It should be understood at the outset, however, that these index numbers are obtained by entirely different methods. Although both are based on a somewhat similar selection of commodities, the Bureau of Labor statistics includes among its eighteen items such articles as quinine and opium. Although these may be regarded as indicative of the trend of the drug market, they are nevertheless subject to extreme fluctuations and at the present time demand unusually high prices. As explained in our issue of Jan. 11, the weighted index compiled by this magazine is based largely on such materials as the heavy chemicals and other similar products of quantity output and demand.

INDEX NUMBERS OF DOMESTIC WHOLESALE PRICES
(Compiled by U. S. Bureau of Labor Statistics)
1913 average = 100

Month	Farm Products	Food, Etc.	Fuel and Lighting	Lumber and Building Materials	Metals and Metal Products	Chemicals and Drugs	All Commodities
1913 (average)...	100	100	100	100	100	100	100
1914 (average)...	103	103	96	97	87	101	100
1915 (average)...	105	104	93	94	97	114	101
1916 (average)...	122	126	119	101	148	159	124
1917 (average)...	189	176	175	124	208	198	176
1918 (average)...	220	189	163	151	181	221	196
1919 (average)...	234	210	173	192	161	179	212
1920 (average)...	218	239	238	308	186	210	243
1920:							
July.....	236	268	252	333	191	217	262
August.....	222	235	268	328	193	216	250
September.....	210	223	284	318	192	222	242
October.....	182	204	282	313	184	216	225
November.....	165	195	258	274	170	207	207
December.....	144	172	236	266	157	188	189
1921:							
January.....	136	162	228	239	152	182	177
February.....	129	150	218	221	146	178	167
March.....	125	150	207	208	139	171	162
April.....	115	141	199	203	138	168	154
May.....	117	133	194	202	138	166	151
June.....	113	132	187	202	132	166	148
July.....	115	134	184	200	125	163	148
August.....	118	152	182	198	120	161	152
September.....	122	146	178	193	120	162	152
October.....	119	142	182	192	121	162	150
November.....	114	142	186	197	119	162	149

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	143.75
Last week	144.49
January, 1921	181
January, 1920	242
April, 1918	286

The very slight drop in the index number during the current week was caused principally by the lower prices for soda ash, caustic soda, bleaching powder and methanol. Slight increases in the prices for aniline oil, formaldehyde, glycerine and linseed oil failed to retard this movement.

Solving Some Problems of Unemployment

A plan to take care of the families of employees out of work or on part time has recently been instigated at Lynn, Mass., plant of the General Electric Co.

All workers, including wage and salary earners, submit to a 1 per cent reduction in pay, which is impounded into a fund to be used among the unemployed. This is, however, only a temporary arrangement, since the company has not approved any general plans for unemployment insurance.

To Market Copper Shingles

The Anaconda Copper Mining Co. expects to use more than 30,000,000 lb. of copper this year in the manufacture of copper shingles. Although the initial cost of the new product is about twice that of the ordinary wooden shingle, has the advantages of durability and light weight. The shingles are supplied in natural copper finish and also in seven shades ranging from green to russet brown.

Unemployment During December

Unemployment increased by 4.7 per cent during December, according to the monthly survey of the U. S. Employment Service. The survey covered 1,428 firms located in the sixty-five principal industrial centers of the country. These concerns were employing 1,493,107 workers on Dec. 31.

Increased employment is shown in textiles, iron and steel, lumber, leather, paper and printing and metals and metal products other than iron and steel. The decreases were mainly in the food industries; liquors and beverages; chemicals; stone, clay and glass products; tobacco manufacture; vehicles for land transportation, and railroad repair shops.

German Export Trade During November

A slight decrease in the volume of German exports for the month of November as compared with the previous month has been reported from Berlin by Commercial Attaché C. E. Herring. Percentage decreases as well as increases in the volume of exports for the principal groups of commodities are shown in the following table:

Commodity	Decrease Per Cent	Commodity	Increase Per Cent
Heavy chemicals	12.0	Leather	2.0
Dyes	3.0	Leather goods	14.7
Cotton manufactures	5.4	Rubber goods	5.8
Wool manufactures	18.8	Paper, pulp and manufactures thereof	24.6
Glass and glassware	7.3	Pottery	1.7
Iron and steel manufactures thereof	4.8	Machinery	5.0
Zinc and zinc products	12.0	Electrotechnical products	19.6

The total imports into Germany decreased more than the exports, with the result that November shows a greatly diminished trade balance by volume.

Three Years' Export Trade in Dyes

Statistics recently released by the Department of Commerce show rather vividly the decline in the value of our exports of dyes and dyestuffs. The commodities shown in the government's classification fell from a total of $30,410,198 for the first 11 months of 1920 to $6,465,665 for the same period of 1921.

The figures for the exports to principal countries show some rather significant changes. The most striking, perhaps, is the tremendous decrease in our dye exports to China. From over $5,500,000 for January-November, 1920, they fell to about $750,000 during 1921. Japan was practically on a par with China in the former year, but in 1921, although her exports were cut in half, she became by far the most important customer for American dyes.

EXPORTS OF DYES AND DYESTUFFS, JANUARY TO NOVEMBER, 1919, 1920 AND 1921.

Total Exports by Classes

	Eleven Months Ended Nov. 30, 1919	Nov. 30, 1920	Nov. 30, 1921
Dyes and dyestuffs—			
Aniline dyes	$9,396,615	$20,662,310	$4,812,122
Logwood extract	1,299,023	2,529,192	545,060
All other	4,654,202	7,218,696	1,108,483
Total dyes and dyestuffs	$15,349,840	$30,410,198	$6,465,665

Total Exports by Principal Countries

Exported to —			
Belgium			$99,357
France	$928,837	$1,728,653	141,484
Italy	382,074	1,233,286	58,861
Spain	553,995	893,730	45,951
United Kingdom	1,063,760	2,955,491	238,691
Canada	1,934,294	2,620,800	971,513
Mexico	624,578	1,085,908	275,561
Cuba			56,961
Argentina	583,761	970,296	177,677
Brazil	1,035,283	934,821	159,510
Chile	165,321	173,521	25,265
Peru	165,731	210,440	34,145
China	2,038,937	5,566,095	759,946
British India	1,442,521	3,283,676	699,340
Dutch East Indies	149,680	25,136	3,277
Hongkong	284,964	724,541	39,915
Japan	2,758,934	5,454,377	2,111,287
Australia	205,323	245,045	216,435
Other countries	1,031,847	2,304,382	355,489

The New York Market

NEW YORK, Jan. 16, 1922.

Business in the chemical market during the past week was not of large proportions. The industry still shows the influence of the inventory period, but there are some signs of improvement. A tendency still exists to shade prices on some commodities to stimulate trading. Among the most important developments reported was a decline in the prices of caustic soda and soda ash for forward shipments and also an easier spot market for both products. Leading producers are making a great effort to get real business this year and believe that attractive prices are the only means. Numerous inquiries for caustic soda from the Orient have reached the market and a fair volume of business has been placed at slight concessions *Silicate of soda* has been reduced by leading makers.

There has been no change recorded in the chlorate market in spite of the large importation from Germany. Commercial white powdered *arsenic* is considerably higher and in some first-hand quarters it was stated that sales as high as 8c. per lb. have been made. Imported material was quoted at $6.75 per 100 lb. Spot resale arsenic was held at 7@7¼c. per lb. for limited quantities only. Imported *prussiate of soda* has reached new high levels and only a few odd lots were obtainable in the open market. Sales of spot material were reported at 17¼c. per lb. for imported. January shipment is held firm at 17c. per lb., with relatively little obtainable. *Bichromate of potash* is slightly lower at 10½c. per lb. Buyers are not taking much interest in this item at present. Imported white granular *salammoniac* is easier, with shipment material offered at 6¼c. per lb. *Caustic potash* continues to show a strong tendency both on spot and forward shipment. Resale stocks are gradually diminishing and while it is still possible to do 6c. per lb. for the 82-92 per cent imported, 6½c. was asked in leading quarters. Export sales of solid *caustic soda* were reported at $3.60@$3.70 per 100 lb. Goods ex-store were quoted at 3¾c. per lb. Producers quote contracts at $2.65 per 100 lb. f.o.b. works, basis 60 per cent, in carload quantities. *Soda ash* in single bags is moving quietly at $1.75@$1.80 per 100 lb. Sales of soda ash in barrels were reported at $2.10@$2.15. At the works, produers are accepting contract business at $1.35 per 100 lb., basis 48 per cent. *Glycerine*, c.p., was advanced ½c. per lb. on spot and quotations at the end of the week ranged from 16½@17c. per lb. Demand has been much better in this item since New Year's. *Prussiate of potash* continued in its firm position and supplies have practically disappeared in second hands. Manufacturers stated that limited supplies were available at 24½@25c. per lb. The red variety was also available in limited quantities at prices ranging from 29@30c. per lb.

VEGETABLE OILS

Leading crushers of *linseed oil* advanced prices 2c. per gal. to a basis of 71c. per gal. in carload quantities, for prompt and forward shipments, the rise being in sympathy with the seed. The demand, however, fell away at the close of the week and the undertone was barely steady. Bids were in the market at 69c. per gal., but these were turned down. Higher prices for imported oil were a feature of the market. English oil was offered at 62½c. per gal., duty paid, January shipment. Dutch oil was available for prompt shipment at 62c. per gal., duty paid. Sales of spot *chinawood oil* were recorded at 12¾c. per lb. for carload lots. On lesser quantities 13@13¼c. was quoted. January delivery oil closed at 13¾c., with February held at 12¾c. There was a firmer market for crude *peanut oil*, prices closing a fraction of a cent higher on prime goods. Holders of prime stocks were asking 7⅞@8⅛c. per lb., buyers' tanks, f.o.b. mills. Refined oil in barrels, for prompt shipment, closed at 10⅞@11c. per lb. The market for English refined *rapeseed oil* was steady at 82@84c. per gal. in barrels. Dutch oil was offered at 81c. Future prices held around 78@80c. per gal. Scattered lots of resale *soya bean oil* were offered at 7@7¼c. per lb., sellers' tanks, f.o.b. coast. The market was dull and featureless.

The Chicago Market

CHICAGO, Ill., Jan. 13, 1922.

An improvement can be noticed in the general condition of the industrial chemical market, but as yet it has failed to show the big increase of business looked for after the first of January. It is quite evident, however, that better times are coming for the chemical trade, and it is to be hoped that things will pick up gradually rather than all at once. Stocks are all low and a sudden rush of business would surely cause an acute shortage, which in turn would send prices upward. Today prices were noticeably firm, with little or no tendency to shade regular quotations.

General Chemicals

The alkalis are moving only in a routine way and while no pressure to sell was evident several holders reduced their prices. *Solid caustic soda* was quoted at $3.75 per 100 lb. for the 76 per cent material in ton lots and similar quantities of the ground at $4.50. *Caustic potash* is very firm at $6.50 per 100 lb. for 88-92 per cent material. Leading factors in this market expect higher prices very soon due to the increasing costs abroad. *Soda ash* is quoted at $2.60 per 100 lb. basis cooperage and is moving only in small lots.

Potash alum is unchanged as to price and is in moderate demand at 5½@6c. per lb. for the lump and 6@6½c. for the powdered. *Ammonium carbonate* is very quiet and unchanged at 9@10c. per lb. for the lump in casks. *White arsenic* is very firm and material at 7c. was difficult to locate. *Barium chloride* is firm but with a small demand. The imported white crystals are quoted at $60 per ton spot delivery. *Bleach* is firm and is moving in a routine way at 3c. per lb. for large drums. *Copper sulphate* is a firm item and is moving in a fair way at 6c. per lb. *Glycerine* is one of the strongest items on the list and the c.p. material is scarce at 16½@17c. per lb.

Potash bichromate is in fair request, and supplies are available at 12¾c. per lb. *Sodium bichromate* is very firm, and while one factor held to 9c. per lb., most of the others advanced their ideas to 9½c. The *prussiates of potash* continue firm and scarce. The best that could be done on the red was 31c. and on the yellow 26c.

The acid market shows no change and is still very dull. *Acetic acid* is unchanged in price, with very little moving. The same is true of the heavy acids, where only small lots are moving in carboys.

Vegetable Oils

Linseed oil is reported to be moving in a fair way and the inquiry especially from the paint trade to be much improved. The boiled oil is today quoted at 80c. per gal. in 5-bbl. lots and the raw at 78c.

Naval Stores

Dealers in naval stores report business as good. *Turpentine* is receiving a good inquiry and is moving in a satisfactory volume. Today's quotation was 91c. per gal. in 1-bbl. lots. *Rosins* are moving very well and the WW grade is quoted at $9 per 280 lb. in less than carlots.

The Iron and Steel Market

PITTSBURGH, Jan. 13, 1922.

While the finished steel markets are commonly described as having been particularly quiet since the middle of December, there is really a fair amount of business being placed at mills. Buyers as a whole have curtailed their purchases somewhat on account of inventory taking, but the influence of this annual operation is perhaps overrated.

Except for the influence of the winter season the fundamental conditions as to steel consumption are substantially unaltered. Demand for oil country goods, which kept up remarkably well until a few weeks ago, is now lighter, but will presumably resume its former gait before the opening of spring.

Dip in Steel Production

On account of the close connection between the steel mill and ultimate consumption of steel, due to buyers having reduced their stocks to a minimum and adopted the practice of ordering from hand to mouth, frequently in single carloads with mixed specifications, steel production has had a dip in harmony with seasonally decreased consumption that has not ordinarily been noticed at this time of year. Production of steel ingots in October was at the rate of 23,000,000 tons a year, November showing an average rate a trifle higher. The American Iron and Steel Institute report for December, just distributed, giving the production of thirty companies, indicates that the average rate in the month was about 20,000,000 tons, which of course means a considerably higher rate at the opening of the month and a considerably lower rate at the close. From this lower rate a recovery has set in this week. January production may possibly not exceed that of December, but in February and March the rate should easily be as great as the rate in October and November, with chances of further increases.

Little Railroad Buying

While the financial condition of the railroads has been steadily improving, there is still but little railroad buying in steel and steel products. The Union Pacific has ordered 4,500 freight cars and the Illinois Central 2,000. Rail orders for 1922 are being placed with more reserve than expected, but in a year's steel business this is of no material importance, since the difference between a close and a liberal policy in replacements is only a very few hundreds of thousands of tons.

The leading interest has booked a large amount of tin plate business for a single week, from large customers in position to act freely in the light of their business prospects. Sheets are decidedly quiet, but a fair volume of business is being placed. The automobile trade is beginning to buy more freely in sheets and other descriptions of steel. Agricultural implement factories, for many months conspicuous by their complete absence from the steel market, are buying in a very small way. One of the poorest features of the general situation is the inability of the farmer to buy, this being important since normally the farm is a large consumer of steel in varous forms.

Steel Prices

Finished steel prices continue to exhibit the steadiness that has characterized them for several weeks past, the condition being in strong contrast with that seen for many months. Price changes are now quite infrequent, while the margin between prices done on small orders and on large orders is quite narrow. The market in general is quotable as follows: Bars, shapes and plates, 1.50c.; hoops, bands and hot-rolled strips, 2c.; plain wire, 2.25c.; wire nails, $2.50; standard steel pipe, 71 per cent basing discount; black sheets, 3c.; galvanized sheets, 4c.; tin plate, $4.75.

W. P. Snyder & Co., operating the Shenango furnaces, have sold 1,500 tons of bessemer pig iron to an Ohio consumer at $19.50 valley. This is the first sale of bessemer of any consequence for quite a while, and establishes a market price, the market having for some time past been quotable nominal at $20 valley. Basic remains quotable at $18.25 valley, and foundry at $19.50 valley.

Coke

Cornellsville furnace coke has stiffened in the spot market and weakened in the contract market, bringing the two close together, as they should be. It would be difficult now to pick up a regular lot of spot coke at under about $3, while a first quarter contract has been made, with an Eastern consumer, at $3.10. Recently spot coke was quoted as low as $2.75, while at the same time first quarter contracts were made all the way from $3.25 to $3.40 and perhaps $3.50.

Steel Scrap

Dealers freely bid $14.50, delivered Pittsburgh, for heavy melting steel scrap and they might pay a trifle more. On round lots to consumers it is unlikely less than about $15.50 could be done. The mills are not in the market at present.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.45
Acetone	lb.	$0.12½– $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.60	2.65 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		10.00 – 10.50	10.75 – 11.00
Boric, crystals	lb.	.12½– .12¾	.13 – .13½
Boric, powder	lb.	.12½– .13	.13¼ – .14
Citric	lb.	..... –	.44 – .45
Hydrochloric	100 lb.	1.50 – 1.60	1.65 – 2.00
Hydrofluoric, 52 per cent	lb.	.12½– 12½	.13 – .13¾
Lactic, 44 per cent tech	lb.	.09½– .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04¼	.04½ – 05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)	....	..... –	..... – .....
Nitric, 40 deg.	lb.	.06½– .06¾	.06¾ – .07
Nitric, 42 deg.	lb.	.06¾– .07	.07½ – .07¾
Oxalic, crystals	lb.	.14 – .14½	.14¾ – .15¼
Phosphoric, 50 per cent solution	lb.	.10 – .10½	.10¾ – .11¼
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	..... –	11.00 – 12.00
Sulphuric, 60 deg., drums	ton	..... –	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	16.50 – 17.00	..... – .....
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 – 22.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.65 – .75
Tannic (tech.)	lb.	.45 – .50	.51 – .55
Tartaric, imported crystals	lb.	..... –	.25½– .26
Tartaric acid, imported, powdered	lb.	..... –	.26 – .27
Tartaric acid, domestic	lb.	..... –	..... – .32
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)	....	..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.41 – .42
Alcohol, denatured, 190 proof	gal.	..... –	.43 – .44
Alum, ammonia, lump	lb.	.03½– .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½– .04	.04¼– .04½
Alum, chrome lump	lb.	.07½– .08	.08¼– .08½
Aluminum sulphate, commercial	lb.	.01½– .02	.02¼– .02½
Aluminum sulphate, iron free	lb.	.02½– .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½– .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.06½– .06½	.06¾ – .07¼
Ammonium chloride, granular (gray salammoniac)	lb.	.06½– .06¾	.07 – .07½
Ammonium nitrate	lb.	.07¼– .07½	.07¾ – .08½
Amylacetate tech	gal.	..... –	2.00 – 2.40
Arsenic oxide, (white arsenic) powdered	lb.	.07 – .07½	.07½ – .08
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 – 12¼	12½ – .13
Barium chloride	ton	50.00 – 51.00	52.00 – 60.00
Barium dioxide (peroxide)	lb.	.21 – 21½	22 – .23
Barium nitrate	lb.	.06½– 07	.07½ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾– 04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – 04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder (see calc. hypochlorite)	....	..... –	..... – .....
Blue vitriol (see copper sulphate)	....	..... –	..... – .....
Borax (see sodium borate)	....	..... –	..... – .....
Brimstone (see sulphur, roll)	....	..... –	..... – .....
Bromine	lb.	.21 – .22	.23 – .28
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½– .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	23.00 – 24.00	24.50 – 28.00
Calcium chloride, granulated	lb.	.01½– 02	02¼– 02½
Calcium hypochlorite (bleach'g powder)	100 lb.	2.25 – 2.40	2.50 – 3.25
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.90 – .95
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.10½– .10¾	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)	....	..... –	..... – .....
Caustic soda (see sodium hydroxide)	....	..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.03½– .04	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½– .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04 – .04½	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.38 – .40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas (see iron sulphate)	....	..... –	..... – .....
Copper carbonate, green precipitate	lb.	.20 – 20½	.21 – .21½
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.60 – 5.65	5.70 – 6.25
Cream of tartar (see potassium bitartrate)	....	..... –	..... – .....
Epsom salt (see magnesium sulphate)	....	..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .70
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.95 – .....
Formaldehyde, 40 per cent	lb.	10½– 11	11¼ – .12
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth—imported powdered—net	ton	30.00 – 32.00	..... – .....
Fusel oil, ref.	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.50 – 1.75
Glauber's salt (see sodium sulphate)	....	..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	16½– .17
Iodine, resublimed	lb.	..... –	3.80 – 3.90
Iron oxide, red	lb.	..... –	12 – .18
Iron sulphate (copperas)	ton	15.00 – 16.00	17.00 – 20.00
Lead acetate	lb.	..... –	10½– 12½
Lead arsenate, powd	lb.	.15 – 15½	15¾ – 16¼
Lead nitrate	lb.	..... –	.15 – 20
Litharge	lb.	.08 – .08¼	.08½– .09
Magnesium carbonate, technical	lb.	.06½– .07	.07½ – .08
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2.75 – 3.00
Magnesium sulphate, technical	100 lb.	..... –	1.05 – 1.80
Methanol, 95%	gal.	..... –	.61 – .62
Methanol, 97%	gal.	$.... – $....	$0.63 – $0.64
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.12 – .12½
Phosgene (see carbonyl chloride)	....	..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.10¼– .10½	.10¾ – .11¼
Potassium bitartrate (cream of tartar)	lb.	..... –	.24 – .26
Potassium bromide, granular	lb.	..... –	.14 – .18
Potassium carbonate, U. S. P.	lb.	.11½– .12	.12½ – .15
Potassium carbonate, 80–85%	lb.	.04½– .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.05½– .06	.06¼ – .12
Potassium cyanide	lb.	..... –	.43 – .45
Potassium hydroxide (caustic potash)	lb.	.06 – .06¼	.06¾ – .06¾
Potassium iodide	lb.	..... –	2.90 – 3.00
Potassium nitrate	lb.	.07⅜– .07½	.08 – .09
Potassium permanganate	lb.	.14 – .15	.16 – .22
Potassium prussiate, red	lb.	.29 – .30	.30½ – .31
Potassium prussiate, yellow	lb.	.24½– .24¾	.25 – .26
Rochelle salts (see sodium potas tartrate)	....	....	..... – .....
Salammoniac (see ammonium chloride)	....	....	..... – .....
Sal soda (see sodium carbonate)	....	..... –	..... – .....
Salt cake (bulk)	ton	..... –	18.00 –21.00
Soda ash, light	100 lb.	1.75 – 2.00	2.05 – 2.40
Soda ash, dense	100 lb.	2.05 – 2.10	2.15 – 2.40
Sodium acetate	lb.	.04 – .04¼	.04½ – 05
Sodium bicarbonate	100 lb.	2.30 – 2.35	2.40 – 2.75
Sodium bichromate	lb.	.07¾– .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.75 – 5.00	5.25 – 6.00
Sodium bisulphite powdered, U.S.P.	lb.	.04¾– .05	.05¼ – .06
Sodium borate (borax)	lb.	.05½– .06	.06½ – 07
Sodium carbonate (sal soda)	100 lb.	1.80 – 1.90	1.95 – 2.15
Sodium chlorate	lb.	.06¼– .06¾	.07 – .07½
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.26 – .26½	.26½ – .27
Sodium fluoride	lb.	.10½– .11	.11½ – .12
Sodium hydroxide (caustic soda)	100 lb.	3.75 – 3.80	3.85 – 4.25
Sodium hyposulphite	lb	..... –	.03½ – .03¾
Sodium nitrite	lb.	.06½– .06¾	.07 – .07½
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04¼– .04½	.04¾ – .05¼
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.19 – .21
Sodium prussiate, yellow	lb.	.17½– .17¾	.17¾ – .18
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.05	1.10 – 1.30
Sodium silicate, solution (60 deg.)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.25 – 1.30	1.35 – 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼– .04½	.04¾ – .05
Sodium sulphite, crystals	lb.	.03⅜– .03¾	.04 – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, red	lb.	.05½– .05¾	.05¾ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09¾ – .10
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.15 – .16
Zinc chloride, gran.	lb.	.09 – .09½	.09½ – .10
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11¼– .11½	.11½ – .12½
Zinc oxide, XX	lb.	.07½– .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.15 — 1.20
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.18 — .19
Aniline salts	lb.	.25 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.35 — 1.45
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.32 — .34
Beta-naphthylamine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.24 — .26
Cresylic acid, 97–99%, straw color, in drums	gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.90 — 1.05
Dimethylaniline	lb.	.40 — .45
Dinitrobenzene	lb.	.21 — .25
Dinitroclorbenzene	lb.	.25 — .27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.38 — .40
Dinitrotoluene	lb.	.25 — 30
Dip oil, 25%, car lots, in drums	gal.	.31 — 35
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.00 — 1.10
Meta-phenylenediamine	lb.	1.10 — 1.15
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.40 — 1.45
Naphthalene crushed, in bbls.	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — .08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.11 — .14
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	3.00 — 3.10
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20

Ortho-toluidine	lb.	.20 —	.25
Para-amidophenol, base	lb.	1.30 —	1.35
Para-amidophenol, HCl	lb.	1.60 —	1.70
Para-dichlorbenzene	lb.	.15 —	.17
Paranitroaniline	lb.	.77 —	.80
Para-nitrotoluene	lb.	.75 —	.80
Para-phenylenediamine	lb.	1.65 —	1.70
Para-toluidine	lb.	1.15 —	1.25
Phthalic anhydride	lb.	.37 —	.40
Phenol, U. S. P., drums	lb.	.11½ —	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.50 —	1.60
Resorcinol, pure	lb.	2.00 —	2.25
Salicylic acid, tech., in bbls	lb.	.20 —	.21
Salicylic acid, U. S. P	lb.	.22 —	.23
Salol	lb.	.75 —	.77
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.16
Sulphanilic acid, crude	lb.	.26 —	.28
Toluidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.24 —	.25
Beeswax, refined, light	lb.	.28 —	.30
Beeswax, white pure	lb.	.34 —	.38
Candellila wax	lb.	.23 —	.24
Carnauba, No. 1	lb.	.45 —	.46
Carnauba, No. 2, North Country	lb.	.22 —	.22½
Carnauba, No. 3, North Country	lb.	.13½ —	.14
Japan	lb.	.19 —	.20
Montan, crude	lb.	.04½ —	.05
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03½ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ —	.05½
Stearic acid, single pressed	lb.	.09¼ —	....
Stearic acid, double pressed	lb.	.09½ —	....
Stearic acid, triple pressed	lb.	.10½ —	.10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.20 —	5.25
Rosin E-I	280 lb.	5.30 —	5.40
Rosin K-N	280 lb.	5.95 —	6.65
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.90 —	....
Wood turpentine, steam dist	gal.	.88 —	....
Wood turpentine, dest. dist	gal.	.87 —	....
Pine tar pitch, bbl	200 lb.	.... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	10.00
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	$2.30 —	2.90
Blood, dried, f.o.b., N. Y	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.35 —	2.40
Tankage, high grade, f.o.b. Chicago	unit	2.75 —	3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	4.50 —	6.50
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	35.00
Potassium sulphate	unit	.95 —	1.00

Crude Rubber

Para—Upriver fine	lb.	$0.23 —	.23½
Upriver coarse	lb.	.13½ —	.14
Upriver caucho ball	lb.	.13 —	.13½
Plantation—First latex crepe	lb.	.18½ —	.18¾
Ribbed smoked sheets	lb.	.18½ —	.19
Brown crepe, thin, clean	lb.	.15 —	....
Amber crepe No. 1	lb.	.17½ —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.12½ —	.13½
Coconut oil, Ceylon grade, in bbls	lb.	.09 —	.09½
Coconut oil, Cochin grade, in bbls	lb.	.10 —	.10½
Corn oil, crude, in bbls	lb.	.08½ —	.08½
Cottonseed oil, crude (f. o. b. mill)	lb.	.07 —	.07¼
Cottonseed oil, summer yellow	lb.	.08¼ —	.09
Cottonseed oil, winter yellow	lb.	.09½ —	.09½
Linseed oil, raw, car lots (domestic)	gal.	.71 —	.72
Linseed oil, raw, tank cars (domestic)	gal.	.66 —	.67
Linseed oil, in 5-bbl lots (domestic)	gal.	.74 —	.75
Olive oil, denatured	gal.	$1.15 —	$1.20
Palm, Lagos	lb.	.08 —	.08½
Palm, Niger	lb.	.06¼ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07½ —	.07¾
Peanut oil, refined, in bbls	lb.	.10¼ —	.11
Rapeseed oil, refined in bbls	gal.	.82 —	.83
Rapeseed oil, blown, in bbls	gal.	.87 —	.89
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.08½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 —	....

FISH

Light pressed menhaden	gal.	$0.46 —	....
Yellow bleached menhaden	gal.	.48 —	....
White bleached menhaden	gal.	.50 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

Prices remain unchanged throughout the list.

Refractories

All prices remain the same as figures appearing in our Dec. 28 issue.

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½ —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00 —	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport	gross ton	54.00 —	58.35
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	57.00 —	59.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25 —	4.50

Ores and Semi-finished Products

Prices remain quotably unchanged as of Jan. 11

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	35.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	32.375
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375
Zinc, spot, New York	5.20
Zinc, spot, E. St. Louis	4.75

OTHER METALS

Silver (commercial)	oz.	$0.66¼
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	84.00–93.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00–60.00
Mercury	75 lb.	52.00–53.00

FINISHED METAL PRODUCTS AND OLD METALS

Quotations have remained unchanged since our previous report.

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.63	$2.78	$2.78
Soft steel bars	2.53	2.68	2.68
Soft steel bar shapes	2.53	2.68	2.68
Soft steel bands	3.13	3.28	3.28
Plates, ¼ to 1 in. thick	2.63	2.78	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The White Star Cement & Coal Co., recently organized under Delaware laws with capital of $3,000,000, has preliminary plans under way for the construction of a new cement-manufacturing plant in the vicinity of Birmingham, with total annual capacity to approximate 1,000,000 bbl. of material. The main office of the company will be located at Nazareth, Pa. A. G. Connolly is president, and Charles W. K. Shafer, secretary. Richard K. Meade & Co., 11 East Fayette St., Baltimore, Md., are engineers for the project.

California

OAKLAND—Fuller & Goepp, 998 Monadnock Bldg., San Francisco, manufacturers of glass products, have plans under way for the construction of a new 2-story, reinforced-concrete plant at 11th and Jackson Sts., Oakland. Work will be commenced at an early date.

Connecticut

NEW HAVEN — The Seamless Rubber Co., Hallock Ave., manufacturer of small rubber goods, is having plans prepared for the construction of a 1-story addition, 140 x 160 ft., with extension 60 x 60 ft., to be used as a spraying department, estimated to cost about $100,000, with machinery. The company is also rebuilding the portion of its plant recently destroyed by fire, with loss estimated at about $200,000. R. W. Foote, 185 Church St., is architect for the new building.

BRIDGEPORT — The Crane Co. has foundation work under way for the proposed 1-story addition to its local South End metal-working plant, 75 x 175 ft., for a new annealing department. Ten large annealing furnaces with auxiliary equipment will be installed. The extension will cost about $50,000.

Delaware

WILMINGTON—Fire recently destroyed buildings of the New Castle Leather Co. and Hercules Powder Co., East Tenth St., with loss estimated at about $50,000 and $15,000, respectively.

Georgia

MILLEDGEVILLE—The Oconee Brick & Tile Co. is planning for extensions and improvements at the plant of the American Fireproofing Co., recently acquired. The capacity will be increased.

Florida

LEESBURG—The Grass Fibre Pulp & Paper Corp., Leesburg, is considering the construction of a branch plant at Arcadia, Fla., for the manufacture of pulp and paper from saw-grass. E. R. Lacy is vice-president and general manager.

Indiana

INDIANAPOLIS—The Piel Bros. Starch Co., State Life Bldg., has filed plans for the construction of an addition to its plant on Drover St., to cost about $50,000. William F. Piel is president.

Kentucky

ASHLAND—The City Council has commenced the construction of a new filtration plant for the waterworks system, to cost about $250,000, including equipment. E. C. Means is city engineer in charge.

Louisiana

NEW ORLEANS—The Celotex Co., manufacture of wall-board composition products from refuse sugar cane under a patented process, is considering plans for the construction of an addition to its plant for largely increased capacity; it is proposed to double the present output. A bond issue for $500,000 is being arranged to provide funds for the expansion.

LAKELAND—Fire Dec. 31 destroyed a portion of the refinery of the Ingleside Sugar Refining Co., with loss estimated at about $200,000, including buildings and machinery.

MONROE—The Owens Bottle Co., Toledo, O., has acquired property at Monroe as a site for the construction of a new plant for the manufacture of glass bottles and other containers. The proposed works will be equipped to give employment to about 500 men.

Maryland

BALTIMORE — The Sherwood Brothers Co., Garrett Bldg., manufacturer of oil products, has acquired a large tract of land adjoining its plant in the Canton section, for the erection of an addition. A number of new buildings will be constructed and machinery installed, while a group of new steel tanks will be built to increase the storage capacity to about 1,000,000 gal. The company was incorporated recently with capital of $1,000,000.

WESTCHESTER—Fire Dec. 29 destroyed a portion of the rendering plant of Frank Leidy, with loss estimated at about $12,000.

BALTIMORE—The Fitch Dustdown Co., Cincinnati, O., manufacturer of sweeping compounds, is negotiating for property at Baltimore for the erection of a branch manufacturing plant. It will be equipped for a capacity of about 30,000 lb. of material per day. The Industrial Bureau of the local Board of Trade is interested in the enterprise.

Massachusetts

WORCESTER — The American Steel & Wire Co. is completing plans for the erection of a 1-story addition to its North Works, to be equipped as a galvanizing department, estimated to cost about $42,000. Practically all of the equipment to be installed will be electrically operated. The engineering department at the works is also preparing plans for other extensions, estimated to cost in excess of $200,000. Charles E. Goodrich is chief engineer.

FALL RIVER — The Fall River Gas Works has preliminary plans under way for the construction of a new water-gas plant, with daily capacity of about 3,000,000 cu.ft. The board of directors recently voted an appropriation of $500,000 for the work.

Minnesota

BABBITT—The Mesabi Iron Co. is considering the erection of a new concentrating plant at its works, estimated to cost about $30,000. W. G. Swart is general manager.

Missouri

KANSAS CITY—The American Foundry & Mfg. Co., Kansas City Life Bldg., has awarded a contract to William R. Jewell, 227 Rialto Bldg., for the erection of a 1-story foundry and plant, 90 x 140 ft., at 18th and Manchester Aves., estimated to cost about $30,000. The company is also considering the erection of two additional plant units, to cost about $65,000. H. H. Akers is manager.

New Jersey

NEWARK—The Celluloid Co., 290 Ferry St., has filed plans for the erection of a new 1-story plant, 71 x 110 ft., at 65-67 Westcott St., estimated to cost about $45,000.

NEWARK—The J. H. Balmer Co., Passaic, N. J., manufacturer of carthenware bathroom fixtures, etc., has leased a portion of the building at 67 Hamilton St., Newark, for the establishment of a new branch plant. Possession will be taken at once.

MILLINGTON—The Asbestos Materials Co. will make immediate improvements and extensions to the local plant of the Bateman Co., recently acquired, and heretofore devoted to the manufacture of agricultural equipment. An addition will be erected to the main building on Central Ave. Machinery will be installed at an early date and operations inaugurated.

JERSEY CITY—Colgate & Co., 105 Hudson St., manufacturers of soaps, etc., have acquired a 2-story and basement building, with two large wings, at Montreal, Que., for the establishment of a new branch plant. The company is now building an addition to its Jersey City factory to co about $140,000.

New York

BROOKLYN—The Perfect Brick & Ho low Tile Co., 188 Montague St., is takin bids for the erection of a new 1-stor plant on Grand St., 95 x 100 ft., estimate to cost about $25,000. Silverstein & Infar ger, 190 Montague St., are architects.

NIAGARA FALLS — The Internation Paper Co. has awarded a contract to th Electric Furnace Construction Co., 90 Chestnut St., Philadelphia, Pa., for th installation of a new 6,000-kw. electri steam generator at its local mill, wit auxiliary operating equipment.

BUFFALO—The city waterworks depar ment, Commissioner Kreinheder, will soo commence surveys for a new filtratio plant at the foot of Jersey St., near th Porter Ave. pumping station of the wate works, estimated to cost about $4,500,00 An appropriation of this amount has bee arranged for the project.

Ohio

NARLO—Following the recent acquis tion of the Dolemite Products Co., Narl by the Kelley Island Lime & Transport Co Leader Bldg., Cleveland, plans are sai to be in progress to increase the productio of limestone at the local plant, effecting total capacity of about 2,500 tons a da

Oklahoma

PICHER—Fire Dec. 26 destroyed th local Plant No. 2 of the Skelton Lead Zinc Co., with loss estimated in excess o $50,000, including equipment.

TULSA—Cosden & Co. are planning fo a number of extensions in their local o refinery, estimated to cost in excess o $1,000,000. The Eastern office of the com pany is at 120 Broadway, New York.

Pennsylvania

PITTSBURGH—The Standard Sanitar Mfg. Co., Bessemer Bldg., has awarded contract to the B. A. Groah Constructio Co., 847 West North Ave., for the con struction of a 1-story addition to its san tary ware-manufacturing plant on Preb Ave., 115 x 130 ft. It will be equippe as a plating department.

PHILADELPHIA—The David Berg In dustrial Alcohol Co., Delaware Ave. an Tasker St., has acquired property adjoinin its plant, 460 ft. wide, and of irregula depth, for a consideration said to be $155 000, and will use the site for expansion.

Tennessee

CHATTANOOGA—The Central Glass Co 4240 Ogden Ave., Chicago, Ill., with plan at North Chattanooga, has acquired th local works of the DeCamp Glass Caske Co., which has been under a receivershi for about a year past, with J. H. McCallun acting as trustee in bankruptcy. The ac quired plant represents an investment o over $200,000, and was secured for a con sideration said to be about $55,000. It wil be used by the new owner for the manu facture of glass caskets, glass shingles and kindred products. It is purposed to inau gurate operations at an early date.

LAFOLLETTE—The Lafollette Coal & Iron Co. has preliminary plans under way for the construction of a new byproduc coke plant at its local works. The main feature of operation will be devoted to fue carbonization, with output to aggregate over 400 tons per day. The plant is esti mated to cost in excess of $500,000. Parke & Wilder, Cincinnati, O., are engineers.

Texas

PORT NECHES—The Humphreys-Pure Oil Refineries Corp., recently organized under Delaware laws with capital of $50,000,000, is selecting a site at Port Neches for its proposed new oil refinery, on the Gulf. The plant is estimated to cost close to $1,000,000, and will form the terminus of the company's new pipe line from the Mexia fields. It will be operated in conjunction with a proposed oil refinery at Houston, Tex., estimated to cost a like amount. Colonel E. A. Humphreys is president.

Virginia

NEW MARKET—Fire Jan. 4 destroyed a portion of the flour mill of M. Driver & Bro., Lacey Spring, near New Market, with loss reported at about $25,000.

Washington

SEATTLE — The Goodyear Rubber Co. has leased a new 2-story factory, 50 x 110 ft., to be erected by the Great Northern Construction Co., New York Bldg., at Terry Ave. and Harrison St., for the establishment of a local works.

Capital Increases, Etc.

THE STORM STEEL BALL CO., 621 Harr Pl., Oak Park, Chicago, Ill., has filed notice of increase in capital from $150,000 to $250,000.

THE MIDDLE STATES OIL CORP., Ardmore, Okla., is arranging for an increase in capital from $16,000,000 to $30,000,000.

THE RUBBER SHOCK INSULATOR CO., a Delaware corporation, has filed notice of intention to operate in New York for the manufacture of rubber specialties, with capital of 2,500 shares of stock, no par value. W. Gutterson, 252 West 64th St., New York, represents the company.

THE INTERNATIONAL PAPER CO., 30 Broad St., New York, N. Y., has arranged for a bond issue of $12,500,000, for financing, general operations, etc.

THE GUNNASH CHEMICAL WORKS, 67 Margaretta St., Newark, N. J., has been declared insolvent, with liabilities totaling about $11,000 over assets.

THE ASSOCIATED PRODUCING & REFINING CORP., St. Louis, Mo., manufacturer of oil products, has filed notice of increase in capital from $2,000,000 to $50,000,000.

THE SKELLY OIL CO., Tulsa, Okla., has arranged for a bond issue of $3,500,000, the proceeds to be used for financing, general operations, etc. W. G. Skelly is president.

The tannery of the VICTOR LEATHER CO., Auburn St., Allentown, Pa., manufacturer of glazed kid, bankrupt, will be sold by the receiver, George H. McNeely, 172 North 11th St., Philadelphia, Pa. The sale will include buildings, land and machinery.

THE HOLLAND-ST. LOUIS SUGAR CO., Holland, Mich., operating refineries at Decatur, Ind., and St. Louis, Mich., has arranged for a bond issue of $1,300,000, the proceeds to be used for financing, general operations, etc.

New Companies

F. R. HENDERSON & CO., INC., New York, N. Y., has been incorporated with a capital of $1,000,000, to manufacture rubber products. The incorporators are F. R., H. H. and B. W. Henderson. The company is represented by Rose & Paskus, 128 Broadway, New York.

THE BIG MARIE OIL CO., Orange, Tex., has been incorporated with a capital of $100,000, to manufacture petroleum products. E. C. O'Neal is president, and P. B. Ryan, vice-president, both of Beaumont, Tex.; and C. G. Sprague, Sour Lake, Tex., secretary-treasurer.

THE STERLING BRICK CO., 5201 Twelfth St., Detroit, Mich., has been incorporated with a capital of $25,000, to manufacture brick and other burned clay products. The incorporators are Harry T. Jenney, E. M. Crider and E. M. Heffron, 5282 Trumball Ave.

THE CELLULOSE PLASTICS & CHEMICALS, INC., Orange, N. J., has been incorporated with a capital of $100,000, to manufacture artificial leather and kindred products. The incorporators are E. A. Mau, C. M. Switzer and Oregon Helfrich, 575 Nassau St., Orange.

B. CANNON & CO., INC., Brooklyn, N. Y., has been incorporated with a capital of $52,000, to manufacture glue, gelatine and kindred products. The incorporators are W. C. Burton, A. Ellis and W. Cunningham. The company is represented by F. J. Knorr, attorney, Albany, N. Y.

THE BEVERLY CHEMICAL CO., Boston, Mass., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are Frank W and William J. Sullivan, 12 Stoughton St., Medford, Mass. The latter will act as president and treasurer of the company.

STRONG & CO., INC., Wilmington, Del., has been incorporated under state laws, with capital of $1,500,000, to manufacture refined oil products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE W. J. EARLY SONS' FOUNDRY CO., Pittsburgh, Pa., has been incorporated with a capital of $60,000, to manufacture iron, steel and other metal castings. J. E. Early, 312 South St., Pittsburgh, is treasurer.

THE SCHULZ CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are C. Schulz, S. N. Johnson and S. D. Strawgate. The company is represented by J. C. L. Daly, 375 Fulton St., Brooklyn.

THE SHAW PAPER BOX CO., Pawtucket, R. I., has been incorporated with a capital of $50,000, to manufacture paper boxes and kindred products. The incorporators are William H. M. Moies, Robert S. Emerson and Charles K. Shaw, Pawtucket.

THE AMERICAN-MEXICAN REFINING CO., 11 South LaSalle St., Chicago, Ill., has been incorporated with a capital of $100,000, to manufacture refined oil products. The incorporators are Henry L. Blim, Norman O. Johnson and D. A. Tasiopoulos.

THE NYOKALA OIL CO., Hamburg (Erie County), N. Y., has been incorporated with a capital of $500,000, to manufacture refined oil products. The incorporators are G. W. Morris, W. Allen and F. J. Carr. The company is represented by A. L. Stratemeyer, Hamburg, N. Y.

THE EASTERN STEEL & WIRE CO., Newark, N. J., has been incorporated with a capital of $1,000,000, to manufacture steel and kindred products. The incorporators are John H. Mesiter, R. Notkin and A. MacMillan. The company is represented by Bilder & Bilder, 790 Broad St., Newark.

THE MEAKIN SOAP CO., Pittsburgh, Pa., has been incorporated under Delaware laws, with capital of $50,000, to manufacture soaps and kindred products. The company is represented by the Capital Trust Co., Dover, Del.

THE CASTING & SUPPLY CO., 239 Washington St., Jersey City, N. J., has been incorporated with a capital of $50,000, to manufacture iron, steel and other metal castings. The incorporators are J. M. and George M. Bachert, and Herman Traeger.

THE BRAZOS OIL CORP., Houston, Tex., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are K. K. Kennedy, T. Lowell Hughes and E. N. Chapman, all of Houston.

THE WATERTOWN PAPER STOCK CO., Watertown, N. Y., has been incorporated with a capital of $100,000, to manufacture paper products. The incorporators are J., N. and S. Stabins. The company is represented by Pitcher & O'Brien, Watertown.

THE PURITAN PAINT & COLOR CO., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture paints, colors, varnishes, etc. The incorporators are W. F. and R. Wolter, and M. Schmidt. The company is represented by Fiero & Fiero, 2 Rector St., New York.

THE FOREST PAPER CO., Portland, Me., has been incorporated with a capital of 5,000 shares of stock, no par value, to manufacture paper products. W. B. Nulty is president, and W. S. Linnell, treasurer. The company is represented by William S. Linnell, Portland.

THE MAGUIRE TIRE & RUBBER CO., Wilmington, Del., has been incorporated under state laws with a capital of $5,000,000, to manufacture automobile tires and other rubber products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE QUEBRACHO PRODUCTS CO., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture tanning extracts and materials. The incorporators are N. A. Randall, P. J. Haley and H. A. Smith, 39 Cortlandt St., New York.

THE UTILITIES OIL & REFINING CO., Mexia, Tex., has been incorporated with a capital of $150,000, to manufacture refined oil products. The incorporators are F. M. Bransford, E. H. Fielder and H. D. Dines, all of Mexia.

THE SPEIDEN-WHITEFIELD CO., New York, N. Y., has been incorporated with a capital of $60,000, to manufacture chemicals and affiliated products. The incorporators are E. K. Speiden, L. M. Whitefield and A. E. Adams. The company is represented by A. Simmers, 95 Liberty St., New York.

THE ALINALL MFG. CO., Worcester, Mass., has been incorporated with a capital of $24,000, to manufacture paints, colors, etc. Everett H. Hall is president; M. G. Allen, vice-president; and Walter B. Allen, Worcester, treasurer.

THE GROESBECK STANDARD BRICK CO., Groesbeck, Tex., has been incorporated with a capital of $40,000, to manufacture brick, tile and other burned clay products. The incorporators are E. Raphael and Joseph Jolesch, both of Groesbeck.

THE-ECONOMY INK TONING CORP., Valley Stream (Nassau County), N. Y., has been incorporated with a capital of $10,000, to manufacture inks, chemicals and affiliated products. The incorporators are M. I. and J. Kahn. The company is represented by Alexander Rosenbaum, 233 Broadway, New York.

THE STRUCTURAL GYPSUM CORP., Jersey City, N. J., has been incorporated with a capital of $1,125,000, to manufacture gypsum products. The company is represented by the Registrar & Transfer Co., 15 Exchange Pl., Jersey City.

THE CALTEX OIL CO., San Antonio, Tex., has been incorporated with a capital of $80,000, to manufacture petroleum products. The incorporators are H. L. Schermerhorn, A. D. Cummings and J. F. Carl, all of San Antonio.

THE JACKSONVILLE CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are N. Sacks, A. Rosenthal and H. C. Lindgren. The company is represented by Joseph Schottland, 160 Broadway, New York.

THE UNIQUE OIL CO., Wilmington, Del., has been incorporated under state laws with capital of $1,000,000, to manufacture refined oil products. The company is represented by the Corporation Service Co., Wilmington.

THE LAMOLE PRODUCTS CORP., New York, has been incorporated with a capital of $20,000, to manufacture chemicals, dyes, etc. The incorporators are M. Lake, A. S. Molnar and O. S. Leazay, 319 East 24th St.

THE CHATHAM CHEMICAL CO., Savannah, Ga., has been incorporated with a capital of $150,000, to manufacturer fertilizer products. The incorporators are George E. Cope, Gordon L. Grover and W. B. Stratford, all of Savannah.

New Publications

BOOKS

A LIFE OF GEORGE WESTINGHOUSE. By *Henry G. Prout, C.E., A.M., LL.D.* 375 pp., illustrated. New York: Charles Scribner's Sons, 1922. Price, $2.50.

This life of George Westinghouse is the second in what may be a series of biographies of great men associated with the American Society of Mechanical Engineers. Mr. Westinghouse left no written record except in the files of his numerous companies. He wrote almost no private letters. He kept no journals or even notebooks. He made but few addresses and wrote few papers. Accordingly it was necessary to draw upon the many men still living and working who were close to Westinghouse. It was the duty of Mr. Prout as editor to digest these contributions, to co-ordinate them, and to keep a reasonable perspective. In this he was aided by the committee of the American Society of Mechanical Engineers appointed for that purpose: Charles A. Terry, chairman; Paul D. Cravath, Alexander C. Humphreys, James H. McGraw, Charles F. Scott, Lewis B. Stillwell, Ambrose Swasey, with Henry Herman Westinghouse always in consultation.

Mr. Westinghouse's activities were so varied that a chronological narrative would of necessity lead to some confusion. For this reason, each topic has been treated by itself and one has but to glance at the chapter headings to realize the tremendous activity and breadth of vision of this great pioneer. The air brake and friction draft gear naturally take first place, followed by the electrical and related activities—the induction motor and meter, the rotary converter, lighting, power transmission, electric traction, steam and gas engines, the turbo-generator, signaling and interlocking. Natural gas and other interests are considered in separate chapters. There are also general chapters on the European enterprises, financial methods, personality and meaning of George Westinghouse. In an appendix are given chronological and classified lists of his patents.

TRANSACTIONS OF THE AMERICAN ELECTROCHEMICAL SOCIETY, vol. 38. 462 pp., illustrated. Published by the American Electrochemical Society at the office of the secretary, Lehigh University, Bethlehem, Pa. Price, $3 to non-members, $2.50 to members, $2 to libraries, colleges, etc.

This volume contains the papers presented at the thirty-eighth general meeting, Cleveland, Sept. 30, Oct. 1, 2, 1920.

THE MINERAL INDUSTRY DURING 1920, Vol. 29. Edited by *G. A. Roush, A.B., M.S.*, associate professor, department of metallurgy, Lehigh University. 907 pp., illustrated. New York: McGraw-Hill Book Co., 1921. Price, $10.

Statistical, technical and commercial data for 1920 are given for the following: Abrasives, aluminum and bauxite, antimony, arsenic, asbestos, asphalt, barium and strontium, bismuth, borax, bromine and iodine, cadmium, cement, chromium, coal and coke, cobalt, copper, cryolite, feldspar, fluorspar, fullers earth, gold and silver, graphite, gypsum, iron and steel, lead,

magnesite, manganese, mica, molybdenum, monazite, nickel, petroleum and natural gas, phosphate rock, platinum, potash, precious stones, quicksilver, radium, selenium and tellurium, sodium salts, sulphur, pyrite and sulphuric acid, talc and soapstone, tin, titanium and zirconium, tungsten, uranium and vanadium, zinc. The book also includes a chapter on ore dressing and coal washing, and a supplementary chapter of mineral statistics.

STUDY QUESTIONS IN ELEMENTARY ORGANIC CHEMISTRY. By *Alexander Lowy, Ph.D.*, assistant professor of organic chemistry, University of Pittsburgh and *Thomas B. Downey*, M.S., instructor in organic chemistry, University of Pittsburgh. 91 pp. New York: D. Van Nostrand Co., 1921. Price, $1.

The study questions in this book are divided into forty-five groups covering the entire field of a general elementary course in organic chemistry. They are designed to aid the students in mastering the subject more thoroughly, and have been used for this purpose with marked success at the University of Pittsburgh. An excellent bibliography of works and periodicals on pure and applied organic chemistry suggests material for collateral study.

OIL SHALES. By *H. B. Cronshaw, B.A., Ph.B., A.R.S.M.* 80 pp. with map. London: John Murray, 1921. Price, 5s.

This is one of the series of monographs on mineral resources with special reference to the British Empire prepared under the direction of the Mineral Resources Committee of the Imperial Institute with the assistance of the scientific and technical staff. After discussing the occurrences, characteristics and uses of oil shales in a general way, the sources of supply are considered in more detail, one chapter being devoted to the British Empire and another to foreign countries. Then follow a world map showing the location of oil shale districts and six pages of references to the literature on oil shales.

THE DESIGN OF STEEL MILL BUILDINGS AND THE CALCULATION OF STRESSES IN FRAMED STRUCTURES, fourth edition, rewritten. By *Milo S. Ketchum, C.E.*, director of the department of civil engineering, University of Pennsylvania. 632 pp., 60 tables, 410 illustrations. New York: McGraw-Hill Book Co., 1921. Price, $6.

This book covers the calculation of the stresses in framed structures, and also the design of buildings having a self-supporting steel frame with a light covering, usually fireproof. In this edition the book has been rewritten and enlarged, the type has been reset and the plates have been recast. The scope of the book has been enlarged by the addition of a concise discussion of the calculation of the stresses in statically indeterminate trusses and frames, several problems in framed structures and detailed designs of a crane girder, a roof truss, and a steel frame mill building. The book is written to serve as a text book in structural engineering and also as a book of reference for engineers. A complete specification for steel frame mill buildings is given in an appendix.

LABORATORIES: THEIR PLANNING AND FITTINGS. By *Alan E. Munby, M.A., F.R.I.B.A.* 220 pp., 165 illustrations. New York: D. Van Nostrand Co., 1921. Price, $6.

Literature on the subject of laboratories is surprisingly incomplete and scattered. Indeed, the author states in the preface that "search has not revealed any work now in print published in this country [England] which endeavors to deal with laboratories in a manner calculated to bring a building committee, a professional staff and an architect on common ground for what is essentially a joint undertaking." The volume opens with a historical introduction by Sir Arthur E. Shipley, ex-vice chancellor of Cambridge University. The subject is then treated by topics as follows: Scope and Inception of Building Schemes; Requirements of Chemistry; Requirements of Physics; Requirements of Biology and Geology; Laboratory Services; Recent Designs. Excellent descriptions and detailed drawings of typical laboratories in England, the United States and on the Continent make the book of great practical value to those interested in the design construction and equipment of laboratories.

ELEMENTARY CHEMICAL MICROSCOPY, second edition, partly rewritten and enlarged. By *Emile Monnin Chamot, B.S., Ph.D.*, professor of chemical microscopy and sanitary chemistry, Cornell University. 479 pp., 162 illustrations. New York: John Wiley & Sons, Inc., 1921. Price, $4.25.

This book is intended to serve as an introduction to the microscope and its accessories as tools for the chemist to work with and even though practical applications are referred to, the author has made no effort and has no desire to have the book take the form of a manual of industrial microscopy. The changes in this edition have been chiefly in the rearrangement of the chapters, in the elaboration of the data presented and in the rewriting of obscure passages. Comparatively little new apparatus has been described or new methods introduced. A brief synopsis of the course in introductory chemical microscopy as now given at Cornell University has been inserted in the appendix.

In order to meet the often expressed needs of advanced students and of professional chemists, a Handbook of Microscopic Qualitative Analysis is in preparation which will be copiously illustrated by microphotographs and which will thus serve to supplement the present introductory text.

CHEMICAL AND METALLOGRAPHIC EXAMINATION OF IRON, STEEL AND BRASS. By *William T. Hall*, associate professor of analytical chemistry, Massachusetts Institute of Technology, and *Robert S. Williams*, associate professor of analytical chemistry and metallography, Massachusetts Institute of Technology. 501 pp., 183 illustrations. New York: McGraw-Hill Book Co., 1921. Price, $5.

This volume of the International Chemical Series by the translators of Bauer and Deiss's "Sampling and Analysis of Iron and Steel" is divided into two parts.

Part I covers the chemical analysis of iron, steel and brass, and includes the determination of the following elements in iron and steel: C, Mn, P, Si, S, Cu, Cr, Fe, Ni, Mo, W, V, Al, As, Ti, N, O, Zr. A chapter is devoted to the electrometric methods applicable to iron and steel analysis and this part of the book closes with two chapters on the analysis of non-ferrous alloys.

Part II deals with the application of metallography to the inspection and sampling of alloys. The topics are as follows: Preparation and Examination of the Specimen; Metallographic Constituents of Iron and Steel; Wrought Iron and Steel; General Study of Steel With the Microscope; Metallographic Examination of Iron; Gray Iron; Sampling of Iron and Steel; the Alloys of Copper.

A MANUAL OF FLOTATION PROCESSES. By *Arthur F. Taggart*, professor of ore dressing, Columbia University. 181 pp., 56 illustrations. New York: John Wiley & Sons, Inc., 1921. Price, $3.

As indicated by the title, this book attempts to review the entire field of flotation. Its purpose is, in part, to counteract the further spread of false conception concerning flotation concentration, by setting forth some of the essential facts which contradict them; in part to describe apparatus and methods of testing which will aid investigators in their own researches; finally, to give some generalizations from mill practice, by means of which the laboratory experimenter can translate his results into commercial operations. The four chapters of the book are: Introduction, Testing Laboratory Equipment, Testing, Mill Data.

ELECTRODEPOSITION AND ELECTROPLATING. A General discussion held at Sheffield, November, 1920. Reprinted from the *Transactions* of the Faraday Society, vol. 40, part 3, 1921. 83 pp. Published by the Faraday Society, 82 Victoria St., London, S. W. Price, 10s. 6d.

This is a reprint of papers and general discussion presented at a symposium on the subject held by the Faraday Society. The following papers are included: "Electroplating for the Prevention of Corrosion," by Leslie Aitchison; "Some Applications of Electrodeposition in Aeronautical Engineering," by W. H. Thain; "Electrodeposition of Cobalt," by Byron Carr; "Commercial Electrolysis of Zinc Sulphate Solutions," by Samuel Field; "Deposition of Gold-Silver Alloys," by Samuel Field; "Use of Colloids in the Electrodeposition of Metals," by W. E. Hughes; "Electro Silver Plating: Its Technical Development," by W. R. Barclay; "The Chemical Composition of Old Silver Plating Solutions," by G. B. Brook; "A New Maximum Current Density in Commercial Silver Plating," by Frank Mason; "The Crystalline Structure of Electrodeposited Silver," by G. B. Brook.

PROCEEDINGS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS, vol. 21, 1921. 1,197 pp. Published by the Society, 1315 Spruce St., Philadelphia, Pa.

This volume contains the proceedings of the twenty-fourth annual meeting, held at Asbury Park, N. J., during June, 1921, a meeting which was reported in CHEMICAL & METALLURGICAL ENGINEERING for June 29, 1921 (vol. 24, p. 1,145). It contains 441 pages devoted to the reports of committees. Four hundred pages are devoted to nearly 100 tentative standards, proposals printed for one or more years, with a view of eliciting criticism. Many of these have to do with methods of testing, the most elaborate being for methods of analysis of aluminum and its light alloys. Another long specification concerns rubber-insulated wire. The remainder of the book contains the technical papers read and discussed.

Manufacturers' Catalogs

PENNSYLVANIA PUMP & COMPRESSOR CO., Easton, Pa., has issued Form 102, superseding Form 101, on Pennsylvania air compressors and vacuum pumps, both power- and steam-driven in straight-line, single-stage types. The Pennsylvania construction is described in detail and illustrations are given. Copies will be sent on request.

THE CALORIZING CO., Pittsburgh, Pa., in a 4-page booklet describes Calite castings for use in high temperatures, and also its characteristics and physical properties. The General Electric Co.'s research engineers have spent many years to get this alloy, which is claimed to stand high heat.

SCHUTTE & KOERTING CO., Philadelphia, Pa., has just issued a new catalog on heat-transfer equipment. This book contains Bull. 10 DE, on evaporators, heaters and distillers; Bull. 10 F, on heaters for water and fuel oil; Bull. 11 T, on Thermofan system for heating ships; Bull. 12 C, on heat exchangers for recooling oil; Bull. 12 G, on heaters and coolers for air and gases; Bull. 12 R, on multitube motor radiators. Each is descriptive, and well illustrated. This is a reference volume which should be valuable to any plant engineer who is interested in heat transfer as applied to fuel oil systems, heating liquids, feed water, etc.

THE BETHLEHEM FOUNDRY & MACHINE CO., Bethlehem, Pa., calls attention to an attractive catalog on chemical equipment of metal. Illustrations and descriptive matter are given on nitrators, sulphonators, reducers, vacuum stills, washers, autoclaves, etc.

THE ATERITE CO., INC., Paterson, N. J., in Bull. 8 describes and illustrates Aterite and Fanosite valves, cocks, fittings and specialties for manufacturers and users of chemicals.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN WOOD PRESERVERS ASSOCIATION will hold its annual meeting Jan. 24, 25 and 26 at the Hotel Sherman, Chicago, Ill.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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Why Prices Are Up or Down

IT IS useful to make a comparison now and then between what we used to expect would occur and what actually has occurred. Our disposition to repose confidence in current appraisals of what is going to come is increased or decreased according to whether or not observation of the phenomenon shows that there is agreement with the prediction.

A year ago it was a common saying that this time we knew why business was poor; it was because men were waiting for declines in prices and wage rates. When proper adjustments had been made, business would resume at its former gait, only at the right prices and costs.

A survey of the situation does not indicate that this appraisal was correct. Some prices have come down very nearly to pre-war levels, others are below pre-war average prices. Some prices are still very high. According to the theory, the lower priced commodities would be moving freely, men having taken hold again, while the higher priced commodities would be moving slowly because of men refusing to take hold on account of not having got what they wanted. This, however, is not the case. While the general average of commodity prices at wholesale, as reported by the Department of Labor, has averaged about 150 since last May and stood unchanged at 149 for November and December, building materials are about double price, and advanced from 197 in November to 203 in December. Next to "house-furnishing goods," which have been at 218 in the past 2 months, building materials are the highest priced class of commodities in the Bureau of Labor's list of nine groups.

Now it is a fact that there has been a very fair volume of building activity lately. There has not been much factory and bridge construction, but there has been activity in erection of garages, dwelling houses and public buildings. The reasonable assumption is that SMITH is like JONES. JONES hopes that prices and wage rates in general and SMITH'S in particular will come down, but he feels individually that JONES is all right and ought to maintain his position as much as possible. If people will buy from him at high prices, he is justified in accepting the money.

People have been buying building materials fairly well. The builder of a garage or dwelling house wants the new facility before he grows any older. The municipality finds it can borrow money to advantage, by tax-exempt bonds, and goes ahead. These buyers do not wait, and so building materials remain at their inflated price levels.

This explanation does not fit all cases, of course. There are some instances, no doubt, where sellers of a commodity are close together and are able to hold up prices by refraining from indulging in strenuous competition. In some commodities, like steel and zinc, there is particularly keen competition, and prices are low. Zinc, after having advanced in recent months, is still well below its pre-war average.

The rule that obtains among sellers of commodities obtains also with workmen, only it is applied in a less practical and intelligent manner. The unions have held wages up where they could, even though they have had little employment. Between 60 and 70 per cent of the bituminous coal-mining capacity of the country is under union auspices and the men adhere to their scale, with the result that the great bulk of the coal being produced today is at non-union mines. The unions in the building trade have submitted to slight reductions only, but they manage to get employment while they are not on strike.

Prices and wage rates that are up are up because they could be held up. Prices and wage rates that are down are down because they could not be held up. There has been no general leveling force. It has not been a case of the general value of the dollar increasing. The value of the dollar, as compared with pre-war times, depends on what you wish to spend it for.

The Value of Personnel Boards

ON THE initiative of the always lively and interesting General CHARLES G. DAWES, Director of the Bureau of the Budget at Washington, a Federal Personnel Board has been established under the supervision of the United States Civil Service Commission.

It is indeed high time that such a board should be established. It is to have, among other duties, the "operation of a service through which employees may be assigned to the several departments or establishments in periods of maximum load, thereby permitting appropriations for the several offices to be made on the basis of their normal loads." It is also to include the training of employees for their positions and to adopt, as far as practicable, "the principle of promotion from within in filling the higher positions in the service with a view to offering a career to properly qualified persons who enter the public service."

This is good business and applied psychology. Now we should like to see another Personnel Board organized among bankers and dealers in investment securities and money lenders to select suitable and qualified directors for industrial corporations so that, when the leaders assume the privilege of naming directors to look after their interests, they may select men who have a reasonable sense of what is required of them. Many directors of great corporations are grossly overpaid by their fees of $10 or $20 a month or a quarter for their services. Others would be grossly underpaid by fees of a thousand dollars per meeting.

Varieties and Vanities Of Millionaires

AT A DINNER of the Alumni of the Massachusetts Institute of Technology held in Cambridge the other day, one of the speakers who made an address in lighter vein offered a little dissertation on Millionaires: Their Varieties and Their Vanities. We venture to repeat a few of his observations for what they are worth, inasmuch as nearly all of us occasionally seek access to millionaires, and when we meet them we usually want the interview to be of an agreeable nature. We are also likely to be ambitious to induce them to accept our own point of view.

Of course they are of all sorts, but an effort was made to discover some of their common traits. Among these is a general conservatism of disposition and that measure of nervousness about property that follows responsibility. Since the only enduring wealth is that of the mind and all other possessions easily take wings, and millions are not mental, this nervousness is justified.

With responsibility comes the consciousness of it, which frequently engenders vanity. One of its most persistent manifestations has to do with the etiquette of calling. If, let us say, a chemical engineer wishes to bring together millionaires A and B who might become jointly interested in an enterprise, he may count on the response from A that "Mr. B knows where to find me; I shall be glad to meet him whenever he calls," and exactly the same from B in regard to A. Neither will call on the other. But both will lunch together without losing face, and whether one or the other pays for it or the engineer himself pays for it, is unimportant.

Habits of speech are to be observed carefully. If the man of wealth is precise in language it behooves the interviewer to call to service all the grammar he knows, and to avoid any solecism; otherwise he will be classed as an inferior person and cannot possibly get in on the ground floor. On the other hand, if the interviewer's speech is more precise or more elegant than that of the rich man, he is in danger of being classed as a theorist, and 90 per cent of our millionaires hate theorists. This expression of hatred of theorists is rather a fashion of speech than a reasonable conclusion, but its use is well-nigh universal, and it serves as a substitute for thought. Such substitutes for thought are more potent to engender obstinacy than earnest deliberation. It is therefore held to be preferable to refer to every measure proposed in regard to apparatus or materials or plant as "the practical application of science."

By association with bankers the millionaire gets the banking habit of mind. Here we meet subjects that we have frequently discussed editorially. We shall merely repeat as blind spots of the banking mind the belief that a balance sheet tells everything; the lack of appreciation that it is only a record of past performances; and the curious illusion that a man who achieves success in one enterprise is almost certain to succeed in another. What is missed is that the very stratagems which apply successfully in one affair will lead to failure in another. The man who has succeeded, for instance, in the manufacture of silk ribbons has a far more difficult path to succeed in garbage disposal than the one who has worked his way along to the administration of the affairs of either of the two fields of activity.

A passion generally caught from banking associations is to "cut out dead wood." Nine men of wealth out of ten, in approaching a reorganization, do not object to their own lack of specific knowledge of the proposed undertaking, but at least eight of them will insist on having a hand in "cutting out the dead wood" if they are to participate in the subscription. It is therefore of leading importance to fix upon some part of a proposed undertaking which the underwriters may have the satisfaction of discovering, as dead wood, and cutting out. If they cannot satisfy this passion, they are likely to break off negotiations. They do not seem to care so much what the dead wood is, so long as they can cut. This they feel they must do. If the engineer does not select it, they will; and as likely as not it will be the very heart of the business.

Some day when bankers get a background of chemistry, millionaires will see the need of it, too. Then chemical industry will have smoother sailing.

Chemistry By Mail

LATELY we protested against a French advertisement offering American university degrees for sale. With equal fervor we object to a misleading announcement in a number of popular American magazines offering to prepare subscribers to earn big money in chemistry by means of correspondence. This consists of thirty-one lessons and lasts 8 months, with the intimation that the subscriber will be a chemist at the end of that time. Salaries of $10,000 to $15,000 a year are set forth as available, to all appearances, to those who take the course. "If your present earnings do not suit you," says the precious booklet which is sent to inquirers, "if you cannot seem to get ahead or do not earn enough to enjoy life, take up chemistry and fit yourself in a few short months to enter a profession which offers unlimited opportunities for sure and rapid advancement."

There's little use in giving more details. They charge $125 for the course, with special discounts for those who make haste to subscribe. The method is a "direct short-cut with all frills and useless details eliminated." No physics, no physical chemistry, no mathematics beyond simple arithmetic—less indeed than may be found in any $2 textbook; and all for $125, which includes the "outfit"—"six test tubes, one glass stirring rod, two glass funnels" and some other things.

The advertisement emanantes from a "Chemical Institute of New York, 140 Liberty St. T. O'Conor Sloane, A.B., A.M., Ph.D., LL.D., Educational Director." The picture of Dr. Sloane is given, which shows him to resemble G. B. Shaw, and it is stated that he was formerly treasurer of the American Chemical Society. A quotation from "Who's Who in America" relates that he made his Ph.D. at Columbia University in 1876 and that he taught natural science at Seton Hall, which is a reputable Catholic school for boys at South Orange, N. J. Inquiry brings out the fact that about 25 years ago Dr. Sloane was treasurer of the American Chemical Society for a short time. He has written some elementary books on electricity, and we are informed that they are not without merit. We know nothing against his earlier career. What appears probable is that in his later years he has got into bad company. Surely no reputable chemist would lend his name to this sort of thing.

We want to do everything we can to advance the teaching of chemistry, so that the public may understand what the science means. But in our judgment this advertisement is misleading. It seeks to get money out of young men under false pretenses, which is a mean trick that should be stopped.

Psychological Adventures in Stupidity

PROFESSOR LEWIS M. TERMAN contributes to the January number of *The Scientific Monthly* an essay entitled "Adventures in Stupidity," which relates to an inferior student called "K." How K managed to slip through high school and graduate at the age of twenty is not given, although the eminence and wealth of his father may have had something to do with it.

He was well brought up, handsome, rather engaging in manner and generally prepossessing in appearance. But after a couple of weeks' experience one of the instructors asked Professor TERMAN to look him over, saying he had never met anyone so stupid. He proved to have a mental age of ten to twelve years, despite the fact that he could read, write and spell acceptably, could drive his high-power motor car as well as the average person, was diligent in his work, and had abundant mental equipment to be, for instance, a champion athlete. At the end of the first term he failed in all his studies and was glad to go home and be a clerk in his father's store. He had not wanted to go to college anyway.

The tests as recorded are involved in psychological jargon that is unfamiliar to most of us, but we can give a few notes that illustrate his intellectual stature. Asked to read a newspaper article and report on it, his replies were childish and inaccurate. He could sometimes carry out instructions if given in a fifteen-word sentence, but if the sentence was thirty or forty words long he would respond with a blank stare. He could not take a mixed sentence, such as "people are many candy of fond," and arrange the words to mean something, because he cannot profit from logical cues. He thinks New York is the largest city in the country "because it covers such a large area." Even his grasp of familiar words is hazy. For instance, lecture means "to be taught," ramble "to go fast," conscientious "very good in his work," brunette "white" and tolerate "to get away from." Summing up, he "lacks intellectual initiative, planning range and flexibility of association, analysis of a situation into its elements, alertness and the direction of attention toward the significant aspects of experience. He is unable to master the intellectual shorthand of general ideas."

Well, how many of us can do these things? It is said with no little authority that the great majority of our high school graduates are drawn from the best 25 per cent of our population, and that the typical university graduate ranks in intellectual endowment well within the topmost 10 per cent. "K is stupid only by contrast. Only occasionally does an individual of his moderate ability manage to graduate from high school or enter college. . . . K is only moderately less dull [*sic*] than the average of the genus homo, judging from intelligence scores made by nearly 2,000,000 soldiers. His intelligence is probably not equaled or exceeded by more than 70 per cent of our white voters by more than 50 or 60 per cent of semi-skilled laborers. It is probably not equaled or exceeded by more than 30 to 40 per cent of our South Italian or 20 to 30 per cent of our Mexican immigrants. Compared with the average American negro K is intellectually gifted, being equaled by probably not more than 10 to 15 per cent of that race."

Professor TERMAN'S conclusions are also interesting. He says K is now a clerk in a general store, and apparently making good. There is no reason why he would not make a reasonably good baker, barber, bricklayer, butcher, carpenter, drill-sharpener, freight checker, game warden, glass blower, harness maker, horse clipper, jail keeper, lathe hand, policeman, professional ball-player, plumber, prize fighter, pedler, railway brakeman, riveter, roofer, section boss, soldier, street-car conductor, timer, truckman, valet, weaver or yardman. or one of a large variety of clerks. He can be loyal to a political party, but he cannot grasp political principles. He can repeat a political slogan, but he cannot understand it.

In short, K represents upward of 50 per cent of the people in his lack of what we call, generically, sense. If we entrust him with work that calls for thinking and judgment, he will fail. If he fails, it may cost us, to put it bluntly, all kinds of good money. He is one of possibly 50,000,000 persons in America who "lack the intellectual shorthand of general ideas"; who can't sense things so as to know what's what.

There's no use getting angry at such folks; the incidence of our wrath should be on ourselves when we entrust them with responsibilities which they are not equipped to meet. It also explains why things happen in Russia as they did when a "dictatorship of the proletariat" was established. K represents the preponderant majority of the proletariat.

Real Progress in Industrial Standardization

DURING December there was held at the Bureau of Standards a conference on sizes and specifications for dry cells, at which a large number of industrial representatives co-operated with the bureau in formulating a revision of the specifications which are recommended by that institution.

One of the most far-reaching influences which will come from the conference was the adoption of recommendations regarding a limited number of standard sizes of batteries and dry cells. Thus all but two of the larger sizes and all but five of the flashlight sizes were dropped from the lists that will hereafter be known as "standard" sizes of dry cells. It was found that this limited number of sizes represented substantially all of the important commercial business of the country. Of course this limited number of cells permits combination into a wider variety of batteries, and for this purpose three flat, three tubular and one box type batteries were recognized for flashlight purposes and two types of radio battery assemblies were also recognized as combinations of the smaller cells. Similarly several combinations of the larger cells were recognized as standard battery assemblies. But all in all the number of stock types which must be kept under these recommendations is very greatly reduced from the old practice.

Industry can well welcome this sort of progress. It is the truest form of assistance and co-operation on the part of the government and one for which the industries may ask greater attention in the future. Nothing has contributed so much to American success as the ability to accomplish mass production, with a minimum of profit on each of a large number of units. This can be done only if the variety of units is made a minimum.

Other industries may well "take their cue" from the battery business and see if they too may not accomplish as much in this way as is promised by these recommendations recently adopted in that field.

Readers' Views and Comments

College Degrees for the Credulous

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of Dec. 7, there appeared an editorial, "College Degrees for the Credulous," based on an advertisement from the columns of *Chimie et Industrie*, published by the Société de Chimie Industrielle at Paris. This advertisement promised French chemists doctor's degrees from an American university, "officially recognized," by the simple process of correspondence and presumably for a suitable fee. As president of the American Section of the Société I could not fail to take notice of your editorial, and promptly brought the matter to the attention of its secretary, M. Jean Gerard, from whom I have just received a reply, the translation of which I herewith inclose. I am asking you in fairness to our French colleagues to have the goodness to publish M. Gerard's letter, as I think it will not only be greatly appreciated by them as a courtesy on your part, but I think it will be of more than passing interest to your readers.

I am sure that French chemists in general will be glad that this matter has received so much attention. The editorial which will appear in the January number of *Chimie et Industrie* on this matter will place them on their guard against advertisements of that nature and I know that American chemists will be thankful to you and to *Chimie et Industrie* for protecting the fair name of their universities against unscrupulous degree factories.

J. E. ZANETTI.

Columbia University,
New York City.

Jan. 3, 1922.

MY DEAR PRESIDENT: Your letter of Dec. 1 reached me safely and has received my most careful attention.

The small advertisement of which you speak was accepted by an advertising agent knowing little of scientific questions, and he accepted it without thinking that its insertion would cause annoyance to our American friends.

I beg you to believe that I sincerely regret the insertion of that advertisement.

You know what admiration our journal *Chimie et Industrie* entertains toward American universities. In no case would we be willing to hurt in any way the excellent reputation which they enjoy in our country, and we try on the contrary at every chance that we have to increase that good reputation.

The relations that we have with American chemists individually and collectively are the best proof of our desire to continue and to increase between our nations an intellectual collaboration, which would contribute in the greatest possible way to scientific progress.

It is in this spirit that I believe it my duty to bring to your attention that besides the campaign by advertisements, numerous French chemists have been approached with circulars, of which the following is typical:

> SIR: I beg to call your attention to the advantages that would accrue to you in the exercise of your profession from the acquisition of the degree of Doctor in Chemistry from a university officially recognized in the United States.
>
> As General Delegate of the Orientale University of Washington, D. C., I gladly place myself at your disposal for all information and requirements in this matter.
>
> The diploma may be obtained by the method of correspondence in about three months.
>
> (Signed) COLLEREDO.
> Villa Bella Vista,
> Roquebrune, A. M.

As in our country we are not very well informed about the mechanism of American universities, it would be desirable that this question should be elucidated by you personally in an article that you would prepare and which we would most gladly publish in the economic section of our journal. This question will in addition be treated in an editorial in our next number over the signature of M. Charles Lormand.

I beg to express my sincerest wishes for the excellent relations between American and French chemists.

(Signed) JEAN GERARD.

Sulphuric Acid Air Lift

To the Editor of Chemical & Metallurgical Engineering

SIR:—I notice in the third of the series of interesting articles on "Recent Developments in the Sulphuric Acid Industry," by A. M. Fairlie, published in your issue of Nov. 23, 1921, that a description is given of a so-called Bihn-Jones automatic air device for elevating sulphuric acid which it is stated was first marketed in 1915. As a matter of fact the device described appears to be identical with that introduced 22 years ago by William Barnes, at one time foreman plumber of the Muspratt Works, Widnes, England, and which has been used universally in the works of the United Alkali Co. as well as by other acid makers for the last 20 years. The device is an admirable one and has the advantage of being adaptable to the acid eggs already existing in practically all sulphuric acid works. Apart from the wear and tear when used on very small eggs and from occasional trouble through particles of grit interfering with the action of the float or the back pressure valve it gives no trouble at all. The automatic elevator was never patented by the United Alkali Co., by whom Albert Jones was at one time employed.

My only reason for writing is to point out that the device is scarcely a novelty or recent development, and to insure the credit for its invention being given in the proper quarter—namely, to William Barnes.

Widnes, England. C. S. IMISON.

The Manufacture of Naval Stores From the Dead Wood of Southern Pines

To the Editor of Chemical & Metallurgical Engineering

SIR:—C. M. Sherwood in his article on "The Manufacture of Naval Stores From the Dead Wood of Southern Pines" makes the statement that the composition of pine oil is rather uncertain and mentions only one probable constituent, terpineol. In Schimmel & Co.'s semi-annual reports, April, 1910, eleven different constituents of pine oil were reported. Six of these, however, were really turpentine constituents, since they had boiling points below 177 deg. C. No quantitative data were given, but apparently the most important constituents were identified. This work was not only abstracted in *Chemical Abstracts* but was also mentioned in detail in Forest Service Bulletin 105, on "Wood Turpentines." This bulletin might also have given Mr. Sherwood more information on the comparative composition of wood and gum turpentine than he seemed to have at his disposal.

We will agree that the origin of pine oil is still a mystery, but from the information given in Bulletin 105 it seems very doubtful that it "is present in the living tree as an essential oil and is not a product of

ıydrolysis or oxidation." Since the oleoresin produced n a longleaf pine tree does not contain pine oil, as is ;hown from the composition of gum turpentine, it is lifficult to see how pine oil can be anything else except ın alteration product of the original oleoresin. That he final resin contained in the stumpwood is a prod- ıct of gradual change from the original fresh oleoresin s indicated by the fact that the crude wood turpentine rom the steam distillation of green sawmill waste con- ains very much less pine oil than that from stumpwood, nd also from the fact that the turpentine from this awmill waste is more like the gum turpentine in that t contains so small an amount of dipentene that it annot be readily recognized.

Very few writers on the subject seem to know that he first extraction plant to use the Yaryan process was uilt at Cadillac, Mich. This was not an experimental lant, but was of full commercial size and operated uccessfully for some time. The quality of the wood vailable, Norway pine stumps, was, however, so poor nat with the declining prices for turpentine and rosin was necessary to suspend operations.

L. F. HAWLEY,
In charge Section of Derived Products.
Forest Products Laboratory,
Madison, Wis.

o the Editor of Chemical & Metallurgical Engineering

SIR:—One cannot dispute the statement by Mr. Haw- y that commercial pine oil contains several distinct)mpounds. We endeavored to make this clear in the rticle on naval stores, but did not care to mention the nstituents other than terpineol, because Teeple and)ch have shown quite conclusively that this compound rms by far the greatest percentage of the high-grade mmercial oils, the quantity of other constituents de- nding largely on the degree of fractionation.

While there is no doubt that oleoresin contains no ne oil, it is acknowledged that wood from the same ee, upon being steam distilled, will show considerable ne oil. It was our theory, therefore, that pine oil is t a product of oxidation or hydrolysis, but rather an sential oil of the trees. Neither theory has been oved or disproved, and therefore we are inclined to nsider the origin of pine oil an unsolved problem.

We have had the pleasure of reading Forest Service lletin 105, written by Mr. Hawley, and believe that me very valuable facts for wood turpentine producers ve been brought out. As he points out, the product ries so much in different methods of manufacture t it is difficult to make any certain statements re- rding the composition. Even with the same general cess, the turpentine may be of an entirely different aracter under varying conditions of operation. It for this reason that it is essential to insist upon uni- m methods of operation in plant practice. We have ced in our experiments that under certain conditions a refined turpentine will be obtained which has a grav- it of 0.860 at 15.5 deg. C., while another one with a most an identical boiling range, refractive index and ymerization residue has a gravity of 0.864 when the ration is conducted slightly differently. In the latter e there is probably only a very small percentage of dipentene, while in the former the percentage of dipen- ene is probably quite large. In short, the character wood turpentine varies so greatly under different nditions of operation and refinement that we did not el justified in discussing it in more detail than given the article.

C. M. SHERWOOD.
Brunswick, Ga.

The Six Blind Men and the Jellyphant

To the Editor of Chemical & Metallurgical Engineering

SIR:—Our good friend Jerome Alexander has been seriously ill, but now I am glad to say he is back at work again, busier than ever with colloidal aggregates and their dispersions. While he was mending, feeling the Muse of Poetry hovering nigh, he bade the ghost of John Godfrey Saxe approach and after duly polite acknowledgment to him for his lead in form, he hearkened to the Muse and wrote. Then, having finished the work, he conjured up the shade of Samuel Taylor Coleridge for aid in developing a marginal syllabus which was duly added to the poem. It occurs to me that you should publish it to tell the world how many sided colloid chemistry is.

MARTIN SEYT.

The Six Blind Men and the Jellyphant

BY JEROME ALEXANDER

There were six men of chemistry
To research much inclined
Who went to see the Jellyphant
(Though all of them were blind),
That each one by observing well
Might satisfy his mind.

The old professor rendereth an opinion.

The first approached the Jellyphant
And, happening to note
Its thirst for sour and basic things,
At once began to gloat.
"I see," quoth he, "the Jellyphant's
An ampholytic goat!"

Hofmeister observeth the ampholytic function.

The second, happening to touch
Th' amino acid paws,
Exclaimed, "This is a biped which
Obeys all biped laws!
To call it quadruped shows lack
Of reason or of cause."

The younger Ostwald declareth the Jellyphant to be a beast of froth and foam.

The third said, "Every housewife knows
Why mayonnaise stands up.
Well-made emulsions don't fall out
When you invert the cup.
'Tis plain the Jellyphant is an
Emulsoid-colloid pup!"

W. B. Hardy declareth the Jellyphant to be a bony beast.

"I feel a firmness," said the fourth,
"That seems to indicate
A solid backbone in the beast.
I have it! Sure as fate,
The Jellyphant is really a
Suspensoid vertebrate!"

T. B. Robertson and Mistress Lloyd would have the Jellyphant to shift its innards.

The fifth deaminized its arms,
But still it quenched its thirst,
Whereat they cried, "This hootch-
hound is
Of all we've seen the worst!
It's a keto-enol chameleon.
Deny this fact who durst!"

Jacques Loeb shooeth back the prodigal Jellyphant into the chemical fold.

The sixth immersed the Jellyphant
In water—without malt,
And heard it sing H-ion hymns
In tune, without a fault.
"Now, of a truth," he cried, "this beast's
An orthodox old salt!"

And so these men of chemistry
Disputed loud and long.
Each in his own opinion was
Exceeding stiff and strong.
And each was partly in the right,
Though all of them were wrong.

So, oft in scientific wars
The disputants, I ween,
Neglect, the while they make their
notes,
What all the others mean,
And so describe a Jellyphant
Which none of them has seen.

German Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

ESSEN, Dec. 22, 1921.

THE chemical industry in general is suffering severely from a scarcity of fuel and although the larger works have made themselves partly independent from coal by acquiring extensive lignite deposits, their supply is inadequate since the railways are also hampered severely by lack of fuel. The acuteness of the situation is further accentuated by the low water in the inland waterways, which prevents boats from carrying full cargoes, thus increasing freight rates.

SUGAR

The prospects for the 1921-22 season in the sugar industries are considered a distinct improvement compared with the last outputs. The harvested acreage of sugar beets has increased by a little over 22 per cent and will be equal to an increase of 13½ per cent in the sugar production. Though the production reached its lowest level in the harvest of 1919-20 and has been recovering gradually ever since, the figures are still far from the pre-war production. It must be remembered, however, that Germany has lost a vast amount of sugar beet acreage on account of the peace treaty. While in 1919-20 the sugar output dropped to ⅕ of the pre-war figure, it is fully expected that the output of the present season will be equal to ⅔ of the 1913-14 figure. The production will in all probability just cover the inland requirements and obviate any importations of cane sugar from abroad. Of course, nothing will be left over for export and by government order sugar is excluded from import as well as from export. While immediately before the war, Germany's share in the sugar production of the world amounted to 11.9 per cent or 25.2 per cent in proportion to the beet sugar industry, these figures dropped to 4.6 and 21.5 per cent respectively, while for the present season these figures stand at 8.1 and 26.2 per cent.

NITROGEN FERTILIZERS

The fact that the combined German nitrate producers had entered into an agreement with the English and American producers not to underbid the current prices of the world markets has alarmed the consumers so much that they brought the matter to discussion in Parliament. The farmers naturally got nervous in the expectation that such a stand on the part of the producers might also reflect upon the inland prices, and an assurance was given to control inland prices to a certain extent as well as to regulate the quantities eventually admitted for export. Several cargoes of nitrate have been imported from Chile at a time before the mark dropped out of proportion of its value altogether, but even by allowing for these conditions it is quite out of the question for the farmers to buy the stuff. It is not used as a fertilizer but is worked up as a raw product for the manufacture of concentrated nitric acid. The demand for fertilizers has at the same time slackened considerably and the German ammonia syndicate formed an affiliated company under the name of Nitrogen Credit Co., Ltd., with a capital of 500 million marks which will enable the farmers to buy nitrate fertilizers on long terms of payment, will help to bridge temporary financial difficulties and will also help to increase the consumption of nitrate fertilizers.

The Oppau plant is recovering gradually from the recent disaster and part of it will be restarted within the next few weeks for the manufacture of nitrates. The Oppau disaster, in which the plant was insured only in small proportion to its actual value, has drawn the attention of the workmen's organizations to the fact that large companies, particularly in the chemical industry, are gradually breaking away from the practice of insuring their plants and instead accumulate certain reserves under the heading "self-insurance." While in the Oppau case this self-insurance could easily be borne by a company as strong financially as the huge chemical combine (although even in this instance the accident is cited as a reason for a further increase in capitalization), the workmen are beginning to fear that in the event of a similar disaster occurring in the plant of a company less sound financially this self-insurance might prove insufficient to rebuild the plant so that the company would be compelled to dismiss its men suddenly. The matter of compulsory state insurance has been brought up in Parliament.

SULPHUR

While the German chemical industry as a whole is practically independent of import of raw materials the sulphuric acid industry is in this respect a great exception, being almost entirely dependent upon the import of pyrites. The available raw material in Germany consists of zinc ores, the quantities of which are, however, quite insufficient to meet the demand of the chemical industry. Sulphur ores are imported mainly from Spain and from Scandinavia. Owing to the unfavorable rate of exchange the import of these ores has not reached half the pre-war figure, but preference is given to Scandinavian ores over the Spanish ones, contrary to pre-war practice. The consequent high prices of sulphuric acid and the inadequate quantities available have given fresh impetus to the utilization of sulphur contained so abundantly in the coal and in blast-furnace slag either to manufacture sulphuric acid or to combine the sulphur directly in another form. None of the processes so far suggested has reached a commercial stage as yet.

PHOSPHATES

Phosphates manufactured from the natural calcium phosphate also demand a very high price due to the fact that the raw material mentioned must be imported from the United States or from North Africa. The dependence of Germany from these sources is felt the more as other phosphate fertilizers such as the basic slag, a byproduct in steel works, must now be imported to a greater extent owing to the loss of so many steel works in Lorraine, Luxemburg, Upper Silesia and the Saar district in consequence of the peace treaty.

TAR PRODUCTS

The market for tar products is very firm of late, due probably to the fact that an agreement with France has been reached regarding the compulsory supplies of tar and tar products as outlined in the Versailles treaty, so that deliveries have been commenced. Like every other branch of industry the tar industry is severely hampered by a scarcity of railway cars because the railways cannot get sufficient coal. This scarcity has been temporarily so great that the railway authorities were even compelled to resort to war measures in requisitioning coal on the lines to be able to keep moving, much to the detriment of the works to which such coal was consigned.

Recent Progress in Electrical Precipitation

Brief Description of the Electrical Field Existing in a Cottrell Precipitator—Reduction in Efficiency Found to Be Due to Back Ionization on a Non-Conducting Plate—Development of a Relation Between Electrode Size and Precipitation Rate

By EVALD ANDERSON

THE commercial development of electrical precipitation during the 12 or more years that have elapsed since Dr. Cottrell conceived and built the first successful commercial precipitator has been in the hands of two rather distinct classes of workers. The engineers, on the one hand, have designed and built precipitators (or treaters, as they are called) and have changed and improved these from time to time so that the modern installation is a very different structure from the earlier ones. The physicists and laboratory investigators, on the other hand, have been more concerned with the fundamental principles involved in the phenomena of precipitation, such as the characteristics of the electrical field in a precipitator and the factors which govern the actual rate of precipitation.

Of these two groups, the engineers have made much the better progress. In fact, it can probably be said without injustice that with but few exceptions all the development in the art that has taken place has until recently been due solely to the engineers. This discussion, however, will be more concerned with the physicists' and investigators' side, and the report of the engineering development that has been done in these years will be reserved for a separate paper.

Types of Treaters in Use

Considering the length of time that has been available for investigation, and particularly the many opportunities for research of a fundamental nature, the progress that has been made has not been very rapid. Take, for example, the type of precipitators that are now used. These types are, of course, based primarily on the fundamental principles involved, and any great advance in this field of knowledge would necessarily be reflected in the apparatus erected for the commercial embodiment of the process. The only types in commercial use today are the so-called plate, pipe and transverse screen treaters, the name in each case being derived from the kind of collecting electrode used. Of these three, the first two were used in the very beginning of the commercial development and the last was described by Dr. Cottrell in his early patent specifications.

Nor have there been until recently many advances in the theory of the process. Most physicists who have investigated the problem have based their theories on the well-known laws of the conduction of electricity through gases, and have assumed that the forces acting in an electrical precipitator are not much different from those that would come into play if an externally charged particle were placed in an electric field. Aside from some improved methods of determining the mobility of such charged particles and some refinements in calculating the strength of the electric field, the latter attempts to explain the process differ little from the earlier ones.

Perhaps the chief reason for this lack of progress has been the difficulty of doing quantitative experimental work on a laboratory scale. For example, practically all such work necessitates a source of fume- or dust-laden gases of controllable characteristics, and this in itself is a difficult problem. Furthermore, the characteristics of the electrical field are very often entirely dissimilar in a small laboratory precipitator from those obtaining in a large installation, even when care is taken to maintain comparable conditions. As a consequence, it has seldom been possible to duplicate field conditions in laboratory investigations or to duplicate laboratory results in actual field operation. Moreover, the ordinary electrical precipitator is not amenable to modifications for experimental purposes, so that field experimentation has been difficult.

Essentials of Electrical Precipitation

Considered superficially, electrical precipitation of suspended particles from gases is very simple. The ordinary precipitator is merely an arrangement of two electrodes of the point to plate type, with a unidirectional potential difference established between them, of sufficient magnitude to cause ionization of the gas at the point, or discharge electrode. The ions thus formed are forced over to the plate or collecting electrode by the electric field, and if any solid particles are present in the gas and pick up any ions, they will also be forced over to the collecting electrode. However, while any such arrangement, or in fact any arrangement whatever consisting of two opposing electrodes in the gas, will precipitate a certain proportion of the suspended particles, the rate of precipitation in many cases is too slow for practical consideration.

A full knowledge of the law governing this rate of precipitation is, of course, absolutely essential for satisfactory progress in the art, and most of the investigations that have been carried on in this field have been concerned with factors pertaining thereto.

Back Ionization

As has already been indicated, there have been many discrepancies between the results of most of the investigations and actual practice. One of the most important causes of these discrepancies has been the phenomenon which has been called "back ionization." It was discovered early in the application of the process that often with certain types of fume quite irregular and unsatisfactory operation resulted from no apparent causes, the usual manifestation being a considerable loss in efficiency and increase in power consumption. It was also discovered that the operation could often be greatly improved by the addition of water vapor to the gases. The real nature of the disturbance was unknown, however, until E. R. Wolcott of this laboratory conducted

an extended investigation in this field. He showed (*Phys. Rev.*, N. S., vol. 12, 1918) that the cause of the disturbance in most cases lay in the non-conducting nature of the deposit. Thus when a non-conducting material is placed on the plate in a point to plate electric field, ionization takes place at the plate near the edges of the dielectric, while otherwise the ions are formed only at the point. Ions of the opposite sign to that of the point are thus introduced into the space between the electrodes, and these not only lower the maximum voltage of operation but also undoubtedly neutralize the effect of some of the ions of the opposite sign which would otherwise take active part in the precipitation.

Non-Conducting Surfaces on Electrodes

One can readily see how this effect is brought about. It is well known that ionization can take place only where the potential gradient exceeds a certain fixed value for each particular gas, and that with electrodes of varying curvature this gradient will be greatest at places of maximum curvature, as at the point in a point to plate arrangement. If now the plate be covered except in isolated spots by another dielectric as, for example, by an insulating powder, or by a sheet of mica having a few holes, the plate itself becomes equivalent to points at such places where it is not covered, the only difference being that at the point the dielectric is entirely air, while at the plate the dielectric is primarily some solid material. The potential gradient can, therefore, become sufficiently high, even at the plate, to cause ionization, and the electrode arrangement then becomes one of a system of points, instead of point to plate. Consequently, while there still may be a unidirectional current flowing, the ions will no longer be substantially of one kind traveling in one direction, but will be of two kinds traveling in opposite directions, so that ions coming from the point may be partly or wholly neutralized by those coming from the plate.

Then, too, the maximum voltage which can be maintained at ordinary pressures and distances is much lower when the point is positive than when it is negative, so that anything which tends to modify the plate, when it is positive, into a point or multiplicity of points greatly lowers this maximum voltage.

Function of Water Vapor

The obvious remedy for this condition when brought about by a deposit of fume on the plate electrode is, of course, to make this deposit conducting. This can be done in many ways, but the easiest way is to introduce moisture. It then becomes a question whether or not the material precipitated absorbs or adsorbs water vapor at the working temperatures so as to become conducting. In this respect there are great variations as, for example, from hygroscopic materials which *absorb* water readily, to substances like glass which *adsorb* moisture and become conducting when in the presence of water vapor of sufficient concentration, or substances like sulphur or silica which remain non-conducting even in the presence of fairly high concentrations of water vapor.

In most cases of actual practice, the desired conductivity of the deposits can be reached either by maintaining the temperature at the collecting electrodes so low that the relative humidity near the deposit becomes sufficiently high due to the water vapor naturally occurring in the gases, or by adding water in the form of spray or steam directly to the gases. In other cases the collecting electrode itself is covered with a film of water, which is then used as a carrier for the precipitated material.

Electrode Size vs. Rate of Precipitation

With this disturbing element understood and capable of being controlled, it has been possible to make better progress in the determination of the factors governing the rate of precipitation. Engineers of this company are just completing a lengthy investigation in this field. This investigation has to do largely with the relation between the size of the electrodes and the precipitation rate. The fume in this case was a soluble potash salt, carried by gases that were saturated with water vapor, so that the actual particles which were precipitated were particles of solution. Consequently the deposit was not only conducting but the electrodes were also self-cleaning, since the collected solution flowed off as soon as it was precipitated.

As a result of these experiments it is now possible to calculate and predict the gas volume, capacities and precipitation efficiencies of treaters or precipitators with much greater accuracy and certainty than has hitherto been possible. Furthermore, the design of such a precipitator can now be made on a sounder economical basis. For example, where the chief reason for installing precipitators is to save the values carried by the gases, it obviously makes a big difference in the design of the treater whether the material in the gases is, say, cement dust, worth perhaps $1 per ton, or lead fumes the value of which may be $50 per ton or more. In the former case it would naturally not pay to construct a very expensive precipitator with high efficiency, while in the latter case such a precipitator could economically be built. In both cases the aim should necessarily be to build such a treater that the net profit on the collected material, after deducting interest on the first cost, depreciation and operating expenses, will be a maximum.

Rational Design of Treaters

W. A. Schmidt of this company has developed a formula, based on the results of the investigation above referred to, by the use of which it is now possible to design and build precipitation installations on this really economical and logical engineering basis. This equation is of the form

$$x = a\left(\frac{\log \frac{b}{c \log d}}{\log d}\right)$$

In this equation a is the gas volume to be treated, b is a function of the unit cost of the precipitator, the rate of interest and depreciation and the cost of labor and power. The value of the solids carried by the gases is represented by c, d is a function of the specific precipitation rate for the fume or dust considered and x is the optimum size of the precipitator.

In this expression everything except x can be determined. Thus the gas volume to be handled, together with the amount and nature of the suspended solids, is always determined before any estimates are made. The potential value of all of the suspended matter can then be computed. The cost of labor and power, as well as the unit cost of construction, is ordinarily known from previous installations, and the constant d is either known from similar installations or preliminary tests can be made for its determination.

The development of such an equation represents a

distinct advance over the former methods of design where the estimates could only roughly be based on some former installations with whatever reservations the designer's ordinary judgment considered necessary. Of course, there is still much to be learned. The factors which influence the power consumption are not well known, nor has any satisfactory quantitative relation been determined between the rate of precipitation and the treater potential. Then there is the quantitative effect of the physical nature of each particular fume. In many of these cases sufficient data have been accumulated to express the relations graphically, but until a satisfactory analytical expression can be derived the problem cannot be considered as solved.

The accompanying table indicates the nature of the agreement between calculated and observed values for the precipitation efficiency, as based on the result of the recent investigations.

Type of Treater	Character of Fume	Gas Volume, Cu.Ft. per Min.	Efficiency — Observed, Per Cent	Efficiency — Calculated, Per Cent
Pipe	Potash fume	23,000	86	86
Plate	Potash fume	18,000	75	71
Pipe	Cement dust	150,000	94	92
Pipe	Metallic chloride	15,000	97	98.8
Pipe	Lead fume	102,000	82	85
Pipe	Bismuth fume	5,000	90	92
Transverse screen	Potash fume	1,000	73	75

Considering the wide variation in both the character of fume and the gas volumes handled, the agreement is encouraging and justifies the expectation of still further advances in the many other directions still under investigation.

Laboratories Western Precipitation Co.,
Los Angeles, Cal.

Copper, Lead and Zinc Production in the U. S. for 1921

THE smelter production of copper in 1921 from ore mined in the United States, as shown by the actual production for the first 11 months and by estimates made by smelting companies for December, was about 461,000,000 lb., according to a report by H. A. C. Jenison of the U. S. Geological Survey. The refinery production as similarly shown was about 601,000,000 lb. from domestic material and about 320,000,000 lb. from foreign material.

According to the records of the Department of Commerce the total imports of copper for the first 11 months of the year in ore, concentrates, matte, blister and refined copper were about 318,000,000 lb., of which about 68,000,000 lb. was refined copper and 157,000,000 lb. was blister copper. The exports for the first 11 months totaled about 567,000,000 lb., of which about 538,000,000 lb. was new refined copper and 29,000,000 lb. was manufactured—wire, rods, pipes, tubes, sheets, etc.

The quantity of primary refined copper withdrawn on domestic account during the year was about 572,000,000 lb., calculated as follows:

	1920	1921
Refinery production from domestic courses	1,182,000,000	601,000,000
Refinery production from foreign sources	344,000,000	320,000,000
Imports of refined copper	109,000,000	75,000,000
Stocks of new refined copper Jan. 1	631,000,000	659,000,000
Total available supply	2,266,000,000	1,655,000,000
Exports (exclusive of manufactured copper)	553,000,000	587,000,000
Stocks on hand Dec. 31	659,000,000	496,000,000
	1,212,000,000	1,083,000,000
Total withdrawn on domestic account	1,054,000,000	572,000,000

The mine and smelter output of lead in the United States in 1921 each fell off about 20 per cent from the 1920 figures.

The output of soft lead by mines of the Mississippi Valley was about 231,000 short tons, and that of argentiferous lead by mines of the Western States was about 170,000 tons, a total of 401,000 tons. The corresponding figures for 1920 are 251,816 tons from the Mississippi Valley (including the small output of the Eastern States) and 259,070 tons from the Western States. The imports of lead in ore were about 7,000 tons, furnished chiefly by Canada, Mexico and South America, and those of lead in bullion were about 41,000 tons, almost wholly from Mexico, as compared with a total of 62,796 tons in 1920.

The output of primary domestic desilverized lead in 1921 was about 190,000 short tons, of soft lead about 145,000 tons and of desilverized soft lead about 55,000 tons, making a total output from domestic ores of about 390,000 tons of refined lead, as compared with 476,849 tons in 1920, which was made up of 220,327 tons of desilverized lead, 189,854 tons of soft lead, and 66,668 tons of desilverized soft lead. The output of lead smelted and refined from foreign ore and bullion was about 50,000 tons, as compared with 52,808 tons in 1920. The total lead smelted or refined in the United States was thus about 440,000 tons, as compared with 529,657 tons in 1920.

Zinc Production Decreases

The mine and smelter output of zinc each declined 60 per cent from last year's figures.

The recoverable zinc content of ore mined in 1920 was about 250,000 tons, as compared with 584,772 tons in 1920. The output of the Eastern States was about 68,000 tons, that of the Central States about 168,000 tons, and that of the Western States about 14,000 tons, as compared with 102,242, 337,652 and 144,878 tons respectively in 1920.

The imports of zinc in ore decreased from 22,487 tons in 1920 to about 2,700 tons in 1921, most of which was imported from Mexico.

The output of primary metallic zinc from domestic ores in 1921 was about 194,000 tons and from foreign ores about 2,500 tons, a total of 196,500 tons, as compared with 450,045 tons from domestic ores and 13,332 tons from foreign ores, a total of 463,377 tons, in 1920. In addition to primary zinc there was an output of about 17,000 tons of redistilled secondary zinc, as compared with 21,371 tons in 1920, making a total supply of distilled zinc and electrolytic zinc in 1921 of 213,500 tons, of which 31,500 tons was high grade and intermediate, 32,000 tons select and brass special and 150,000 tons prime Western. The output of the corresponding grades in 1920 was 114,606, 59,811 and 310,331 tons, respectively, a total of 484,748 tons.

Imports and Exports of Zinc

The imports of foreign slab zinc amounted to 6,674 tons, as compared with 15 tons in 1920. The exports of zinc made from foreign ores were about 1,260 tons and those of zinc made from domestic ores were about 3,200 tons, as compared with exports of 28,368 and 85,898 tons, respectively, in 1920. The exports of domestic zinc included about 1,800 tons of sheet zinc, as against 11,852 tons in 1920.

The two largest zinc-rolling mills have added zinc shingle machinery to their equipment. This use of sheet zinc is one of the most promising now being developed.

Brittleness Developed in Aluminum and Duralumin by Stress and Corrosion

Aluminum Is Deeply Corroded Where Impurities Lodge Between Primary Grains, but, if Recrystallized, Is Not Embrittled—Duralumin Is Subject to True Intercrystalline Embrittlement, Starting From Unknown Causes, but Intensified by Corrosion and Stress

By HENRY S. RAWDON, ALEXANDER I. KRYNITSKY and JULIUS F. T. BERLINER*

LE CHATELIER[1] has published a description of drinking flasks stamped out of sheet aluminum which disintegrated in service by intercrystalline crumbling of the metal. The material, which had a copper content of 3 per cent, cannot be properly designated as "aluminum." By electrolysis in a solution of sodium chloride, it was stated, the aluminum grains were dissolved, leaving unattacked the envelope of the copper aluminum compound ($CuAl_2$) which surrounded them. Seligman and Williams[2] have stated that they were unable experimentally to confirm Le Chatelier's observations, although they found that corrosion of overheated sheet aluminum and of the cast metal by dilute sulphuric acid produced somewhat the same effect.

Specimens of metal used as pyrometric standards[3] were used in some tests at the Bureau of Standards to determine whether pure aluminum behaved like lead when exposed to combined stress and corrosion.

Chemical analysis of the material gave: Fe, 0.18 per cent; Si, 0.15; Cu, 0.004; Mn, trace; C, 0.01; Co and Ni, not detected, and Al (by difference), 99.66.

Disks, 0.3 in. thick, were cut from a cylinder of cast aluminum, rolled to sheets 0.1 in. thick, and after being cut to size for the test and ground on the surface were annealed in order to remove the effect of cold-working and also to cause recrystallization and grain growth. The specimens used were of the approximate dimensions 4 x 1.9 x 0.15 cm.

As corroding liquids normal solutions of aluminum sulphate and of aluminum chloride were used, together with the same solutions after the addition of the corresponding acid. The results obtained for the two types of corroding solutions were very similar, so that only the results produced by the sulphate series are given in Table I. Corrosion was permitted to proceed for a period of 109 days at room temperature, which varied between 15 and 29 deg. C.

TABLE I. CORROSION OF PURE ALUMINUM

Spec. No.	Dimensions, Cm.	Area, Sq.Cm.	Corroding Solution	Loss of Wt. After 109 Days, Mg.	Loss per Sq.Cm per Day, Mg.
1	0.156x1.91x4.07	17.35	*N* aluminum sulphate	132	0.07
2	0.154x1.78x3.94	15.80	*N* aluminum sulphate + *N*/4 sulphuric acid	170	0.099
3	0.152x1.83x3.91	16.04	*N* aluminum sulphate + *N*/2 sulphuric acid	249	0.14
4	0.154x1.78x3.76	15.11	*N* aluminum sulphate + *N* sulphuric acid	320	0.19
5	1.56x1.91x3.94	16.92	*N* auminum sulphate + 2*N* sulphuric acid	520	0.28

The appearance of the plates after the corrosive attack is, however, more instructive as to the real character of the attack than is its numerical measure in terms of the loss of weight. From Fig. 1, which shows the characteristic appearance of the aluminum plates after corrosion, it is clear that the attack is not uniform over the entire surface. The definite etch-pattern which resulted suggests that the attack of the metal was intercrystalline in character. However, the crystals of the metal are very much smaller than the meshes of the network pattern which the corrosive attack revealed.

The examination of the corroded specimens after grinding off sufficient metal from the surface so that only traces of the etched pattern remained made it evident that the corrosion had been directed by the presence of certain constituents within the metal. These are shown in Figs. 2 to 4 to be without doubt the micro-constituents which existed as films enveloping the crystals in the cast metal and which are the result of the contaminating elements which the aluminum contained, principally iron and silicon. Although the position of these impurities may be changed somewhat by the distortion of the metal when the alloy is cold-worked, subsequent heat-treatment, short of melting, has no effect upon their distribution, so that a rough record of crystalline structure of the cast metal may be thus preserved in the annealed sheet by the location of these constituents. These impurities so accelerated the attack of the metal adjacent to them that the corrosive pattern produced constituted a record of the previous crystallization rather than that existing in the annealed sheet.

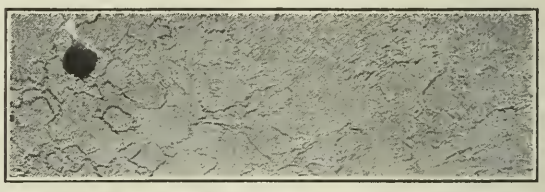

FIG. 1. ANNEALED ALUMINUM SHEET 4 AFTER 109 DAYS IMMERSION. × 1

The corroded strips were tested for intercrystalline brittleness by bending them sharply. However, no decided evidence of intercrystalline brittleness such as was reported for lead[4] was obtained. The surface network pattern appeared to be made up of wide and relatively shallow ditches rather than of narrow and deeply penetrating fissures. If the metal contains a higher percentage of impurities than the material used so

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*Physicist, Associate Physicist and Laboratory Assistant respectively, Bureau of Standards.

[1] *Compt. rend.*, vol. 152 (1911), p. 650.

[2] R. Seligman and P. Williams, "The Action on Aluminum of Hard Industrial Waters," *J. Inst. Metals*, vol. 23 (1920).

[3] Bureau of Standards Circular 66, "Standard Samples for Thermometric Fixed Points."

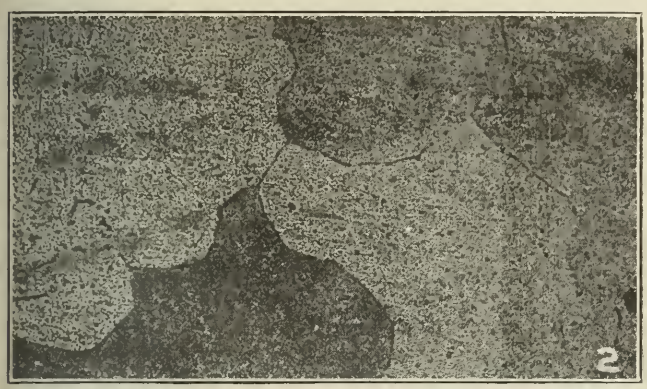
[4] H. S. Rawdon, "Intercrystalline Brittleness of Lead," Bureau of Standards Paper 377.

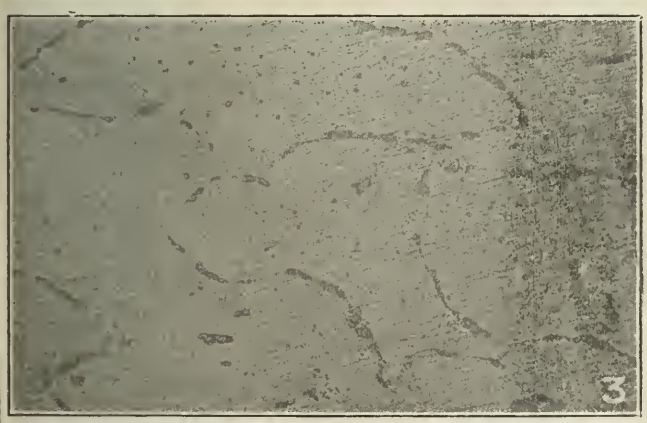
that the amount of the network constituent is considerably augmented, or if the sheet metal is overheated so that a large crystal size results and the impurities become somewhat intercrystalline in respect to their location, as the grains of the annealed metal approach the size of those formerly existing in the cast metal "intercrystalline" brittleness would be much more likely to occur as a result of a corrosive attack than was the case with the material tested.

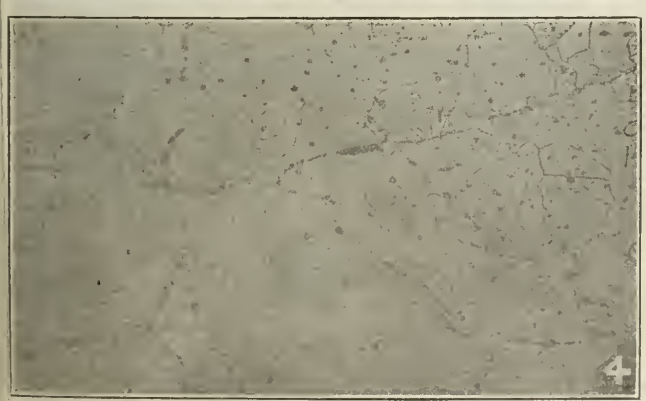
Embrittlement Under Service Conditions

A striking illustration of service deterioration of an aluminum alloy by intercrystalline brittleness was afforded by the examination of some sheet duralumin used as covering material in the elevator of an "all-metal" airplane. The two covering sheets, upper and lower, 0.012 in. in thickness, were of the corrugated type and fastened to each other by aluminum rivets along the edge and also to the duralumin tubes inserted between the sheets. A protective lacquer had been applied to both surfaces of the material. Most of the deterioration was localized near the riveted edge of the sheet and, in general, was confined to only one of the sheets; this happened to be the upper one. Portions of the sheet which were embrittled to the extent shown in Fig. 5 were in contact with apparently unchanged material of the other sheet.

FIG. 5. APPEARANCE OF THE EDGE OF A DURALUMIN SHEET WHICH BECAME EMBRITTLED IN SERVICE AS AIRPLANE COVERING. × 1







FIGS. 2 TO 4. RELATION OF THE CORROSION PATTERN PRODUCED ON THE SURFACE OF ALUMINUM SHEETS TO THE MICROSTRUCTURE OF THE METAL. × 75

Fig. 2—Cast aluminum. Fig. 3—Same material after reducing in thickness in the ratio 5 : 1 by cold rolling. Fig. 4—Material of Fig. 3 after annealing so as to cause recrystallization and grain growth. Etching reagent, 8 per cent hydrofluoric acid followed by an immersion in concentrated nitric acid.

When received, a brown deposit was found in spots on the surface of the embrittled sheet, and the surface, after cleaning, had the appearance of having been corroded in such spots, as shown in Fig. 5. The metal was most severely embrittled in the white spots. The characteristic appearance of the deteriorated sheet, as revealed by slightly etching the surface, is shown in Fig. 6. The intercrystalline nature of the attack by which the metal was embrittled is very evident, and the microscopic examination of cross-sections of the sheet demonstrates beyond question that the attack was of this nature. Fig. 7 shows the embrittled sheet without etching; several deep cracks are noted which become jointed together in a network on etching (Fig. 8). Deep corrosion produces the etching pits of Fig. 9, which demonstrate beyond question that the fissures which caused the embrittlement are intercrystalline.

The results of the chemical analysis[5] of the two sheets are given in Table II. The sheet which was most severely embrittled has been designated as *B*, the other one as *A*.

TABLE II. COMPOSITION OF DURALUMIN SHEETS WHICH DETERIORATED IN SERVICE

Element Determined	Bottom Sheet *A*, per Cent	Top Sheet *B*, Most Severely Embrittled, per Cent
Copper	3.40	3.56
Silicon	0.19	0.38
Iron	0.36	0.40
Manganese	0.21	0.29
Magnesium	0.54	0.57
(Lead, nickel and zinc)	Not detected	Not detected
Aluminum	95.30	94.80

The two sheets were of essentially the same composition and the results of the chemical analysis suggested no explanation as to the unusual behavior of some of the material in service. The percentage composition of each

[5]The authors are indebted to J. E. Scherrer, associate chemist, Bureau of Standards, for the analysis given here.

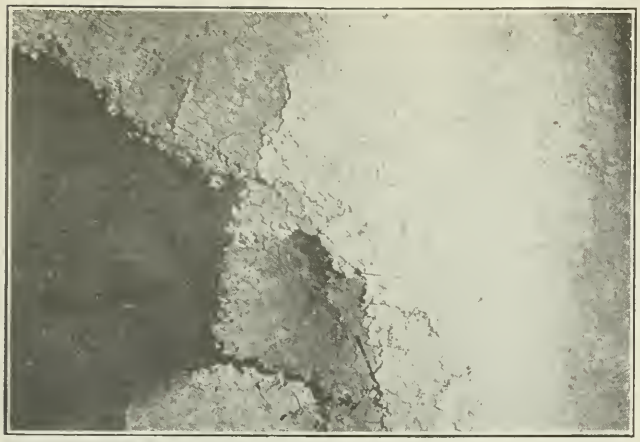


FIG. 6. PORTION OF SPECIMEN SHOWN IN FIG 5, SLIGHTLY ETCHED WITH 10 PER CENT NaOH FOLLOWED BY 8 PER CENT HF. × 5

of the sheets falls within the usual limits for duralumin.[6]

The mechanical properties[7] of the two sheets as determined by a tension test of portions which appeared to be sound are summarized in Table III.

Both sheets are inferior in their tensile properties to what may be developed in this alloy by proper treatment. The results of the test do not suggest that the material was given any special treatment for improvement of its mechanical properties. The ductility of sheet *B*, which deteriorated in service, was found to be distinctly lower than sheet *A*. The most probable explanation for this is that deterioration (intercrystalline embrittlement) had occurred over the surface of the sheet to an appreciable extent. The effect of such an attack of the surface would be to produce numerous microscopic "notches" in the "skin" of the sheet, a feature which would affect the ductility of sheet to a greater degree than the other tensile properties.

TABLE III. TENSILE PROPERTIES OF THE DURALUMIN SHEETS EXAMINED

Sheet	Orientation of Specimen	Width of Specimen, In.	Cross-Sectional Area, Sq.In.	Yield Point, Lb./Sq.In.	Ultimate Tensile Strength, Lb./Sq.In.	Elongation in 2 In., per Cent
A (bottom sheet)	Longitudinal	0.782	0.00954	20,500	34,100	8.0
		0.785	0.00958	20,900	35,500	9.5
B (top sheet)...	Longitudinal	0.774	0.00944	21,200	30,200	4.0
		0.783	0.00955	18,300	24,100	2.0
A (bottom sheet)	Transverse..	0.765	0.00933	24,100	39,500	6.0
		0.760	0.00927	22,100	37,700	5.0
B (top sheet)...	Transverse..	0.763	0.00931	26,900	45,100	5.5
		0.764	0.00932	26,900	40,600	1.0
		0.740	0.00903	25,500	30,500	1.5

[6]Bureau of Standards Circular 76, "Aluminum and Its Light Alloys."

[7]The mechanical testing of the material was done by S. N. Petrenko, associate engineer physicist, Bureau of Standards.

Attempts to Induce Brittleness

The fact that corrosion is of prime importance in producing the embrittlement of the sheet was readily demonstrated by means of a series of corrosion tests. Transverse strips representative of both sheets were cut from the portions which were still ductile and immersed in the following solutions: (1) *N*/20 aqueous sodium hydroxide; (2) *N* aqueous aluminum sulphate; (3) *N* aqueous aluminum sulphate containing *N*/10 sulphuric acid; (5) *N* aqueous aluminum sulphate with *N*/5 acid. Strips ¼ x 1½ in. were used. Some of these were bent into an arc of a circle with a radius of approximately 1 in. and held in this position by means of a thread tied at each end of the strip. The material was not permanently bent out of shape by a distortion of this amount. Other specimens were immersed in the unstressed or flat condition. It was expected that if intercrystalline embrittlement occurred as a result of corrosion, the network of fine cracks would develop "spontaneously" in those specimens which were corroded while under stress, whereas in the flat unstressed strips such "embrittlement cracks" would become apparent only upon sharply bending the corroded specimen.

The action of sodium hydroxide upon aluminum is a vigorous one even with solutions as dilute as N/20 and it was soon evident that embrittlement of the alloy would not result as a consequence of alkaline corrosion of this kind. The surface of the metal was attacked rather uniformly and at a rapid rate so that the strips became very thin and were covered by a closely adhering black coating. Sharp bending of the corroded speci-

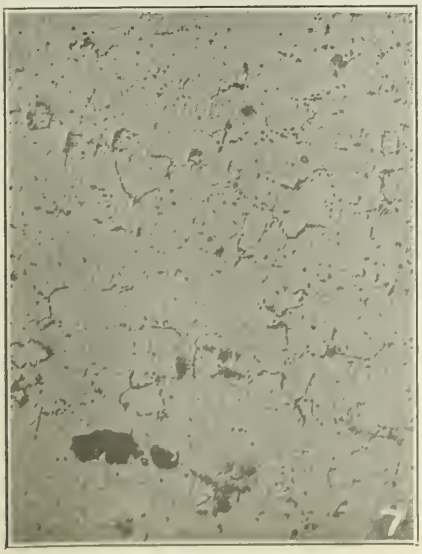
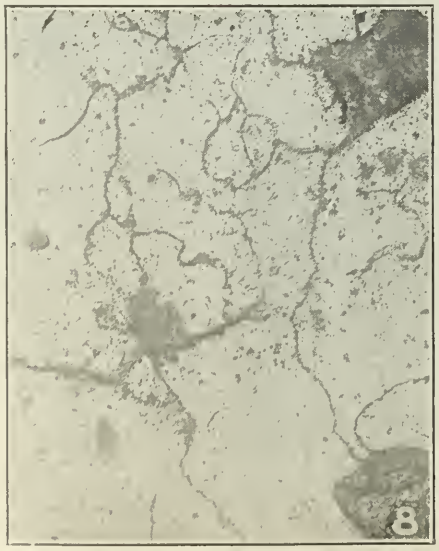


Fig. 7—Embrittled sheet *B*; unetched. × 100.



FIGS. 7 TO 9

Fig. 8—Same as Fig. 7, etched with 1 to 1 H_2SO_4 with 2.5 per cent $KMnO_4$. × 100.

Fig. 9—Fig. 8 at 500 diameters; revealing etching pits.

men after removal of the coating revealed no trace of an intercrystalline attack such as developed in service in sheet *B*.

The three other solutions closely resembled one another with respect to their corrosion of the specimens immersed in them. The intensity of the attack was approximately proportional to the acidity of the solution. All of the specimens became coated with a black deposit which became brown after standing several weeks in the solution, undoubtedly by the oxidation of the copper which it contained. This deposit resembled, in appearance, that which was found upon the sheet which deteriorated in service. Fig. 10 is typical of the results obtained with sheet *B* in these solutions. It represents a portion of a 2-in. strip from the ductile part of sheet *B* immersed for 12 days in normal aluminum sulphate solution while simultaneously stressed by being bent into the form of a bow. It was then slightly bent to show the resulting damage. Fine intercrystalline cracks developed in the specimens in a relatively short time. Some of the stressed specimens developed cracks, revealed upon sharp bending, in the acidified solutions in 4 days, and in 12 days' time the

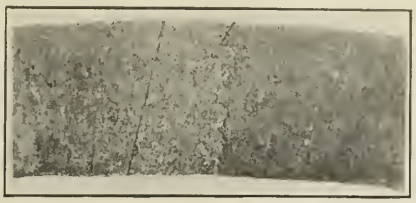


FIG. 10. SHEET *B*, DUCTILE PART, CRACKED UNDER STRESS AND CORROSION. × 4

cracks were evident in the stressed specimens in these solutions without bending and in the unstressed specimens upon bending. Some of the stressed specimens immersed in the neutral corroding solution (*N* aluminum sulphate) after an interval of 12 days showed cracks upon bending, but these were not pronounced until later. After an immersion period of 30 days all of the specimens cut from sheet *B*, in each of the three corroding solutions, showed well-developed intercrystalline network of "cracks."

The behavior of specimen *A* was quite different from that of *B*. After an immersion period of 55 days in each of the three solutions nothing suggestive of intercrystalline brittleness was found. Although in some cases, particularly in the acid solutions, the specimens became somewhat brittle as shown by the behavior upon bending the strip, the deterioration appeared to be caused by pitting rather than by an intercrystalline attack. As might be expected, however, the specimens of sheet *A*, immersed in *N*/20 sodium hydroxide solution, were attacked in a manner similar to that of sheet *B* in this solution.

Anneal Not Determining Factor

From a comparison of the microstructure of the two sheets (Figs. 11 and 13) it might be inferred that a difference in the annealing which the sheets received was mainly responsible for the difference in their behavior under corrosive conditions, although the tensile properties of the two sheets were not suggestive of any pronounced difference in this respect. Apparently the answer is not so simple as this. Specimens from the two sheets were annealed by us for 2 hours at 410 deg. C., but this did not change their relative behavior upon corrosion.

The theory of Rosenhain[5] that a metal or alloy in which the crystals have smooth rounded outlines is subject to intercrystalline changes, while the same metal or alloy in a different physical condition whereby deeply interlocking grains result does not seem to answer the question here. It is evident from Figs. 11 and 13 that there is a considerable difference in crystal size, but that the nature of the grain boundaries is not markedly different in the two cases, particularly if the difference in grain size is taken into account.

In general, the results of the tests indicated that a corrosive attack, particularly an acid solution, is a powerful aid in producing intercrystalline brittleness in certain types of duralumin sheet. The results do not warrant the conclusion, however, that corrosion of duralumin always manifests itself by an intercrystalline attack with an accompanying embrittlement of the

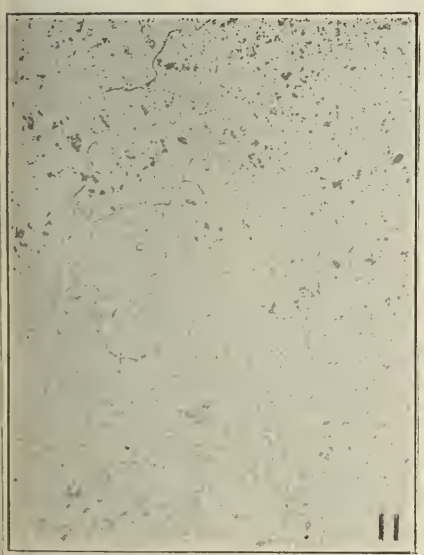


Fig. 11—Ductile portion of sheet *B*, shown in Fig. 5. × 100. Etched with 1 to 1 H_2SO_4 containing 2.5 per cent $KMnO_4$.

Fig. 12—Embrittlement cracks in metal of Fig. 7 after deeper etching with same reagent. × 100.

Fig. 13—Sound sheet *A*; etched with 10 per cent NaOH followed by 8 per cent HF. × 100.

FIGS. 11 TO 13

[5] "Introduction to Symposium on the Effect of the Prolonged Application of Stress on Metals," *J. Faraday Soc.*, vol. 16 (April 1921). Also Rosenhain and Archbutt, "Intercrystalline Fracture of Metals Under Prolonged Application of Stress," *Proc. Roy. Soc. London*, vol. A96 (1919), p. 56.

material. The physical state of the alloy and the character of the surface of the sheets appear to be factors of importance which determine the stability of the material when subject to corrosive conditions.

Summary

The nature of the attack in aluminum is determined largely by the amount and distribution of the microstructural constituents which are always present to some extent in commercial aluminum on account of the impurities contained. In the case of cast aluminum, these constituents are intercrystalline in their distribution, but not usually so after recrystallization and grain growth have taken place upon annealing after cold work. Annealed aluminum may, upon being corroded, appear to be attacked in an intercrystalline manner. Examination will often show, however, that the attack was not truly intercrystalline in its nature, but was determined by the presence of certain constituents which existed in the cast metal as intercrystalline lodgments but which, because of a subsequent recrystallization of the metal, no longer coincide with the network of crystal boundaries existing in the annealed metal.

The alloy of aluminum, duralumin, in the form of sheets is subject to a type of deterioration which is truly intercrystalline in character. The rate at which such deterioration progresses can be very much increased by the action of a corroding medium, but the evidence available did not warrant the conclusion that corrosion alone can initiate such deterioration, nor was it evident that the distribution of impurities or microstructural constituents was entirely responsible.

Life Tests of Platinum:Platinum-Rhodium Thermocouples

By C. O. Fairchild and H. M. Schmitt

FOR many years the so-called Le Chatelier thermocouple, consisting of one element of platinum and the other of an alloy of 90 per cent platinum and 10 per cent rhodium, has been known to be the best type of thermocouple for use at temperatures in the range 1,000 to 1,600 deg. C. No other metals or alloys have been found to compare favorably with this combination. The couple does, however, deteriorate quite rapidly when used at high temperatures, and requires frequent replacement or recalibration. The reasons for this have never been thoroughly investigated. Experimenters and other users of thermocouples have frequently observed that thermocouples obtained from different makers or even from the same source do not always exhibit the same rate of deterioration—i.e., time-rate of change of emf.—at any particular temperature. It has been supposed that the couple was particularly sensitive to the slightest contamination and that the variations in rate of deterioration depended primarily upon this fact.

Our attention was first brought to the problem of identifying the causes of the changes in thermocouples by a request addressed to the Bureau of Standards to test the relative efficiency of different types of porcelain protection tubes for thermocouples. Such tests have been deferred until couples can be obtained which are sufficiently free from deterioration under laboratory conditions. The experiments have shown that few thermocouples now in the possession of the Bureau of Standards will withstand exposure to high temperatures sufficiently well to offer exact means of determining the relative efficiency of different modes of protection.

Thermocouples to be tested were loaned to the Bureau of Standards by manufacturers, with the understanding that the results of the tests would be available for publication by this bureau. There are only two distinct makes of rare-metal couples now on the American market, one of American and the other of English manufacture.

The results of comparative tests, given below, are described for couples designated as American and English. The standard couple used is called *P*21.

Effects of Exposure to High Temperatures

The couples were first carefully calibrated by comparison with a laboratory standard numbered *P*21 used only for this purpose, and exposed to high temperatures for very short intervals only. The calibrations were made at a depth of immersion of 11 cm. The original values obtained follow:

ELECTROMOTIVE FORCE VS. TEMPERATURE, DEG. C.

Millivolts	*P*21 Deg. C.	American Deg. C.	English Deg. C.
2.00	267	269	264
3.00	375	377	369
4.00	478	480	467
5.00	578	580	559
6.00	674	677	646
7.00	767	771	730
8.00	858	862	811
9.00	946	950	889
10.00	1,032	1,036	965
11.00	1,116	1,120	1,039
12.00	1,199	1,203	1,111
13.00	1,281	1,285	1,181
14.00	1,363	1,367	1,250

After being heated for 18 hours at 1,250 deg. C. in a clean platinum-wound furnace at a depth of immersion of 11 cm. the couples were again compared with *P*21 at the same immersion, giving results as follows:

Thermocouple	Temperature Indicated, Deg. C.	Error In Pt, Deg. C.	Error In Alloy Deg. C.
*P*21	1,200	..	..
American	1,198	0	2
English	1,191	0	9

The couples were then heated as before for 6 hours at 1,450 deg. C. and again compared with *P*21:

Thermocouple	Temperature, Indicated, Deg. C.	Error In Pt, Deg. C.	Error In Alloy Deg. C.
*P*21	1,200	..	..
American	1,194	3	3
English	1,186	3	11

Since the effects observed cannot be attributed entirely to contamination in the furnace and must therefore be due in part to elimination of impurities by heating, it appeared desirable to accelerate the removal of impurities by use of a solvent. The following treatment was accordingly applied:

Each couple was heated, in air, at about 1,400 deg. C. by passing an electric current through it, and borax was applied which melted and washed the surface. The borax was then removed with hot hydrochloric acid and the couples electrically heated for 3 hours at 1,500 deg. C. Next the temperature was lowered to about 900 deg. C. and the couples were kept covered with borax applied at frequent intervals for 2 hours. The borax was then dissolved off as before and the couples were heated again for 30 minutes at 1,500 deg. C.

This borax treatment has been used for a number of years at the Bureau of Standards for improving contaminated couples and has been found very effective in rendering the couples more homogeneous. The follow

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ing results were obtained by again comparing the couples with *P*21 at 11 cm. immersion:

Thermocouple	Temperature Indicated, Deg. C.	Error In Pt, Deg. C.	Error In Alloy, Deg. C.
*P*21	1,200	..	..
American	1,191	6	3
English	1,142	4	54

In order to indicate still more strikingly the difference in the metals, comparison with *P*21 was made with 6 cm. immersion:

Thermocouple	Temperature Indicated, Deg. C.	Error In Pt, Deg. C.	Error In Alloy, Deg. C.
*P*21	1,200	..	..
American	1,180	17	3
English	1,118	12	70

It would be expected that these couples should show greater changes when tested at 6 cm. immersion, after use at 11 cm. immersion, than when tested at 11 cm. immersion, since in the former position the region of thermo-electric heterogeneity developed by the previous heating is brought into a region of high temperature gradient. It is not evident, however, why the comparatively pure platinum wires of the couple should show a change as great as the equivalent of 17 deg. C.

In these last comparisons the combined effects of the heating and the borax treatment are apparent. To show the effect of the borax treatment alone, comparison with *P*21 was made at 14 cm. immersion:

Thermocouple	Temperature Indicated, Deg. C.	Error In Pt, Deg. C.	Error In Alloy, Deg. C.
*P*21	1,200	..	..
American	1,197	0	3
English	1,150	1	49

Spectroscopic tests were used to show what impurities were originally present in the metals. The analyses explain the effects described above. The platinum showed in each case traces of calcium. The alloys each showed traces of copper and calcium and the English alloy showed the presence of considerable iron. Chemical analysis resulted in finding iron to the extent of 0.34 per cent in this alloy.

Weight Loss by Volatilization at High Temperatures

Sections of wire carefully cleaned and heated momentarily to a red heat were carefully weighed and heated electrically in air as follows:

1. Temperature, 1,375 deg. C.; time, 30 min.

Material	Loss in Weight, G.
American Pt.	0.00016
English Pt.	0.00016

2. Temperature, 1,450 deg. C.; time, 30 min.

American alloy	0.00041
English alloy	0.00076

(*a*) Continued for 2 hr. at 1,450 deg. C.:

American alloy	0.000162
English alloy	0.000171

(*b*) Continued for 1 hr. at 1,600 deg. C.:

American alloy	0.000184
English alloy	0.000188

The action is mostly on the surface, such that repeated heatings show decreasing differences. The results are computed for loss per sq.cm. of surface.

The tests described are sufficiently complete for the purpose in mind. They indicate quite plainly that purity of the metals used in making rare-metal thermocouples is of primary importance and that a very high degree of purity is desirable. It is obvious that such impurities as were found, all of which volatilize or oxidize easily, are particularly objectionable.

The platinum has been found to be very good and to compare fairly well with the purest obtainable. No doubt there was some accidental contamination of the thermocouple, but it is not apparent that this could have materially affected the general conclusions concerning the alloy elements.

Conclusion

Tests of thermocouples obtainable on the American market have shown that considerable improvement is desirable, particularly in the English make. The fact that the manufacturers have been able for years to supply thermocouples closely reproducing their thermo-electric standards permits us to infer that the materials used in manufacture of the couples are the same now as they have been in the past. The usefulness of the couples in industrial applications has been proved, though the tests explain some of the faults which have been found during use in manufacturing plants.

The manufacturers of the thermocouples tested have been informed of the results enumerated and are now working to improve their product. The Bureau of Standards will probably repeat the tests in the near future, when better couples have been made.

The Pyrometry Section of this bureau has been aided materially in this work by Dr. E. Wichers of the Chemistry Division and Dr. W. F. Meggers of the Optical Division. Dr. Wichers and his assistants are making a special study of the platinum metals, and Dr. Meggers and assistants are engaged in research in spectroscopy, including its application for quantitative measurement of impurities in metals and alloys.

* * *

Later Tests on English Thermocouple

Subsequent to the completion of the tests reported in the preceding article, the manufacturer of the English rare-metal thermocouple submitted new material to the Bureau of Standards and an additional series of tests was made. It is significant to note that although in the previous tests the alloy wire of this make had been found to contain 0.34 per cent of iron, spectroscopic tests of the new alloy failed to show the presence of iron.

The tests made on the English thermocouple are not comparisons of the English and American makes, and since the conditions of the previous test could not be duplicated exactly, no attempt was made to follow the original procedure. This procedure was, however, adhered to closely enough to prove definitely whether or not the new thermocouples are better than the old thermocouples submitted by the English maker. The results obtained are highly satisfactory, as shown below.

The couples were first carefully calibrated by comparison with a laboratory standard numbered *B*1. The calibrations and all subsequent comparisons with the standard were made at a depth of immersion of 25 cm. The test couples are designated as *L* and *M*, the latter having an alloy of 90 per cent platinum and 10 per cent rhodium and the former 13 per cent rhodium. The original values obtained follow:

ELECTROMOTIVE FORCE VS. TEMPERATURE, DEG. C.

Millivolts	*B*1	*L*	*M*
2	265	260	265
3	374	363	374
4	478	459	477
5	578	551	577
6	675	639	674
7	769	724	768
8	861	806	859
9	950	886	948
10	1037	964	1034
11	1122	1040	1118
12	1206	1114	1201
13	1289	1186	1284
14	1372	1257	....

This calibration of couple *L* is different from that of

the couple submitted for the original tests, on account of the elimination of iron from the alloy. This difference will not seriously affect industrial applications, though it amounts to 15 deg. at the higher temperatures.[1]

Effect of Exposure to High Temperatures

After heating for 6 hours at 1,450 deg. C. in a clean platinum-wound furnace the couples were again compared with *B*1, giving results as follows:

Thermocouple	Temp. Indicated, Deg. C.	Error	
		In Pt, Deg. C.	In Alloy, Deg. C.
*B*1	1,200	...	...
L	1,199.7	0.5	0.8
M	1,199.4	0.2	0.8

The couples were then heated for 18 hours at about 1,600 deg. C. by passing an electric current directly through them suspended in air, and were again compared with the standard, *B*1:

Thermocouple	Temp. Indicated, Deg. C.	Error	
		In Pt, Deg. C.	In Alloy, Deg. C.
*B*1	1,200	...	...
L	1,198	0.7	2.7
M	1,202.3	2.0	0.3

One of the couples was then treated with melted borax as in the previous tests, giving the following results:

Thermocouple	Temp. Indicated, Deg. C.	Error	
		In Pt, Deg. C.	In Alloy, Deg. C.
*B*1	1,200	...	...
L	1,198	2.1	4.1

At the request of the maker a test in the platinum-wound furnace at 1,500 deg. C. was begun. At the end of 23 hours the couples were removed for comparing with *B*1, giving these values:

Thermocouple	Temp. Indicated, Deg. C.	Error	
		In Pt, Deg. C.	In Alloy, Deg. C.
*B*1	1,200	...	...
L	1,197	1.3	4.3
M	1,200.2	0.3	0.1

In order to determine if possible whether or not the couples were undergoing contamination, sections from near the hot junction of couple *L* were removed and tested spectroscopically. The only result of this test was the identification of rhodium in the platinum. The section removed was far enough from the hot junction to exclude the portion contaminated by welding the junction and to permit the conclusion that rhodium had been volatilized from the alloy and had contaminated the platinum. Apparently the 13 per cent alloy had lost rhodium appreciably faster than the 10 per cent alloy, and the tests were stopped at this point, because results of long continued exposure to the higher temperature would not indicate the quality of the wire, but would be confused with the change due to the transfer of rhodium.

Spectroscopic Analysis

Spectroscopic tests of the platinum and alloys were made which indicated that both metals were exceedingly pure, very minute traces of calcium and copper being found in each. Re-examination of the spectrograms made in the original tests resulted in finding traces of copper in all the platinum submitted.

The traces of impurities found in the platinum account for most of the changes observed in these tests, but the loss of rhodium from the alloy has prevented any conclusion from being drawn as to the effects of the impurities in the alloys. The Bureau of Standards has been studying the properties of pure platinum and it is now known that the impurities found cause variations in the thermo-electric properties of the metal to approximately the extent noted in these tests, and it is highly probable that such quantities of impurities can slightly affect the refractoriness of the alloy. However, the alloy of couple *M* remained remarkably homogeneous throughout the tests.

Conclusion

The original tests of the English and American makes of thermocouples revealed that the former deteriorated too rapidly when exposed to high temperatures; and the tests showed that this trouble was caused mainly by iron in the English make of alloy. The English maker has improved his products, and as a result rare-metal couples conforming to the high emf. standard can now be obtained, which will be satisfactory for use at high temperatures. The latter type of couple will now be known as a 13 per cent alloy couple. This 13 per cent alloy has a thermo-electric power against platinum of approximately 14 microvolts per degree at 1,200 deg. C., while the 10 per cent alloy gives but 12 microvolts per degree at this temperature. The tests indicate that the 10 per cent alloy is more refractory than the 13 per cent alloy, but, as shown above, a total change of only 4.3 deg. due to change in this alloy alone was found after the very severe treatment received.

For industrial use the rare-metal couples now obtainable are sufficiently refractory to direct attention once more to methods of and materials for protection. Adequate protection from furnace gases and vapors at 1,450 deg. C. and upward is still lacking. A more refractory porcelain is wanted and one which has been fired and vitrified at a temperature of not less than 1,550 deg. C.

Bureau of Standards,
Washington, D. C.

[1] See Bureau of Standards Tech. Paper 170 for mean calibration of a large number of couples of this type submitted to the bureau for testing.

National Safety Council Compiling Census of Safety Workers

The National Safety Council is undertaking the compilation of a census of all persons engaged in safety and industrial health activities. The chemical industry has, because of inherent hazards of its nature, always been among the leaders in industrial safety, but it has never been established definitely how many persons in the chemical industry are engaged in accident prevention and industrial health work, or how this industry compares with other industries in this respect.

Industry in general and the nation at large will profit from the results of this census. It will enable the Council quickly to find speakers on industrial and public safety for any occasion in any locality; authors for special articles on accident prevention; writers of safety textbooks; lecturers on accident prevention and industrial health work for universities and colleges. The Council at present continually receives requests from industrial companies, municipalities, civic associations, clubs, schools, colleges and other organizations for help in finding speakers or writers on safety subjects. The census records will greatly increase the facilities of the Council for filling such requests.

Every reader of this publication who is professionally engaged in industrial or public accident prevention or industrial health work—whether he is devoting all or only part of his time to accident prevention—is urged to assist in the taking of this census by sending his name to the National Safety Council, 168 North Michigan Ave., Chicago.

Explosives and Fertilizers*

A Broad Economic View of the World's Resources Indicates That Our National Defense, Our Future Food Supply and Our Continued Industrial Pre-eminence Depend on Nitrogen Fixation and the Maintenance of Chemically Trained Personnel

By ALFRED H. WHITE
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THE intimate connection between explosives and fertilizers has been well known to the scientific world, but the roar of the stupendous explosion at Oppau in Germany a few months ago has perhaps accentuated it and has certainly brought vividly to the lay mind the possibility of the use of the same material for the two widely differing purposes. The mechanism of that unexpected explosion, which blotted out four hundred lives, is still a matter of conjecture, but it seems clear that a warehouse reported to contain 7,000 tons of a mixed salt of ammonium nitrate and sulphate, intended perfectly legitimately for fertilizer and believed to be entirely safe, unexpectedly exploded with all the violence of a high explosive.

The battle of Crecy has been famous for nearly 700 years, not so much because of the victory which the English won as because of the introduction of gunpowder and artillery as a decisive factor in warfare. It has been recognized for centuries that superiority in explosives and artillery was one of the strongest assets of a contending nation. As Napoleon cynically phrased it, "God is on the side of the heaviest artillery." Our own country has been hampered in all its major wars by lack of sufficient explosives. The Continental Congress urged the colonists in the days of the Revolution to make niter plantations to supply the nitrate needed for gunpowder. During the war of 1812, the earthen floors of Mammoth Cave in Kentucky were leached for the meager supply of nitrates stored therein. In the Civil War the armies of the North were not nearly so hard pressed as those of the South, but many of the battles came to a standstill through exhaustion of ammunition. We remember the desperate state of the British armies in Flanders in 1914 and 1915, when they were subjected to the withering fire of the German batteries without even the possibility of an effective reply.

The Allies' Demands for Explosives

When we entered the war, in 1917, the first demand made upon us was for explosives. This was emphasized in the meetings of the Interallied Council in the fall of 1917, when it was brought out that during the year 1918 Great Britain and France could supply artillery for all of our troops, as well as theirs, but that they were in desperate need of explosives for their own troops. They specifically requested "that the American efforts shall be immediately directed to the production of propellant and high-explosive powders on the largest possible scale." The reason for this shortage of explosives in France and Great Britain is found in the lack of raw materials in these countries. We think of smokeless powder as requiring cotton, nitric and sulphuric acids, and alcohol; and of the high explosives as requiring ammonium nitrate together with toluene, sulphuric and nitric acids, but the fact which escapes our attention is that the raw material whose tonnage is greatest is one that does not appear at all in the finished product. It is coal. Each pound of smokeless powder requires 9 to 10 lb. of coal. The French had to import from 8 to 12 tons of raw materials for each ton of high explosives, and from 15 to 20 tons of raw material for each ton of smokeless powder. The expenditure of explosives during the World War was on a scale undreamed of before that time. Our American artillery, in its preparation for the attack on the St. Mihiel sector, fired two-thirds as many rounds of ammunition in 4 hours as the Union forces fired in 4 years during the Civil War.

The response that we made to our allies' demand for explosives was a striking proof of the ability of this country to undertake large operations. Fortunately, most of the raw materials were present in abundance. Coal, cotton, alcohol and sulphuric acid were obtainable in ample quantity. The production of toluene had to be stimulated, but the process of manufacturing it from California petroleum, which was developed to meet the emergency, was capable of furnishing many times more than the needed amount. The greatest shortage of material was in fixed nitrogen, especially in the form of nitric acid. The main source of the world's nitrate was in Chile, separated by a long ocean voyage from this country and from Europe, and the submarine campaign called for the diversion of every possible ship to carry troops and supplies to France. There was no certainty whether it would be possible to maintain the shipment of the amounts of nitrate required, nor indeed whether Chile would remain neutral and willing to furnish us the raw material. Germany had foreseen that any war which involved Great Britain would immediately cut her off from supplies of nitrates, and she had guarded against this contingency, first by a large reserve stock, and second by the development of processes for fixation of the nitrogen from the air, which would render her independent of outside supply.

Nitrogen Preparedness—1914 and 1922

Germany's success in her nitrogen fixation program is a matter of common knowledge. She built plants which supplied her army with munitions and her soil with at least a part of its normal supply of fertilizer. No other country had deliberately planned for war, and so no other country had subsidized the development of this industry of nitrogen fixation. The ammonia from the coke ovens in the allied countries was entirely inadequate for the emergency, and England, France and the United States all worked feverishly to install

*A contribution to the Symposium on Chemical Engineering and National Defense presented before the Baltimore meeting of the American Institute of Chemical Engineers, Dec. 6, 1921.

fixation plants. These could not be built in a day and so the armistice came with the most of the plants uncompleted.

At the close of the war Germany had as assets her plants, whose construction cost had already been largely amortized. They have been merged into one immense combination with government assistance, so that they are in a position to act as a unit and expend their energies where they are needed. In our own country the unfinished plants were scrapped and only two were retained. U. S. Nitrate Plant No. 1, built to produce ammonia by direct synthesis of nitrogen and hydrogen under high pressures—a modification of the Haber process—was not entirely successful in its operation. U. S. Nitrate Plant No. 2, at Muscle Shoals, built to fix 41,000 tons of nitrogen a year by the cyanamide process, was a pronounced success. Both these plants are being maintained in a standby condition pending final decision by Congress as to their method of operation, if indeed they are to be operated at all. Other developments during and since the war have contributed to make our condition of nitrogen preparedness much better than it was in 1916. The stimulation in construction of byproduct coke ovens has doubled the amount of ammonia which may be produced in the United States from this source. Methods for oxidation of ammonia to nitric acid were developed during the war. Provided our country maintains a reasonable stock of nitrate of soda as a military reserve, these sources of ammonia production should permit us to supply the needful explosives for a defensive war. If, however, we were to be drawn into another such terrific cataclysm as that of 1914-1918, we would again be forced to construct new fixation plants.

Development of Nitrogen Fixation Processes

If we had to face another such emergency, we would be better prepared, for the processes of nitrogen fixation are much better known than they were when we entered the war. The cyanamide process had been well developed before the war both in Europe and at Niagara Falls, and the plant at Muscle Shoals, designed by the American Cyanamid Co., represents the most advanced construction in these lines. The other important process for nitrogen fixation, the Haber process and its variants, reached a high development in Germany during the war. The one plant attempted in this country and constructed with government funds at Sheffield, Ala., failed to operate satisfactorily. But the same private interests that designed this plant have, with the experience gained through the first venture, designed and constructed a plant at Syracuse, N. Y., which is said to be producing 12 tons of anhydrous ammonia per day and to be operating very smoothly and satisfactorily. In case it becomes necessary for the government to construct synthetic ammonia plants, there is a pilot plant with trained personnel, whose services would undoubtedly be made available to the government for the national defense.

From France comes the report that the famous French engineer M. Georges Claude has been successful in his daring attempt to produce ammonia synthetically, not at pressures of 100 atm., or even 250 atm., but at pressures of 1,000 atm. This process, which works with flammable gases in steel containers at red heat under pressures which are almost half of those set up in a cannon when fired, is certainly one of the most remarkable that has ever been attempted, and the success of M. Claude is further evidence that he is a chemical engineer of the very highest type.

It appears then that from the standpoint of raw materials for explosives our country is fairly well prepared for national defense. The one raw material which has been lacking, fixed nitrogen, is now provided in reasonable amounts from our coke ovens, with the government plant at Muscle Shoals as an immediate reserve and at least one private plant for direct synthesis of ammonia in successful operation.

Importance of Maintaining Trained Personnel

Raw materials are, however, only one of the things needed for explosives. Even more essential is the knowledge of manufacturing processes which exists only with the maintenance of a trained personnel. It is probable that commercial explosives will always be manufactured in this country, and it may therefore be argued that there will always be an adequate nucleus of personnel for war needs. But is it probable that the manufacturers of commercial explosives will be leaders in the development of new materials which might be used in warfare? What kind of explosives will be used in the next war? The only answer which we are warranted in giving at the present time is that they will be unstable chemical compounds which must be synthesized with very great care and will almost certainly be complex organic compounds. The one type of factor which is always working with this form of synthetic organic compounds is that which manufactures dyes.

The connection between the dye industry of the country and the manufacture of poison gases has been frequently discussed. The relation between the dye industry and explosives has not been emphasized so much, and yet the operations of nitration are fundamental both to the dye industry and to the manufacture of explosives, and certain materials such as picric acid and dinitrophenol are in themselves explosives as well as products of the dye manufacturer. The relation of explosives to poison gas is so very close that it is not possible to say with certainty where one begins and the other leaves off, and I cannot refrain from giving one specific instance of the ready adaptation of a dye works to the manufacture of poison gas.

Demonstrating the Impossibility of Chemical Disarmament

The Badische Anilin- und Soda-Fabrik of Germany has a capacity to produce 800,000 lb. of indigo each month. Its process starts with alcohol, which is converted into ethylene and then into ethylene chlorhydrin. This latter product is heated with aniline and the oily residue is fused with caustic potash; indigo is at once obtained from this fusion by solution in water and oxidation by air. Were Germany to be drawn into war this plant might be converted into a mustard gas plant in scarcely an hour's time. The first two steps in the process are identical; in the third step, sodium sulphide, a cheap chemical, is substituted for aniline and the solution thus obtained is concentrated and treated in large tanks with hydrochloric acid. The oily product settling out at the bottom is the well-known mustard gas, and may be drawn off at will.

This instance of the adaptation of a dye works to war purposes is cited partly to show the impossibility of chemical disarmament. Any nation which permits its dye industry to perish is in danger of destruction

by an enemy which is prepared to unmask these terrible agencies of destruction. These industries play an important part in our modern industrial organization, and unless the world is willing to do without colors and also synthetic medicinal products, these plants cannot be wiped out. The only safe protection appears to be in an equality of preparedness.

Preparedness for Peace

Let us turn our attention from preparedness for war to preparedness for peace—to the measures necessary to maintain the fertility of the soil. The importance of the subject has been well summed up by Theodore Roosevelt, who, writing in the *Outlook* in 1912, said:

> I have always been fond of history and of science, and what has occurred to Spain, to Palestine, to China and to North Africa from the destruction of natural resources is familiar to me. I have always been deeply impressed with Liebig's statement that it was the decrease of soil fertility, and not either peace or war, which was fundamental in bringing about the decay of nations. While unquestionably nations have been destroyed by other causes, I have become convinced that it was the destruction of the soil itself which was perhaps the most fatal of all causes.

One of our most eminent American agriculturists, he late Dr. C. G. Hopkins of the University of Illinois, howed in 1909 that one of their experimental fields vhich had been carried on crop rotation for 7 years vithout fertilization decreased in fertility so that the rop of corn fell from 57.3 bu. to 33.9 bu., and oats lecreased from 74.4 to 25.9 bu. per acre. A check plot ertilized by addition of nitrogen and phosphorus in- reased its yields of corn over that given in the earlier ears, and gave a crop of oats which, while not so large s in the first year of the test, was still 20 bu. greater han that given by the unfertilized plot.

The same authority cited the case of Russia, where he average annual yield of wheat for 20 years is 8½ u. to the acre and where a decrease of only 2 bu. to he acre means a famine. He gave the following solemn arning, which is strikingly similar in import to that of resident Roosevelt cited above:

> With the exception of a few small countries, the record of our race is a record of ruined lands; and if we repeat, in the great corn belt of America, the history of the white race in Palestine, in southern Europe, in Russia and in the eastern part of the United States, where shall our children go for bread?

We in the United States are accustomed to think of ır soil as a permanent asset, just as a generation go we considered our petroleum, natural gas and coal s permanent assets which did not need to be conserved. et the evidence is clear that even our richest soils e deteriorating. The State of Illinois is on the whole ıe of the richest farming states in this country, and t Dr. Hopkins has stated that if continuous crops of rn of 100 bu. per acre were grown on the Illinois farm nds, the supply of phosphate in the soil reached by ıe plow would be not diminished but totally exhausted from 51 to 105 years. A corn crop of 100 bu. quires for the grain alone 100 lb. of nitrogen. Some the poorer farm lands of Illinois contain only sufficient trogen in the surface soil for forty-six crops of this rt and none except the deep peat soils contain enough trogen in the surface soil to last more than 67 years. is recognized that phosphates and other mineral rtilizers in some form must be added to the soil if s fertility is to be maintained. The nitrogen problem . however, of more importance. The Illinois Agricultural Experiment Station states: "The nitrogen problem is the most important practical problem confronting the American farmer."

The Nitrogen Problem in Agriculture

Although there is agreement among agriculturists and scientists as to the seriousness of the nitrogen problem in agriculture, there is not the same unanimity as to the best means of maintaining the nitrogen content of the soil. The early Roman writers on agriculture knew the value of leguminous crops as restoratives of soil fertility. The system of maintenance of a permanent system of soil fertility by proper rotation of crops and utilization of plant residues forms the basis of the system advocated by Dr. Hopkins for Illinois soils. However, the system requires more than the usual care, for their bulletin states:

> The nitrogen of the soil, therefore, cannot be maintained simply by incorporating a legume in the rotation, as is too often assumed. The proper utilization of the legume hay produced, and the return of its nitrogen to the soil, is a problem of utmost practical importance.
>
> The use of a legume cover crop in wheat and oats also plays an important part in maintaining the nitrogen supply of the soil. The legume so used is probably of more importance really than its occurrence in the regular rotation.

It has been proved that the nitrogen content of soil such as that of Illinois can be maintained without addition of a commercial fertilizer, provided sufficient attention be paid to the biological processes. The question is not, however, decided for other types of soils and other methods of farming, and it is not settled whether the maintenance of the nitrogen content of soil through legumes is as economical as its partial restoration through commercial fertilizers. This is a question which can be answered only by a careful economic study and one which from its nature will have to be reconsidered with every variation in the cost items which enter the computation. The recent increase in the value of farm lands and in farm labor has made it necessary to recast pre-war figures.

Investigations made by the Farm Management Department of the Iowa State College of Agriculture, in co-operation with the Iowa Farm Bureau Federation in 1920, showed that the average direct cost of growing an acre of wheat in Iowa was $18.19, of which almost exactly 50 per cent was labor and less than 10 per cent was charged to fertilizer. It may be noted that this fertilizer was merely manure and undoubtedly entirely inadequate to replace the nitrogen lost in the crop. The point to be emphasized is that this typical acre which produced 18.5 bu. of wheat had expended upon it $18.19 as direct charges, to which was added the figure of $16.80 for land charges, so that according to the computation the total cost of wheat was nearly $1.90 per bushel. Almost one-half was a fixed charge due to the land.

Methods of Nitrogen Replacement

The Illinois system of permanent soil fertility as advocated by Dr. Hopkins dispenses with the use of commercial nitrogenous fertilizers, but gives no return at all to the owner of the soil during the fourth year, when the land is wholly given over to the cultivation of clover, which is to be plowed under and from which not even hay is to be cut. If the direct cost of caring for the land during this year is estimated at only $5 per acre and the land charge is to be $16.80 per acre, as

estimated in the Iowa figures given above, it will mean that the cost of this method for replacing the nitrogen in the soil is $21.80 per acre. If nitrogen in fixed form may be purchased by the farmer at 15 cents per lb., he could buy 145 lb. for this sum, and if nitrogen could be purchased by the farmer at 10 cents per lb., which is not at all an impossible figure, he could buy 218 lb. of nitrogen. This would provide for the nitrogen removed by 218 bu. of corn, so that theoretically the farmer could grow a heavy crop of grain every year and possibly be better off financially than if he kept up the nitrogen content of his soil wholly by clover or other leguminous crops. The advantage to the nation is evident, for the product of the land during every year, instead of only three years out of four, would add a potential one-third to our crop production.

The Chemical Engineer's Responsibility

It is not for the chemical engineer to decide what method of nitrogen replacement is best from the agricultural standpoint. It is proper for him, however, to consider how far he might meet a demand if it were made upon him.

The combined crops of wheat, oats and corn in the United States amount roughly to 5,000,000,000 bu. annually. Each bushel removes from the soil about 0.9 lb. of nitrogen, so that the total annual loss of nitrogen from the soil in the grains alone is 4,500,000,000 lb., or 2,250,000 tons, of nitrogen. This is not an exorbitantly high estimate. Dr. Lipman, director of the New Jersey Agricultural Experiment Station, was quoted in the hearings before the Senate Committee on Agriculture and Forestry (Senate Document 3,390) as having estimated that the total annual loss of nitrogen from all land under cultivation in the United States, after making allowance for all returns to the soil, was between three and four million tons.

These figures are staggering, but the authority is good. Let us assume that we must return to the soil through commercial fertilizers, not the larger figure of 4,000,000 tons, but the smaller figure of 2,250,000 tons representing the loss in the grains alone. The tankage, cottonseed meal and other organic compounds now used account for only 4 per cent of this amount and their total is decreasing rapidly. The coke ovens and private plants for nitrogen fixation in the United States would make up less than 5 per cent. Imports of Chilean nitrate in the same amount as used for fertilizer before the war would furnish only 2 per cent. There is lack of agreement as to the future life of these Chilean nitrate deposits, just as there is lack of agreement as to the number of years before our petroleum resources in the United States will be exhausted. There is, however, general agreement that the life of both resources is limited and that within one generation, or at most two generations, substitutes will have to be sought for the large uses of both these materials.

The organic wastes, coke-oven ammonia and Chilean nitrates might together account for perhaps 11 per cent of the 2,250,000 tons of nitrogen called for annually to replace that removed from the soil by the grain crops. The remaining 2,000,000 tons would have to come from fixation processes.

There is only one really large fixation plant in the United States—that owned by the Government at Muscle Shoals. It has a capacity for fixing 41,000 tons of nitrogen per year, but it would require forty-nine such plants to provide the nitrogen called for. Nitrogen fixation on this tremendous scale at a price which will render the product available for fertilizer is entirely impossible with our present technical developments. But is the prospect of such a demand merely a wild dream?

It was Sir William Crookes who twenty-three years ago, in his presidential address before the British Association for the Advancement of Science, first called the world's attention to the probable exhaustion of the nitrogen of the soil throughout the world. I quote from his address:

> Gradually all the wheat-bearing land on the globe is appropriated to wheat growing, until we are within measurable distance of using the last available acre. We must then rely on nitrogenous manures to increase the fertility of the land under wheat, so as to raise the yield from the world's low average, 12.7 bu. per acre, to a higher average. To do this efficiently and feed the bread eaters for a few years will exhaust all the available store of nitrate of soda. For years past we have been spending fixed nitrogen at a culpably extravagant rate, heedless of the fact that it is fixed with extreme slowness and difficulty, while its liberation in the free state takes place always with rapidity and sometimes with explosive violence. . . . The fixation of nitrogen is vital to the progress of civilized humanity. Other discoveries minister to our increased intellectual comfort, luxury or convenience; they serve to make life easier, to hasten the acquisition of wealth or to save time, health or worry. The fixation of nitrogen is a question of the not far distant future. Unless we can class it among certainties to come, the great Caucasian race will cease to be foremost in the world and will be squeezed out of existence by races to whom wheaten bread is not the staff of life.

This solemn warning aroused the scientific world to the importance of nitrogen fixation, but after nearly a quarter of a century it is only a few in our nation who appreciate the vital importance of this problem.

Our National and Industrial Pre-eminence Dependent on Fixed Nitrogen

This discussion of the question of fertilizers and explosives has hinged largely on the question of supply of fixed nitrogen. From the military standpoint, our situation is much better than in 1917 and it would seem that our coke ovens with their increased production and the private plants for nitrogen fixation, with the government plants standing as a reserve, are sufficient to provide explosives for national defense.

The maintenance of our soil fertility stands out as a far larger problem. The United States will have to struggle to maintain its industrial pre-eminence and its high standards of living in the face of decreasing natural resources. Our soil fertility has been our greatest asset. As New England farms became unproductive their occupants moved to the Ohio and Mississippi valleys, where the soil produced in as rich a measure as the world has ever known. Even these marvelous soils are deteriorating.

The elements taken from the soil must be put back into it. The most important single constituent is nitrogen. Agriculturists have shown that it is possible to replace this by a system of crop rotation, but it involves an absolute lack of return from the soil during every fourth year. The increase in the value of farm land has greatly increased the expense of this process through the increase in fixed charges and has correspondingly increased the opportunity of the chemical engineer to produce fixed nitrogen at a price which can compete with this method of fertilization through biological processes.

The principles of nitrogen fixation are clearly outlined but the developments are still in their infancy. The process of the synthesis of ammonia through direct

combination of nitrogen and hydrogen presents possibilities and difficulties which challenge the best efforts of our chemical engineers, for this process has been called the most difficult chemical engineering operation which has ever been undertaken. The fixation of nitrogen can be accomplished as a military measure. Can it be accomplished so economically that it can produce the nitrogen needed by this country to maintain its soil fertility? That remains for the future.

In our study of national preparedness, we may list the raw materials for explosives as adequate, but the personnel which is to guide the future development is largely dependent on the fate of the dye industry and its related industries which deal with synthetic organic chemicals. The importance of a far greater supply of nitrogenous fertilizer is hardly yet recognized. The agriculturist through crop rotation and biological processes can meet the need in part. Can the chemical engineer develop the processes of nitrogen fixation so that the soil will remain productive and our children and our grandchildren live as comfortably as we do?

History shows that the fallen nations of the world either perished from exhaustion of the soil or were conquered by a hardier race after they had lost much of their original vigor through too much prosperity or indulgence. In either case they had failed in national preparedness. It was pardonable in the days of the dawn of civilization. It will be unpardonable if we, with our knowledge of the mistakes of the past and with the powerful weapons of modern science in our hands, make the same mistakes.

Fusibility of Open-Hearth Slag Containing Titanium Dioxide

By George F. Comstock
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THE comparative fusibility of basic open-hearth slags from soft steel heats and of similar slags with small additions of titanium dioxide has recently been investigated in the physical laboratory of the Titanium Alloy Manufacturing Co., with interesting results. Two slags were used in this work, one from the Wickwire-Spencer Steel Corporation in Tonawanda, N. Y., and the other from the National Enameling & Stamping Co. in Granite City, Ill. The former had a very much lower melting point than the latter, so that it could be melted in a coke fire, while with the latter this method was impracticable. The experiments with the low-melting Wickwire slag will be described first.

This was melted in small crucibles in a coke fire, two No. 12 Dixon graphite crucibles and one old crucible of about the same size, formerly used for bronze, being consumed in these trials. The corrosive action of the slag and the high furnace temperatures required for the melts caused the crucibles to wear out very fast. Plain crushed slag was first melted and taken out in the furnace to cool in the air, while various methods of determining the freezing point were tried. Owing to the viscous consistency and poor thermal conductivity of the slag, this determination was a much less simple matter than a similar determination is with metals. The slag passes very gradually from the liquid to the solid state through all stages of plasticity, and during cooling no two layers in the crucible are at the same temperature. Consequently a thermocouple inserted in the cooling slag gives a series of gradually decreasing readings, with any stationary period such as denotes the freezing point of a metal. It was planned therefore to note the progress of solidification by visual observation while stirring the slag, using a thermocouple and an optical pyrometer to give temperature measurements when the slag seemed to be just solid.

In the first trial, a nichrome tube closed at one end was inserted into the slag in the furnace and heated until all was at a uniform temperature, and the pot with the tube in it was withdrawn and permitted to cool. A quartz tube containing a platinum thermocouple was inserted in the nichrome tube, and the slag was stirred till it solidified, while readings were also taken on the liquid slag with the optical pyrometer. By this method the freezing point was determined as 1,175 deg. C. by the thermocouple and 1,115 deg. C. by the optical pyrometer. But on removing the thermocouple the quartz tube was found to be contaminated by slag, as the end of the nichrome tube had been burned off. A new iron tube was tried, but did not last any better, so finally a graphite tube had to be used. In another trial both pyrometers agreed fairly well on a freezing point at 1,110 deg. C.

A next trial was made with powdered slag to which 0.33 per cent TiO_2 was added, which was intended to represent the proportion of titanium which the slag would acquire by the total oxidation of the usual 3 lb. per ton addition of ferro carbon-titanium in soft steel. This addition would amount to about 0.5 lb. of titanium, or roughly 1 lb. of oxide per ton of steel, while the slag made was estimated at 15 per cent, or 300 lb. per ton, of steel. The mixture of 1 part TiO_2 to 300 parts slag was melted four times, and temperature measurements were made on it each time it cooled. The thermocouple in the carbon tube did not prove a very satisfactory arrangement, however, as the slag froze around it and it interfered with stirring because it could not be moved freely with the pyrometer wires and quartz tube in it. Also the optical readings on the slag itself were unsatisfactory, because the surface of the melt was always cold, and even when the skin was broken the hot liquid became covered at once with a cooler film before a reading could be taken. Consequently the best plan seemed to be to use the graphite tube as a stirrer, without any thermocouple in it, and to get the temperature measurements by sighting down into its hot end with the optical pyrometer. This method probably gave slightly low readings on account of the loss of heat from the hot end to the colder top of the tube, but it was convenient in operation and seemed to give concordant and regular results. All further trials were made in this way.

Such observations on the 0.33 per cent TiO_2 mixture described above showed a freezing point of about 1,085 deg. C. The crucible was thoroughly cleaned out after this trial, and another melt of the plain slag without titanium was made by the same method. Three tests in this way gave an average reading of 1,085 deg. C., showing that the addition of 0.33 per cent TiO_2 had no appreciable effect. In both these trials considerable white cast iron was reduced from the slag by the carbon of the crucible and tube during the repeated meltings, and the crucible was entirely used up at the end of this trial. No way of avoiding the reduction of iron from the slag could be thought of, with the melting facilities available.

Two separate trials, each consisting of several remeltings and in different crucibles, were made of this slag mixed with 1.33 per cent TiO_2, the proportion assumed to

be acquired from the recommended addition to rail steel. These trials resulted in freezing points of 1,060 and 1,055 deg. C., respectively, being found. Another trial was made with twice as much TiO_2, giving a result of 1,025 deg. C. Thus it seems that larger quantities of TiO_2 do indeed lower the melting point of basic open-hearth slag, and the slags from these latter trials were noticeably thinner when hot and more glassy when cold.

A final trial of the plain slag to check the first result of 1,085 deg. C. was made, and a lower result—namely, about 1,065 deg. C.—was obtained. It was noticed on the last few trials that after the first melting the slag generally showed a comparatively high solidification temperature, while on subsequent meltings it remained liquid when colder. It is believed that the slag as received was in a chemically unstable state, with certain compounds incompletely formed, and that a considerable period of fusion and quite a high temperature are required to complete these reactions. This condition would involve various uncertainties in the action of titanium dioxide on the slag in open-hearth practice, for the results would depend on the exact condition of the slag when this oxide entered it and the time available for combination to take place before freezing. In view of these uncertainties arising from the unstable and probably irregular composition of the slag, its viscosity and low thermal conductivity, the results described above are probably as accurate as it is worth while or possible to get them. They may be summarized in Table I.

TABLE I—SOLIDIFICATION POINTS OF SLAG FROM WICKWIRE-SPENCER CO.

	Deg. C.
Plain slag	1,065 to 1,085
Slag with 0.33 per cent TiO_2	1,085
Slag with 1.33 per cent TiO_2	1,055 to 1,060
Slag with 2.67 per cent TiO_2	1,025

Results on this slag indicate that titanium dioxide increases the fusibility of basic open-hearth slag, but not unless it is present in amounts greater than that available from the usual alloy addition to soft steel. If it may be assumed, however, that all the titanium is oxidized in the steel, and this oxide combines first with the slag particles included in (not resting on) the liquid steel, almost any percentage of TiO_2 might be present in these particles from a very small total titanium addition to the bath. Thus the fact that 2 or 3 per cent of TiO_2 made quite a noticeable improvement in the fusibility of this slag may be of practical interest and importance, even though the entire slag from a titanium-treated open-hearth heat may never reach this comparatively high TiO_2 content.

The other slag sample available, from Granite City, could not be melted by the coke fire, so that a different method had to be used with it. The only other method which appeared practicable with the heating equipment available involved making briquets or cones of the crushed slag, standing them up on a magnesite brick in a small reverberatory furnace which could be made very hot by two high-pressure oil burners, and noting with the optical pyrometer the different temperatures at which they sagged or bent over when softened by the heat.

A trial of this method having been decided upon, a mold of steel was first made for the briquets, which were to be in the form of a rectangular wedge, with sides 2 in. high and ends in the form of equilateral triangles of ½ in. base. The granular material for the briquets was moistened with a dilute solution of dextrine to act as a binder, and packed in the mold, which was previously lined with paper to prevent sticking. Twenty to fifty thousand pounds pressure was applied to the mold in forming the briquets, but they were not very firm until after drying. This operation was performed over night at about 100 deg. C. and the next morning they were hard enough to stand handling readily.

The first trial of this method showed that it was necessary to grind the slag to at least 100 mesh in order that the briquets should be sufficiently resistant to cracking or spalling in handling and heating and that the dried briquets must be dressed to an exact size and shape to insure proper comparative results in the furnace. These precautions were taken therefore in the experiment with this slag, and two briquets were made without any addition and called No. 1; two others, with 0.33 per cent TiO_2, were called No. 2; two others, with 1.33 per cent, No. 3; and finally two with 4 per cent TiO_2, called No. 4. These were all stood up on a level magnesite brick in the oil-fired furnace, with bricks placed behind to protect them from the direct blast of flame. The temperatures were taken with an optical pyrometer.

The No. 4 briquets began to bend at 1,285 deg. C., and one failed at 1,305, the other at 1,325 deg. C. The No. 3 began to bend at 1,333 deg. C., failing at 1,348 and 1,358 deg. C., respectively. The No. 2 began to bend at 1,360 deg. C. and bent over completely at 1,373 and 1,377 deg. C., respectively. The No. 1 briquets began bending at 1,385 deg. C., and one failed at 1,418 deg. C., while the other remained upright, but was considerably melted down at 1,458 deg. C., when the furnace was shut down. These results, tabulated in Table II, are very regular and satisfactory, checking those obtained on the Wickwire slag except that all the temperatures are much higher, and even the 0.33 per cent addition of TiO_2 was found to increase the fusibility quite decidedly.

TABLE II—TESTS OF BRIQUETTED SLAG FROM NATIONAL ENAMELING & STAMPING CO.

	Beginning of Bend, Deg. C.	Failure, Deg. C.
Plain slag	1,385	1,418 to 1,460
Plain slag with 0.33 per cent TiO_2	1,360	1,373 to 1,377
Plain slag with 1.33 per cent TiO_2	1,333	1,348 to 1,358
Plain slag with 4 per cent TiO_2	1,285	1,305 to 1,325

It is interesting to note that both under the reducing conditions of the graphite crucible and in the oxidizing atmosphere of the oil furnace the TiO_2 had a distinctly fluxing action on the slags, so that the action could scarcely be any different under the intermediate conditions existing in the region between metal and slag in an open-hearth steel ladle. The amount of TiO_2 actually acquired by slags in practice from titanium treatment is of course more or less questionable and variable, but in one series of fourteen soft steel heats of which half were treated, the average TiO_2 content of the final slags from the seven treated heats showed an increase of 0.33 per cent over the average for the seven untreated heats, which is exactly the theoretical increase assumed. However, as explained in a paragraph above, it is really the slag included in the metal which it is desired to make more fusible for the sake of cleanness, and the increase in TiO_2 content in these included particles would undoubtedly be higher than in the whole mass of slag, so that the effect of more than 0.33 per cent of TiO_2 is also of practical importance.

Purification of Cotton Linters for the Manufacture of Guncotton and Various Pyroxylin Products

Production of Cotton Linters—Equipment for the Purification of Linters: Digesters, Wash Tanks, Bleach Tanks, Stuff Chests, Surge Tanks, Caustic Tanks, Bleach House, Dry House—The Purification Process—Purification for Pyroxylin Products

By W. STARK

THIS article is being written with the thought that it will perhaps be interesting and informing to those who were not brought into direct contact with the huge munition plants erected in this country beginning with the war in 1914 and reaching their zenith of expansion in the latter part of 1918. The present article has to do only with the conversion of the crude fiber into pure cellulose, from which it passes through the various stages to guncotton, and thence into finished smokeless power, and is a description of the process as applied in the Du Pont plant at Hopewell, Va., and the U. S. Government explosive plants located at Nitro, W. Va., and Nashville, Tenn.

It will be recalled that the United States at the time of the armistice was producing approximately 3,000,000 lb. of smokeless powder a day, and since the conversion factor from cellulose to smokeless powder is approximately 1.5, this meant that 2,000,000 lb. of cellulose had to be produced to be converted into this quantity of powder.

Raw cotton is probably the purest form of cellulose as it occurs in nature, but owing to the high price of this product and its value for the manufacture of cloth, cotton linters and hull fiber were used in its stead. Aside from this fact, ordinary cotton lint has such a long fiber that it packs in going through the various mechanical and chemical processes, and this fact alone precludes its use as a raw material for this purpose.

Production of Cotton Linters

Cotton linters is the fuzzy fiber adhering to the cotton seed after it has been ginned. It is removed by a process known as delinting. The fiber of linters is usually about $\frac{1}{16}$ in. long and leaves the outer shell of the cotton seed exposed. The outer shell of the seed, however, contains considerable cellulose, and the necessities of the situation were such during the war, owing to the large demands for any form of cellulose, that mills were erected to shave the outer shell of the seed and produce the material known as hull fiber.

The recovery of cellulose from cotton linters on a 10 per cent moisture basis, after going through the purification process, is about 82 per cent, the remaining 18 per cent being removed in the form of oil and impurities; the recovery of cellulose from hull fiber is about 45 to 50 per cent. In actual practice, therefore, these raw materials were mixed in the proportion of 60 per cent linters and 40 per cent hull fiber as they entered the digester.

When it is remembered that the annual production of cotton linters in this country is 1,250,000 bales of 500 lb. each per year, and the production of hull fiber during 1917 was only 500,000 bales of the same weight, it will be seen that, with the large quantities of powder being manufactured at the time of the armistice, it would soon have become necessary to use wood to a large extent for the manufacture of cellulose for this purpose. It is to be assumed that Austria and Germany were almost entirely dependent on wood for their source of raw material in this respect.

Equipment for the Purification of Linters

The purification building in its essential details consists of eight welded steel digesters, 27 ft. long and 9 ft. in diameter and $\frac{1}{8}$ in. thick in the shell. These digesters are designed to stand a pressure of 150 lb. per sq.in., and at the top there is an opening 30 in. in diameter, which is for the purpose of charging. This opening is closed by the digester cover during the digesting and blowing period. At the bottom center of the digester is a 10-in. valve connecting the digester proper with a 10-in. line which extends to the cyclone tank at the top of the building and enters the tank tangentially. These digesters are set on a steel foundation and are covered with asbestos to conserve the heat during the cooking period. It is into this cyclone tank that the whole charge of cotton and caustic solution is blown after digestion has taken place. At the top of the cyclone tank and extending through the top of the building is a 24-in. vent to release the steam that is the motive force used to raise the charge to the tank from the digester, a distance of approximately 125 ft. The charge flows from the tank by gravity and force, through a 30-in. diameter swinging spiral pipe to the wash tanks. Each cyclone tank serves two digesters, as the blowing of the charge takes only about 5 minutes. The spiral pipe can be swung so as to discharge into either of two wash tanks and after each blow this pipe drips into a drip tank which takes care of any caustic which may flow through it for some time after the main charge. This drip tank has a false perforated bottom and empties into the main spent caustic line.

Wash Tanks

The wash tanks, one for each digester, are made of steel and are 10 ft. in diameter by 16 ft. deep and have a false bottom and a three-arm agitator operated by a gear, which in turn is connected to the drive shaft by a clutch. The whole charge of cotton and caustic flows into the wash tank and the spent caustic passes through a pipe at the bottom of the tank into the main spent caustic line and from there to the drain, or, if the plant has a caustic recovery unit, to the spent caustic storage tanks. There is naturally a

valve in the line connecting the wash tank with the main caustic line. The wash tanks are supplied with water jets, both for cold and hot water, which are located at the top of the tank and are so arranged that the spray covers the entire surface of the charge.

Bleach Tanks

The bleach tanks are the same size as the wash tanks and are located directly below them. They are made of cypress and other suitable wood, have individually driven three-arm agitators and are connected with the wash tanks by a 16-in. line and a 16-in. quick opening valve through which the washed cotton drops by gravity. These tanks have a perforated false bottom and a pipe connection to the main drainage line. It is desirable to have a compressed air connection entering the bottom of the bleach tanks below the false bottom so that agitation will be facilitated during the bleaching operation.

Stuff Chests and Surge Tanks

Stuff chests made of wood and the same size as the bleach tanks are located directly below them and on the main floor of the purification building. They are connected with the bleach tanks by a 16-in. line and a corresponding quick opening valve. They have a compressed air connection at the bottom, but no agitators, and at the bottom there is a 6-in. line with a centrifugal pump which lifts the bleached charge to a lead-lined trough, through which the charge flows to the dry house. This trough is set at such a pitch that the charge flows freely through it to the surge tank, which is located on the far side of the dry house from the purification building. As the flow passes through this trough a sufficient amount is taken out at the washer of each drier by automatically operated gates. The charge in the surge tank is agitated constantly and a centrifugal pump circulates the charge from the surge tank to the main trough at a point between the purification house and the dry house. A float in the surge tank operates lights in the purification house, which indicate to the operators when the surge tank is full.

Dissolving Caustic

The strong caustic storage and dissolving tanks, two in number for each building, are on the top floor of each building, are made of steel and have false bottoms, and have a circulating system for the more rapid dissolving of the drum caustic and to secure a homogeneous mixture of the caustic solution. Either solid drum caustic is used or caustic solution made from soda and lime. This is pumped from the caustic plant. At Hopewell both were used, as the caustic plant was not sufficiently large to produce the 200,000 lb. of caustic used daily. After the caustic has been thoroughly dissolved, a sample is taken to be titrated, using a standard acid solution and methyl orange as indicator. From this analysis it is determined how many pounds of strong caustic is necessary to make up the caustic charge to be pumped into the digester.

Preparation of Weak Caustic Solution

Just below each strong caustic tank there is a weigh tank with a capacity of 40,000 lb. of solution. This weigh tank is of course connected with the caustic tank above, and has connections with both the hot and cold water supply. After the caustic charge has been prepared in the weigh tank, where it is thoroughly agitated, it is referred to as "weak caustic" (usually 2 per cent) and is dropped to the weak caustic storage tanks, six in number, located on the main floor of the purification building. These tanks are the same size as the caustic weigh tanks and have steam coils in them so the caustic can be heated to the proper temperature before entering the digester. From these storage tanks the caustic is pumped to the digesters when ready for use.

Bleaching Solution

The bleaching solution is prepared in a separate house, which consists of the requisite number of leaching tanks with agitators and storage tanks. Chlorinated lime is used containing about 33 per cent chlorine and a solution is made containing about 2 per cent chlorine. After the solution has become perfectly clear, it is siphoned off to the storage tanks in the bleach house and is then pumped to the bleach measuring tanks in the purification house. There are two of these tanks to each purification house, set on the floor above the bleach tanks so that the solution can flow by gravity to them. They are equipped with a suitable measuring device so that the requisite amount of solution can be readily drawn into the bleach tanks for each charge.

Drying Equipment

Each purification house has its corresponding dry house. These consist of six Sargent continuous apron driers. The cotton flows from the trough mentioned above through a chute to the washer of the drier, where the rake moves it constantly to the rolls. It is the movement of this rake which automatically operates the gates of the trough through which the cotton flows to the chute. The rolls press the cotton into flakes about the size of one's hand and deposit them on an apron, which in turn drops them into a picker, which breaks the flakes into a fluffy mass. This mass then passes on to the wire apron of the drier proper and slowly moves forward toward the exit, coming out in the form of a solid sheet. The cotton as it enters the drier contains about 80 per cent moisture and emerges at the end of the drier containing about 1 per cent moisture, from which point it is put into metal or fiber cans, weighed and sent over the telpherage line to the nitrating houses. The drier is heated by steam pipes and the temperature is kept at about 125 deg. C.

The Purification Process

The cotton is brought in bales from the crude fiber storage warehouses on an industrial railway and is carried to the charging floor of the purification houses. Here it is weighed, the tare deducted and each bale broken up and dropped into the digester. The tops of the digesters are flush with this floor. The amount of each charge is 5,000 lb. After the cotton is placed the caustic from the weak caustic storage tanks is pumped in and the covers are adjusted. Steam is then turned into the digester and the pressure raised to 65 lb. per sq.in. and the cooking proceeds for about 5 hours, the hot caustic dissolving the oils, fats resins and other impurities contained in the cotton. After digestion is completed, steam pressure is raised to 90 lb. per sq.in., the 10-in. valve at the bottom o

the digester is opened and the whole charge blown to the cyclone tank.

In the wash tanks about three successive washings and drainings are sufficient to dispose of the spent caustic contained in the cotton and the charge is then dropped to the bleach tanks, where sufficient bleach solution is added to turn the cellulose perfectly white. Bleaching proceeds for about 3 hours at a temperature of 30 deg. C., and after about 2 hours a sufficient amount of sulphuric acid is added to the charge to drive off any remaining chlorine. The charge is then dropped to the stuff chests ready to be pumped to the dry house when needed.

It will be understood that from the time each charge of cotton enters the wash tanks until it enters the driers it is suspended in about 5,000 gal. of water. Using a mixture of 60 per cent linters and 40 per cent hull fiber, the original charge of 5,000 lb. gives a recovery of about 3,500 lb. of purified cotton, estimated on the basis of 10 per cent moisture.

At the end of one of the driers in each dry house a fan is located connected with a 10-in. galvanized iron pipe line which leads to a bale house. When the production of cotton is greater in the purification area than the nitrating houses can utilize, the excess is baled and stored. It is then used when the nitrating houses are consuming more than the purification area can produce. This discrepancy in balance is caused by bad charges in the purification houses and an undue number of explosions in the nitrating houses.

The purification of cotton for the manufacture of celluloid, fabrikoid, moving picture films and other pyroxylin products follows this same general principle except that in such cases a superior grade of linters is used, a stronger caustic solution is required, the cooking period is extended and a longer period of bleaching is necessary. Also in the manufacture of these pyroxylin products, extreme care must be taken that no dust or other impurities enter the charge at any stage of the process.

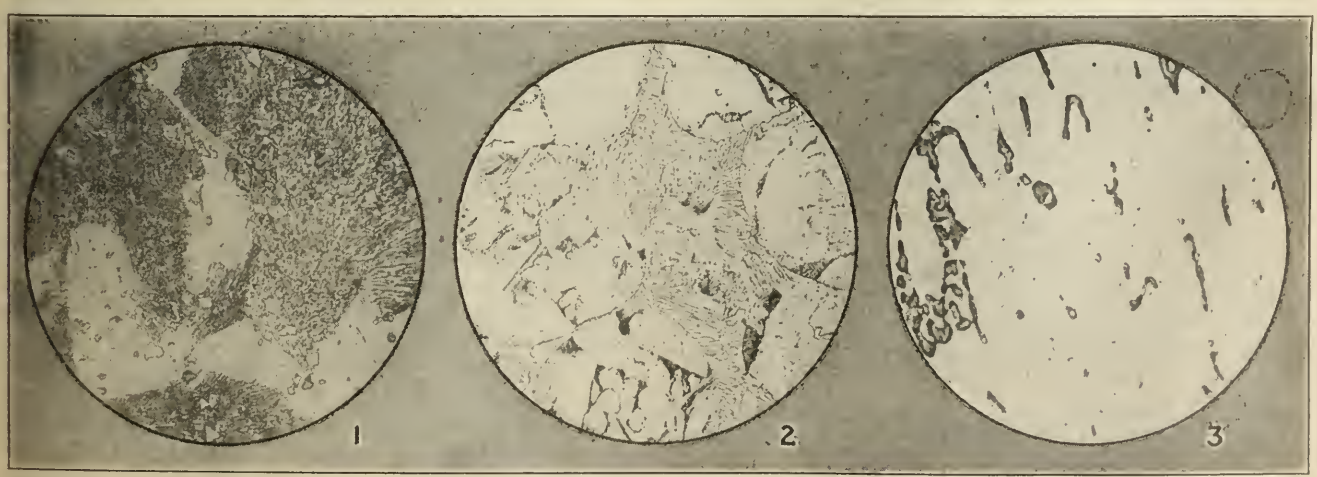
Steels With Zirconium, Cerium or Boron

AN INVESTIGATION to determine the utility of certain rare-metal alloy steels when used for body armor is shortly to be published by the Bureau of Standards. About 193 heats of steel containing in various combinations the following principal variable elements: carbon, silicon, nickel, aluminum, titanium, zirconium, cerium, boron, copper, cobalt, uranium, molybdenum, chromium and tungsten, have been studied.

Zirconium, like titanium and aluminum, acts primarily as a scavanger, and when it is not removed as part of the slag remains in the steel, as shown in Fig. 1, in the form of square bright yellow inclusions not directly visible at magnifications much lower than 500. The Bureau of Standards does not consider that these inclusions can be very beneficial and if they are segregated and rolled out into thin plate-like streaks they may be detrimental, especially in armor plate.

Of the other elements that are regarded as special alloying additions, chromium, tungsten, vanadium and molybdenum go into solution and produce a martensitic pattern in the air-cooled specimens. Cerium and uranium act in a similar manner, but also show characteristic inclusions. Copper goes into solution, but a larger amount is required to produce a martensitic pattern in the air-cooled samples than for the others.

Figs. 2 and 3 show the structure of boron steel (Fig. 2, carbon 0.16, boron 0.49, nickel 2.82; Fig. 3, carbon 0.16, boron 0.39 per cent). When the attempt was made to roll this steel under the same conditions used with satisfactory results for steels of similar composition but containing no boron, the metal crumbled and cracked badly in the rolls. Indeed, some ingots were so brittle that they broke under their own weight when carried from the furnace to the rolls. By heating the ingots for a sufficiently long time until considerable coalescence of the eutectic occurred and by reducing the temperature of the ingot somewhat—that is, below the eutectic temperature—no unusual difficulties on working the metal were encountered. As shown in Fig. 3, hot-working breaks up the eutectic and spherical hard particles, similar to iron carbide globules, are formed.



FIGS. 1 TO 3

Fig. 1—Microstructure of steel to which additions of zirconium have been made. × 425. The small light-colored inclusions, square or triangular in outline, are characteristic of steel to which zirconium has been added. They are of a striking lemon-yellow color. Etching reagent, 2 per cent alcoholic solution of nitric acid.

Fig. 2—Section of an ingot of boron steel which broke in the rolls and could not be worked. The addition of the boron causes the formation of the eutectic shown. Etching reagent, 2 per cent alcoholic solution of nitric acid. × 425.

Fig. 3—Longitudinal section of a rolled plate of boron steel, showing the coalescence of the eutectic which has occurred. Etching reagent, hot alkaline solution of sodium picrate, coloring the carbide a dark brown and sometimes nearly black. × 425.

Colloidal State in Metals and Alloys III—White Metal and Brass

Solid Solutions and Eutectics, Just Before Solidification, Are Adsorption Compounds—Copper in Alpha Brass Aggregates So Rapidly That Zinc Is Only Partly Adsorbed; Hence Cored Structure—Laminated Eutectic Caused by Skeletal Solidification of Predominating Partner*

BY JEROME ALEXANDER
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THE presence in a metal of a second metallic or non-metallic element, whether as an intentional addition or as an accidental impurity, opens a wide range of possibilities, which may be roughly outlined as follows:

1. The second element may form a definite compound with the metal, or it may not.

2. If formed, the chemical compound may be stable at all temperatures or only within a certain temperature range; or there may exist a reversible equilibrium, with a lag on either side of the equilibrium point.

3. The second element or its compound with the metal may be soluble in or miscible with the metal in all proportions; or, as usually the case, there may exist zones of thermal or percentage solubility, dispersion or peptization; or even practical non-miscibility at all temperatures, in which case there usually is a certain degree of segregation.

4. Dissolved or dispersed elements or compounds may materially alter the melting point, viscosity (internal friction), surface tension, vapor pressure, freezing point, conductivity, allotropic equilibrium, and crystallization tendencies of the metal.

The presence of still other additional elements complicates the situation correspondingly; and when to this welter of variable factors we add the further complications of the effects of mechanical treatment and the thermal history of the section of metal under consideration (which involves such factors as speed of chilling, size and shape of the original mass, hot and cold working, tempering), we can well imagine why it is impossible to frame one general law covering the protean behavior of impure metals and alloys. Each case must be individually considered.

The attempt will be made, therefore, to consider some well-known metallurgical phenomena[1] in the light of the colloid-chemical principles above referred to.

TIN-LEAD ALLOYS

Considering first the binary system between tin (melting point, 232 deg. C.) and lead (melting point, 327 deg.) (Fig. 1), it is found that all the alloys melt at a lower temperature than the melting point of lead, which is an instance of the general rule that the freezing point of a solvent is lowered by the presence of a solute. Of all the alloys, that consisting of 63 per cent tin and 37 per cent lead has the lowest melting point, a fact indicated by its Greek-derived name "eutectic." If the metals are mixed in other than eutectic proportion, the excess metal tends to crystallize out alone on cooling, leaving in still fluid condition the maximum possible amount of eutectic, which solidifies later. That the eutectic does not consist of a chemical compound is brought out by the microscope, which reveals its heterogeneity; it is usually laminated and can be brought into relatively coarse dispersion by slow cooling.

But some forces do control the formation of the eutectic, and the mechanism seems to be the following: As the fused alloy approaches solidification, the lead, having the higher melting point, first begins to form molecular groups, crystallogens or tiny crystals. This aggregation of the lead molecules is opposed by the more fluid tin, which accounts for the lowering of the freezing point of the mixture. Diminishing thermal agitation permits the tin to form groups and a stage is reached where both metals exist largely in colloidal state.[2] In this zone a colloidal adsorption compound is formed, the ratio 63 tin to 37 lead being consequent upon their specific forces; and any excess of tin or of lead is free to crystallize independently. In the eutectic, although tin tends to crystallize rapidly, the adsorbed lead interferes with its crystallization to such an extent that, if quickly cooled, its structure is extremely fine.

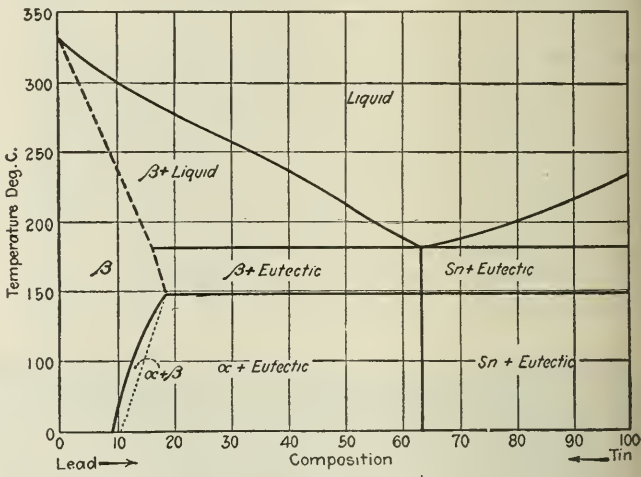

FIG. 1. EQUILIBRIUM DIAGRAM FOR LEAD-TIN ALLOYS. AFTER ROSENHAIN

The present series of papers was written mainly in the fall of 1919. Reduced to about half their original form, they were read before the Columbus meeting of the American Insitute of Mining and Metallurgical Engineers, October, 1920, and will so appear in vol. 64 of its *Proceedings*. They are now given in full, together with some recent additions which are indicated by enclosure within square brackets [].

*Part I, on Molten Metal, appeared in CHEMICAL & METALLURGICAL ENGINEERING, Jan. 11, 1922, p. 54; Part II, on Crystallization, in the issue of Jan. 18, 1922, p. 119.

[1] I have made free use of, and frequently quoted from W. Rosenhain's excellent book, "Introduction to Physical Metallurgy," D. Van Nostrand Co., 1914.

[2] All metals in solidifying pass through an isocollodial zone, the narrowness of which is indicated by the sharp peak or cusp in the inverse-rate curve, see Rosenhain, pp. 85-87, and Part I of the present series of articles, CHEM. & MET. ENG., vol. 26, No. 2, p. 54, Jan. 11, 1922.

As with all colloids, this represents a metastable condition, and if the temperature is kept within limits which permit molecular orientation without disruptive thermal agitation, the eutectic undergoes a gradual synæresis analogous to coagulation or demulsification—a further separation into its constituent phases.[3] The laminated structure, common in eutectics, already represents the coagulation of the pre-existing colloidal dispersion, as will be especially pointed out later in the discussion of pearlite in steel.

Eutectic Structure

Speaking of the tin-lead eutectic, Rosenhain says on p. 133 of his "Introduction to Physical Metallurgy" that "this laminated character, though often beautifully marked, is not to be regarded as an essential feature of these substances. If a specimen of a well-laminated eutectic is heated for a long time at a temperature a few degrees below its melting point, the structure gradually changes, various laminæ coalescing to form lumps or globules, and the result is a much coarser granular structure. Such a granular structure may also be obtained if the molten eutectic is very slowly cooled.

"The eutectic alloy is the result, so far as its structure is concerned, of the simultaneous crystallization or freezing of the two component metals. As a rule one of these metals acts as the 'predominant partner,' and its own crystalline form or habit determines the way in which the whole structure is arranged. It has been shown that eutectic alloys, like pure metals, consist of an aggregate of juxtaposed crystals. These crystals are, however, merely skeletons formed of one of the metals—'the predominant partner'—with the interstices filled in by the other metal. In the case of the lead-tin alloys,

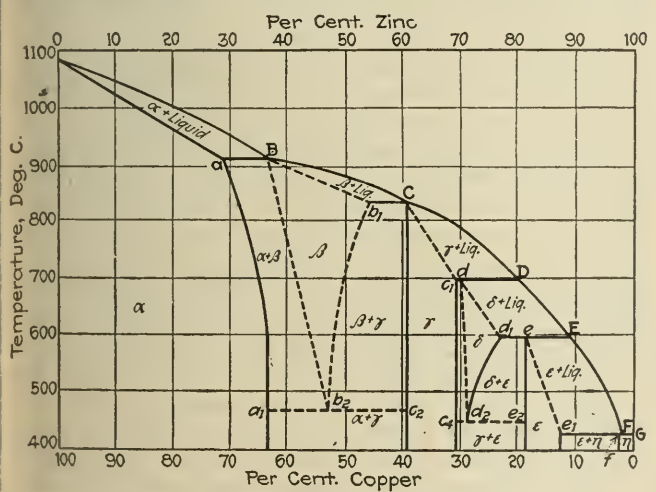

FIG. 2. EQUILIBRIUM DIAGRAM FOR COPPER-ZINC ALLOYS, AFTER GULLIVER

the tin is the predominant metal, and each of the crystals of the eutectic is in reality a radiating structure, known as a 'spherulite,' of tin carrying the lead in its interstices." This is clearly a picture of tin crystallized in the presence of adsorbed lead. Although tin has a lower melting point than lead, its superior crystallization power and speed make it predominant.

Rosenhain also points out[4] that lead-tin alloys containing up to about 16 per cent of tin form a series of solid solutions, which approach their true equilibrium condition very slowly; "it was found that heating at a temperature of 175 deg. for a period of 6 weeks was required in order to bring the alloys approximately into their final state." This is indicative of the slowness with which the tin in these alloys is peptized or dispersed by the lead. Another observation is that the lead-tin alloys "exhibit an evolution of heat on cooling and a corresponding absorption of heat on heating at a temperature which lies, for alloys containing from 16 to 23 per cent of tin, at 149 deg." Rosenhain's explanation is that this is due to the diminution at that temperature of the capacity of lead to dissolve tin. In any event there is some form of non-stochiometric molecular aggregation, accompanied by an evolution of heat, quite analogous to what happens when silver hydrosols coagulate. Thus J. A. Prange found[6] that upon precipitation by ammonium citrate 1 g. of colloidal silver developed from 250.98 to 126.73 calories, depending upon the concentration of the solution; and the further aggregation of the precipitate by H_2SO_4 set free 60 calories more. But here restraining water films were present, and the final product was not yet solid metal.

[The metastability of metals and matter generally has been studied by Prof. Ernst Cohen (Utrecht). At a lecture delivered recently in London[8] he exhibited specimens of explosive antimony, which when scratched, were converted into ordinary antimony with a heat evolution of 20 calories per gram of metal.[7]]

Another point of interest in the lead-tin alloys is found in solder used by plumbers for wiping joints. At about 210 deg., this alloy begins to extrude crystals of lead into the still fluid eutectic cement, rendering it pasty and easy to mold into the desired shape. Here the eutectic acts as a viscous colloid or glue thickened by the addition of clay or other fine insoluble filler.

Bearing Metal and Brass

The introduction of the highly crystalline antimony (melting point 630 deg. C.) into the lead-tin alloys results in the early formation of crystals of antimony or of the hard brittle compound SnSb, with the result that the ternary alloy is much harder. Type-metal, which varies in composition according to price and service conditions, is usually chilled quickly, which is conducive to hardness and fine structure. White bearing metals, on the other hand, are usually cast in larger masses and chill more slowly; and their composition is chosen to yield, under these circumstances, hard wear-resisting crystals of SnSb imbedded in a colloidal plastic eutectic, which can adapt itself to the bearing's irregularities of shape and pressure.

A consideration of the zinc-copper alloys shows how vitally treatment and composition affect the nature and degree of dispersion of their phases. Brasses containing less than 30 per cent of zinc, whether quickly or slowly chilled, always consists of a solid solution of zinc in copper, known as the pure α body;[9] but it does not follow from this that the alloys are necessarily homogeneous in all circumstances. If we recall the process of freezing, as already described for a solid solution, we see that in the case of an alloy containing, say, 20 per cent of zinc, the solid which first separates when the alloy *begins* to freeze will have approximately the composition 13 per cent zinc, 87 per cent copper. If the cooling at this stage is not slow enough to permit

[3] With tin-lead alloys, this occurs at room temperature.

[4] P. 132; also Rosenhain and Tucker, *Phil. Trans. Roy. Soc.*, vol. 209A, p. 89 (1908).

[5] *Recueil des Trav. Chim. des Pays Bas*, vol. 9, pp. 121-133 (1890).

[6] [See *J. Soc. Chem. Ind.*, vol. 40, p. 1922 R.]

[7] [See also E. Cohen and K. Inonze, "Die Metastabilität unser Metalwelt," *Z. phys. Chem.*, vol. 71, p. 301, (1910).]

[8] Rosenhain; p. 142.

the attainment of complete equilibrium, the central portion of each crystal—i.e., the portion first formed—will remain to the end considerably richer in copper than the outer or later-formed crystals. Each crystal of metal of such composition will, in the circumstances, consist of a core which is richer in copper, and an outer portion which is poorer in copper, than the average composition of the alloy. A quickly cooled alloy in the cast condition thus shows an apparent duplex structure (Fig. 3), although consisting only of one phase,[9] for although the layers of solid solution of varying concentration which form these crystals are all of the same α phase, their different concentration renders them susceptible to the attack of etching reagents to different degrees; by most reagents the regions richest in copper are less attacked than those which contain a larger proportion of zinc. Since those portions of the crystals first formed consist of the dendritic branches occurring in the early stages of freezing, the etched pattern of an alloy reveals this dendritic structure, and in some circumstances this may be almost as clearly defined as if the outer regions consisted of a different phase.

"When, however, such an alloy is slowly cooled, or, after rapid initial cooling, is subsequently heated so as to allow the attainment of equilibrium by the slow process of diffusion, the metal becomes entirely homogeneous,[9] the dendritic cores disappear, and we have again the familiar aggregate of homogeneous crystals such as are seen in all pure metals. It should be noted that the mechanical work and subsequent annealing which occur in the working of brass as usually carried out are also sufficient to render the metal homogeneous in this sense,[10] with the result that wrought brasses containing less than 30 per cent of zinc do not as a rule show any trace of dendritic structure; their structure is in fact very similar to that of pure copper when treated in the same way—i.e., it consists of an aggregate of twinned[11] crystals whose size depends upon the manner of heating and working."

FIG. 3. SKELETON CORES IN LARGE α GRAINS OF 93:7 COPPER: TIN ALLOY
Etched with solution of Br in HCl. After Heycock and Neville. × 18.

These facts seem to me to indicate that α brass is really an adsorption compound between copper and zinc, in which the large percentage of copper with the high melting point of 1,083 deg. aggregates so rapidly that even in so-called quickly cooled specimens, the zinc with a melting point of 419 deg. C. is for the most part still so finely dispersed as to be only partly adsorbed by the copper; hence we expect to find a dendritic structure which shows a copper crystallization as modified by adsorbed zinc, the amount of which increases from the center outward as the copper aggregates and the mother liquor becomes richer in zinc. It is probable that small pieces of α brass drastically quenched from fusion in liquid air would appear homogeneous in the microscope. As Rosenhain points out, the percentage of each metal and its state of aggregation are varying momentarily during cooling, and because of the wide disparity between the melting points of the two metals, homogeneity is favored in this case either by extremely rapid quenching from fusion or else by slow cooling or annealing, which favor more complete dispersion and adsorption of the "segregated" zinc.

With brasses containing 30-37 per cent of zinc, there appears a new hard, brittle, metastable phase, β brass. Such brasses if quickly cooled are relatively hard and brittle, but if cooled slowly the β phase disappears. With more than 37 per per cent of zinc, the β phase is stable at all temperatures down to 470 deg., and the slowly cooled alloys possess the duplex structure (Fig. 4), which is well seen in ordinary Muntz metal (40 per cent of zinc). Carpenter holds that below 470 deg. the β phase decomposes into α and γ phases; in fact, that β is an almost ultramicroscopic mixture of α and γ phases.[12]

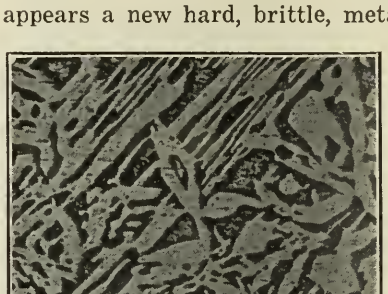

FIG. 4. HOT-ROLLED BRASS. ETCHED WITH DILUTE H_2SO_4 AND POTASSIUM DICHROMATE
A yellow β matrix and reddish α figures. After Rawdon. × 100.

Speaking of the γ phase of brass, Rosenhain (p. 145) says that it "is exceedingly hard and brittle and its presence in the alloys renders them useless for any purpose where strength and toughness are required. This is a typical example of a law very widely applicable to alloy—viz., that those phases of a binary system which contain the two elements in anything like equal proportions are hard and brittle, only the alloys near the ends of a series being as a rule sufficiently strong and ductile to be of practical ultility. We have already seen that the β phase is harder and more brittle than the α, so much so that the best brasses, in which strength and ductility are of importance, are generally made with a zinc content of approximately 30 per cent, this being the cheapest alloy which does not contain the β phase."

Von Weimarn[13] has shown that with solutions, medium concentrations are favorable to the development of relatively large crystals, whereas dilute solutions tend to yield colloidal dispersions; and in mixtures of two metals this seems to hold true also. The amorphous or colloidal phase of most metals is stronger at ordinary temperatures; and highly crystalline metal, deficient in amorphous or colloidal phase, is brittle because it tends to split along the lines of crystal cleavage. We should therefore expect brittleness where the component metals of a binary alloy are in about equal proportions, for this concentration hinders the development of colloidal metal and favors larger and more perfect crystals.

(Part IV, dealing with Iron and Steel, will appear in a subsequent issue.)

[9]The phase rule of Gibbs is postulated on the basis of the homogeneity of the phases involved. Within the colloidal zone, one or more of the phases become heterogeneous, in the sense of the phase rule, which is therefore no longer applicable.

[10]Obviously Rosenhain means homogeneous *to the microscope*, for all alloys are essentially heterogeneous.

[11]Rosenhain, "Introduction to Physical Metallurgy," p. 142.

[12]This means colloidal dispersion, favorable to hardness.

[13]*Koll. Zeit.*, vol. 3, p. 282 (1908); vol. 4, p. 27 (1909).

Low-Temperature Distillation of Amalgams of Non-Coking Coal and Asphaltic Oils*

By Joseph D. Davis† and C. E. Coleman‡

DURING some distillation experiments conducted by the Bureau of Mines in co-operation with the Trent Process Corporation[1] it was observed that amalgams[2] of heavy petroleum oils and finely pulverized coal tended to produce a denser coke than that obtainable from the coal when retorted alone. Even anthracite when retorted with oil yielded a coke. This led the writers to believe that by mixing a low rank coal—subbituminous or even lignite—with asphaltic oil, and retorting it, a coke suitable for domestic fuel could be made. Thus was contemplated production of domestic coke and utilization of a low-grade oil in one operation.

In order to decide on the practicability of this process it was necessary to know the value of products obtainable by such a method, as compared with those obtained by separate distillation. A laboratory method was therefore devised, and while it was realized that no small-scale testing apparatus for destructive distillation gives results that are directly applicable to commercial-scale operations, by keeping distillation conditions uniform for comparative tests, results were obtained valuable for purposes of comparison. The plan was to distill mixtures of coal and oil in a laboratory retort, and then distill the constituents separately under the same conditions. The comparative quantities of products yielded were thus directly obtained, and their quality was determined by analysis. The following are the main points investigated:

(1) Quantity and quality of coke; (2) quantity of oils boiling below 221 deg. C. (gasoline stock) and of oils boiling at 221 to 300 deg. C. (kerosene stock); and (3) quantity and quality of gases.

The apparatus used in these experiments has been described in a previous article. (Chemical & Metallurgical Engineering, vol. 25, p. 1132, Dec. 21, 1921.)

Materials Used

The coal used was a mixture of equal parts of Utah Standard lump and Utah King lump, both being non-coking coals. They were pulverized to 200 mesh, and a sample of the mixed product gave the following analysis:

	As Received Basis, Per Cent	Dry Basis, Per Cent
Moisture	3.43	.....
Volatile matter	44.92	46.52
Fixed carbon	45.62	47.24
Ash	6.03	6.24
	100.00	100.00

The oil used was Casmalia crude obtained from Santa Maria, Cal. It contained approximately 9 per cent water, and when dehydrated showed a specific gravity of 1.001 at 15 deg. C. It was a very viscous asphaltic base oil, and left a residue of approximately 15 per cent on distillation to dryness.

About 12 liters of hot water was added to 12 kg. of coal in a 20-gal. stoneware churn. After churning the mixture for 10 minutes, whereby the coal was thoroughly wetted, 5.1 kg. of oil was added. The mixture was now churned until the coal and oil agglomerated into little balls the size of a pea. The water was drained from the resulting amalgam, which was squeezed to remove inclosed water and allowed to air dry for several days before retorting.

TABLE I—YIELD OF DISTILLATION PRODUCTS

Yield Expressed as per Cent of Charge

Charge	Amalgam	Oil	Coal
Max. dis. temp., deg. C.	600	600	600
Water, per cent	14.0	7.0	10.6
Tar:			
Per cent	14.2	69.3	11.5
Sp. gr.	1.038	0.928	1.015
Gas:			
Per cent	17.0	4.5	10.1
Sp. gr.	0.5561	0.6185	0.5816
B.t.u.	820	966	726
Light oil from gas, per cent	8.1	4.0	3.2
Residue, per cent	40.1	15.2	60.3
Distillation loss, per cent	6.6	0.0	4.3

Yields per Ton of Amalgam

	Amalgam	Oil (670 lb.)	Coal (1,110 lb.)	Sum of Oil and Coal When Distilled Separately
Tar, gal.	32.8	60.9	15.2	76.1
Oils boiling 0 to 221 deg. C., gal.	9.9	9.0	4.1	13.1
Oils, boiling 221 to 300 deg. C., gal.	8.1	17.3	4.1	21.4
Gas, cu. ft.	7,450	668	2,500	3,168
Coke, lb.	802	103	660	763
Heating value of gas:				
B.t.u. per cu. ft.	820	966	726	777
B.t.u. per ton	6,109,000	645,288	1,815,000	2,460,288

Duplicate distillation runs were made with charges of oil, coal, and a mixture of the two. The charges, approximately 5 kg. in each case, were placed in the cold retort, and gradually heated to a temperature of 600 deg. C. The heating current was then regulated so as to maintain the temperature constant at this point until gas ceased to be evolved, when the test was considered finished. Coal and amalgam were charged directly into the retort, but it was necessary to use a welded sheet-iron container for the oil to prevent it from seeping through the clay baffle into the cold retort bottom and outside the constant temperature zone.

At the end of each test the coke was carefully removed from the retort and weighed, likewise the tars. In order to get the total tar yield, it was found necessary to weigh all parts of the condensing apparatus before and after each experiment.

Table I gives the average yields of distillation products in percentage of material charged, and also in quantities obtained per ton of amalgam. The yields for oil and coal were calculated from the separate distillation tests for quantities sufficient to make 1 ton of amalgam. The sums of yields for oil and coal are therefore comparable with those obtained for the amalgam.

The tar oils were first dehydrated in a 600-c.c. Barrett copper retort, which was heated over night in a Freas electric oven at 105 deg. C., the water and light oils distilling over being caught in a graduated separatory funnel. The water thus collected was measured and drawn off from the supernatant oils, which were returned to the retort. The dry tar was now fractionated from the copper retort, which was heated over a ring gas-burner so that the distillate collected at the rate of two drops per second. The amount of liquid collecting for each 25-deg. interval was noted and the results are given in Table II, together with fractions collected below 221 deg. C. and from 221 to 300 deg. C. These last-mentioned fractions were taken to represent gasoline stock and kerosene stock respectively.

Light oils absorbed in the charcoal scrubber were

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[1]Previous papers on the Trent Process will be found in Chem. & Met. Eng., vol. 25, Aug. 3, 1921, p. 182; Dec. 21, 1921, p. 1131.

[2]The term "amalgam" is used in its broadest sense to designate an intimate mixture of materials; in this case, approximately 70 parts finely pulverized coal and 30 parts oil.

TABLE II—TAR FRACTIONATION ANALYSIS

(Per Cent by Volume)

	First Drop, Deg. C.,	0–150 per Cent	150–200 per Cent	200–225 per Cent	225–250 per Cent	250–275 per Cent	275–300 per Cent	0–221 per Cent	221–300 per Cent	Residue per Cent	Water per Cent	Remarks
Amalgam No. 1	125	2.3	6.7	5.0	8.4	12.6	13.8	12.2	35.6	52.2	50.0	240 c.c. sample—245.0
Amalgam No. 2	135	...	4.6	5.8	9.2	10.4	14.6	....	....	....	....	240 c.c. sample—247.0
Average		2.3	5.6	5.4	8.8	11.5	14.2					
Oil No. 1	90	3.2	6.8	4.8	7.2	6.4	16.4	14.8	28.4	56.8	9.3	250 c.c. sample—235.5
Oil No. 2	80	4.4	8.0	4.0	6.4	7.6	11.2	....	....	....	....	250 c.c. sample—236.5
Average		3.8	7.4	4.4	6.8	7.0	13.8					
Coal No. 1	95	2.0	9.3	7.7	8.3	8.0	10.3	18.0	27.0	55.0	52.5	300 c.c. sample—297.0
Coal No. 2	110	2.8	8.4	8.4	7.6	9.6	8.0	....	....	....	....	250 c.c. sample—249.5
Average		2.4	8.8	8.0	7.9	8.8	9.1					

removed by distillation of the charcoal with superheated steam in a retort heated to 400 deg. C. The oils recovered in this manner from the amalgams and coals were analyzed by fractionation (see Table III), but those from the oil distillation were too small in amount for analysis.

TABLE III—FRACTIONATION OF OIL SCRUBBED FROM GAS

	Amalgam	Coal
Sp. gr.	0.833	....
First drop, deg. C.	55	85
From 0 to 75 deg. C., per cent	6.5	....
From 75 to 100 deg. C., per cent	42.0	22.6
From 100 to 125 deg. C., per cent	23.4	32.7
From 125 to 150 deg. C., per cent	10.3	26.6
From 150 to 175 deg. C., per cent	5.8	....
Residue, per cent	7.0	18.1

A number of gas samples were taken at corresponding intervals during each test run and analyzed in the Bureau of Mines gas laboratory. These analyses were averaged, and results are given in Table IV, together

TABLE IV—AVERAGE ANALYSIS OF GASES

	Amalgam	Coal	Oil
Carbon dioxide	5.1	8.0	7.3
Unsaturated hydrocarbons	8.0	4.0	5.0
Oxygen	0.5	0.2	0.2
Hydrogen	30.2	28.1	20.6
Carbon monoxide	6.1	9.2	0.8
Methane	46.6	45.6	51.1
Ethane	2.9	4.6	15.0
Nitrogen	0.6	0.3	0.0
Calculated heating value, B.t.u. per cu.ft.	820	726	966

with heating values calculated from the analysis in each case.

Discussion of Results

The results just described show that the amalgam yields more than twice as much gas as its constituents distilled separately, and less than half as much tar oil. The amalgam gas is richer than the combined gases from coal and oil by 43 B.t.u. per cu.ft., so that the total heating value in the gas from 1 ton of amalgam is 2.5 times that in the combined gases from the coal and oil. There was obtained from the amalgam 18 per cent more solid residue than from its constituents, and, while it was not as dense and firm as byproduct coke, it was far superior to the residue obtained from the coal. The latter was only loosely caked together, and could be easily crushed in the hand. The light oil scrubbed from the amalgam gas amounted to 4.4 gal. per ton of charge, and that from the constituents was 0.9 gal. per ton of charge. The oil from the amalgam gas was lighter than that from the coal gas; 42 per cent of the former boiled under 100 deg. C., compared with 22.6 per cent for the latter. There was not sufficient oil obtained from the gas of the oil distillations for analysis.

The main effect of mixing oil and coal previous to distillation under the conditions prevailing for these tests is to increase greatly the gas yield at the expense of the tar. The increase in gas doubtless comes from the oil. At least a part of the oil in an amalgam must be regarded as adsorbed oil, and under those conditions it would have an abnormally low vapor pressure, which would tend to hold it in contact with the coal at temperatures far above its normal boiling point. This would promote cracking or breaking up into simpler hydrocarbons. In this case, very light liquids and gaseous hydrocarbons were produced.

It is conceivable that the severity of the cracking reactions could be modified by distillation under reduced pressure, so that a high yield of light liquids at the expense of the gas might be obtained. Reduced pressure would certainly increase the yield of liquid products from that part of the oil not adsorbed by the coal.

Conclusions

Amalgams of a bituminous non-coking coal and a heavy asphaltic oil were distilled to a temperature of 600 deg. C., and the products were collected and examined. The method consisted of charging the material into a cold retort, slowly heating to 600 deg. C., and holding the temperature at this point until gas ceased to be evolved. Following distillation of amalgams, samples of the coal and oil used were distilled separately under the same conditions as those prevailing for the amalgam, the products in each case being collected and examined as before. On comparing the distillation products from the amalgam with the combined products for equivalent quantities of coal and oil distilled separately, the following conclusions were reached: Under the distillation conditions prevailing—

(1) The amalgam yields only about half as much tar oils as its constituents.

(2) A lower yield of gasoline and kerosene stock is obtained for the amalgam—9.9 and 8.1 gal. respectively per ton, as compared with 13.1 gal. and 21.4 gal. from the coal and oil.

(3) The residues obtained from the oil and coal were not coked; whereas that obtained from the amalgam was a coke of fair quality. The residue from the amalgam was 18 per cent greater than the combined residue from coal and oil.

(4) The amalgam yields over twice as much gas as the coal and oil distilled separately and its heating value is 5 per cent higher. The total heating value of gases from one ton of amalgam was 6,109,000 B.t.u. against 2,460,288 B.t.u. for the combined gases from coal and oil.

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Potash Salts of Western Texas

By George Steiger

THE possibility that a workable deposit of potash exists in western Texas is shown by the co-operative work of the United States Geological Survey and the Bureau of Economic Geology and Technology of the University of Texas. Samples of salts brought to the surface by the bailer, during the routine drilling of wells being bored for oil in this region, have been analyzed and if truly representative of beds of any considerable extent and thickness they contain sufficient potash to be of industrial value. Careful consideration, however, must be given the specimens, as these samples were from wells being drilled for oil and not potash, and while not intended to be in any way pessimistic, the object of the first part of this paper is to describe conditions under which samples were collected and to point out some of the pitfalls in the path of those drawing too hasty conclusions from the samples already analyzed.

Conditions of Sampling Not Recorded

Oil being the objective and not the soluble salts, no record was kept, so far as known in the Geological Survey, of the quantity of water in the wells or the length of time it may have been in contact with the salts. Neither are any data available concerning casing used, consequently no conclusions could be drawn regarding the possible contamination due to material falling in from higher levels, and only a vague guess could be made as to what extent the potash content of the samples assayed may have been changed by the action of water. Also it is not known whether the entire amount of material supposed to have come from the section in question had been carefully sampled or a grab-sample taken from a single bailerful.

Concentration by Loss of More Soluble Salts

The samples as received were in fragments approximating in size cracked corn. Had water played the part of dissolving the more soluble salts, the remaining fragments would be expected to show certain characteristics. Fragments of salt only partly dissolved would probably be found with rounded edges. On the other hand, sharp edges on angular fragments might be accounted for by assuming the presence of water in volume sufficiently large to dissolve quickly all salts, including polyhalite, shortly after being torn loose by the drill.

Under the latter condition a sample would represent material through which the drill had passed immediately before bailing. Many of the samples examined contained well-rounded grains of sodium chloride, and, as might be expected, the angular structure of the fragments of polyhalite and anhydrite had been more perfectly preserved.

Potash Present Largely as Polyhalite

A number of samples chemically tested showed in every case the potash to be present entirely in the form of polyhalite, and a visual inspection of many more showed this mineral invariably present in the richer salts. With our present knowledge it cannot be positively stated that polyhalite is the only form in which potash is present in these salts, but it certainly occurs largely as this mineral.

Polyhalite, when treated with a quantity of water insufficient to dissolve all the calium sulphate, leaves a deposit of easily recognizable gypsum.[1] Small quantities of gypsum were found in some of the samples, but the majority of them contained the calcium sulphate in the form of anhydrite.

If these salts had been exposed to the action of water with violent agitation, polyhalite, being rather less soluble than the other commonly occurring salts, could easily have been concentrated. On the other hand, had potash been present in one of its more soluble salts such as sylvite, it would have been dissolved along with the sodium chloride and thus compensate or possibly overbalance the concentration due to polyhalite.

Intensive Study Required

So many unknown factors must be taken into consideration that it is extremely doubtful just what the samples available at the present time represent. It might be that the drill has passed through one or more beds several feet in thickness of potash-rich salts; again, none of them may be more than a few inches in thickness. One thing we do know is that polyhalite has been laid down in the massive form and practically pure, and it seems reasonable to assume that somewhere in the vast salt deposits of this region beds sufficiently thick to be worked economically will be found. In order to locate such beds, if they do exist, core drilling must be resorted to. Meanwhile parties drilling for oil are showing more interest in the possible potash value of their wells and some of the samples recently submitted for assay are accompanied by more carefully taken data. An intensive study made at the wells now drilling will be rewarded certainly with a better knowledge of the extent and thickness of the potash-rich beds and possibly with data upon which industrial development can be based.

Polyhalite, as it occurs in these salts, is light red to gray in color, compact with a fairly granular structure, and practically without taste. It so closely resembles in its properties the anhydrite, which is abundant, that it is not possible to distinguish between the two minerals without resorting to chemical or optical tests.

Factors Influencing Interpretation of Analytical Results

In the analysis of these salts, a point which deserves special attention is the necessity for stating the ratio of salt to the water used for solution. In the method used by the Geological Survey, 5 g. of the salts is boiled with slightly less than 500 c.c. of water, the solution cooled and made up to 500 c.c. The ratio of 1 : 100 was arbitrarily taken. If these salts become of industrial importance it may be advisable to adopt a ratio in their analysis more nearly agreeing with that used in their commercial extraction. The necessity of stating the quantity of water used in dissolving these salts for analysis is clearly brought out when the analysis of pure polyhalite is considered. One gram of polyhalite contains 0.452 g. $CaSO_4$, 0.199 g. $MgSO_4$, 0.289 g. K_2SO_4 and 0.060 g. of water. While the presence of other salts will slightly change the figures, 100 c.c. of pure water is capable of dissolving at 25 deg C. 0.208 g. of $CaSO_4$.

[1] A notation made by R. C. Wells in the course of routine assays.

This dissolved $CaSO_4$ added to the easily soluble $MgSO_4$ and K_2SO_4 in 1 g. of the mineral will total 0.696 g. or 69.6 per cent of soluble salts. By calculation we find that the 15.6 per cent of K_2O in polyhalite becomes 22.4 per cent of K_2O in the soluble salts. This figure will vary accordingly if a larger or smaller amount of water is used.

An actual analysis made by R. K. Bailey of pure polyhalite separated from salts that were taken from the McDowell well gave the following results: soluble salts 69.9 per cent, K_2O 15.10 per cent, which is equivalent to 21.7 per cent of K_2O in the soluble salts. These figures agree with theory within the limits or error in manipulation.

Analyses of some of the richest salts are given in Table I, the location of the wells being as follows: Bryant well, 9 miles south of Midland, Tex.; Burns well of the La Mesa Oil and Gas Co., 16 miles east of La Mesa, Tex.; Pitts Oil Co.'s well, 8 miles east of Barstow, Tex.; Means well, Loving County, Tex.

TABLE 1—ANALYSES OF SOME OF THE RICHEST SALTS

Depth, Ft.	Soluble Salts, per Cent	K_2O in Sample, per Cent	K_2O in Sol. Salts, per Cent	MgO in Sample, per Cent
Bryant well:				
2,405-2,425	....	....	8.94	....
Burns well:				
1,864-1,865	....	10.82	....	....
Means well:				
935-940	18.7	2.6	13.7	....
990-995	69.6	11.2	16.1	....
995-1,000	21.7	3.4	15.5*	....
1,005-1,010	76.4	4.0	5.3†	....
1,235-1,240	85.7	6.4	7.5†	....
1,245-1,250	94.5	4.0	4.1*	....
1,505-1,510	51.1	3.3	6.5	....
1,580-1,585	92.4	2.4	2.6	....
1,625-1,630	90.6	4.5	5.0	....
1,630-1,635	88.4	4.2	4.8	....
1,690-1,695	90.9	2.4	2.6	....
1,695-1,700	99.9	3.1	3.1*	....
1,740-1,745	76.4	9.0	11.8	....
1,745-1,750	84.0	7.9	9.4	....
1,780-1,785	93.7	2.5	2.7	....
1,820-1,825	57.4	8.2	14.3	....
1,825-1,830	63.7	8.7	13.7	....
1,855-1,860	70.6	5.5	8.0*	....
2,000-2,005	27.3	4.3	15.8	....
2,005-2,010	27.0	3.4	12.6	....
2,335-2,340	92.5	3.1	3.3	....
Pitts well:				
1,600-1,610	62.74	9.03	14.40	4.12
1,610-1,614	66.54	5.60	8.42	2.58
1,645	40.32	4.23	10.50	1.94
1,695-1,700	55.42	6.29	11.35	3.02
1,700-1,704	43.46	2.49	5.74	1.30
1,875	53.60	5.65	10.54	2.72

*R. C. Wells, analyst. †George Steiger, analyst. Remainder, R. K. Bailey, analyst.

MgO found in the six samples from the Pitts well is lightly more than the polyhalite ratio would require to combine for combination with K_2O found in the respective samples.

Selected Sample Checks With Polyhalite

One sample of rather roughly separated red salt from the Pitts well gave on analysis 13.74 per cent K_2O, while a specimen in a single lump weighing 75 g. contained 11.50 per cent of K_2O. A small sample very carefully separated from salts taken from the Bryant well had the following composition:

	75 g. Lump	Theoretical, Polyhalite
CaO	18.14	18.6
MgO	7.05	6.6
K_2O	15.63	15.6
Na_2O	2.06	...
H_2O	6.13	6.0
R_2O_3	0.35	...
Insoluble	0.22	...
SO_3	Not det.	53.2

Sufficient material was not available for the determination of SO_3. For comparison the composition of pure polyhalite is given in column 2.

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Export Trade of Switzerland

An interesting summary of Switzerland's foreign trade is given in a recent issue of the *Swiss Exporter.* Up to 1919, Germany was the principal purchaser of Swiss goods, but at that time the various import restrictions of 1920, together with the depreciation of currency rates, relegated her to the fourth rank of markets for Swiss goods. England, which had been third in the list of consumers of Swiss goods up to 1920, now took first place. The increasing difficulties of exporting goods to countries with low rates of exchange makes the exportation of Swiss goods to Great Britain, the Dominions and Colonies an important factor. The total exports to the British Empire amounted in 1920 to 914,000,000 fr., or almost 28 per cent of the total Swiss export trade. This is nearly triple the figure for 1913, while the exports of the British Empire to Switzerland increased more than 3¼ times.

The second place among customers of Swiss industries has been occupied by France since 1915, that country taking one-sixth of the total of Swiss exports. The value of machinery exported to France in 1920 reached the sum of 104,500,000 fr. or 35 per cent of the total exports of Swiss machinery.

The goods imported by Switzerland from the United States in 1920 totaled 865,000,000 fr., as compared with exports to this country of one-third that figure.

The exports of coal-tar dyes and synthetic indigo from Switzerland have increased sevenfold since 1913 and total 211,000,000 fr. for 1920. The principal markets during this year were Great Britain with 62,750,000 fr., France 49,200,000 fr., U. S. 16,000,000 fr., Belgium 15,500,000 fr., Italy 10,700,000 fr., South America 8,000,000 fr., and Japan and China 6,500,000 fr. The Swiss coal-tar dye industry goes back to the year 1856 and has its headquarters at Basel. Another important branch of the Swiss chemical industry is that of pharmaceutical products, which is also centered at Basel. The export returns of pharmaceutical products for Switzerland in 1920 totaled 32,000,000 fr., of which 19,000,000 fr. was for vegetable extracts, powders, pastilles, etc., 11,700,000 fr. for alkaloids and 11,100,000 for other remedies, mainly synthetic.

Of recent years there has been great progress in the exports of saccharine from Switzerland and of perfumery, mostly in concentrated form. Recently the manufacture of photochemical preparations has been taken up with considerable success.

Russian Soviet Organizes Production and Sales of Platinum

Commerce Reports of Dec. 26, 1921, reports the organization of a state-controlled "platinum trust" by the the Soviet Government which will have charge of all the platinum prospecting and mining business in Siberia, as well as the platinum smelting and refining works near Petrograd, Moscow and Ekaterinburg. This trust will act as the central sales agency for both foreign and domestic trade, and will thus be in a position to regulate the prices of platinum in the international market.

The total production for 1921 up to August was about 6,000 troy ounces. The annual average production for 5 years prior to 1914 was 172,000 troy ounces. After the beginning of the World War the output of Russia's platinum mines showed a steady decline, production coming to a complete standstill about the middle of 1918.

Fullers Earth Deposit at Olmstead, Ill.

By Cullen W. Parmelee
Professor of Ceramic Engineering, University of Illinois

THE purchase by the Standard Oil Company of Indiana of a considerable tract of land at Caledonia, near Olmstead, Ill., during the past summer has directed attention to the large deposit of fullers earth there.

The discovery of this deposit dates back to about 1912, when H. J. Gardner, then connected with the Kentucky Geological Survey, visited the bluffs on the Illinois side of the Ohio River during the course of his professional studies. Prior to that time Mr. Gardner had met C. C. Ruprecht, who had had considerable experience with fullers earth generally and the Florida deposits in particular. As a sequel of that chance meeting Mr. Gardner's interest in fullers earth had been aroused and noting the peculiar character of the deposit outcropping in the river bluffs, he sent samples to Mr. Ruprecht. Thus, by a fortunate chance, the material was brought to the attention of an expert well qualified to recognize its value and well equipped to devise means for the proper development of the deposit.

Since the raw material proved to be dissimilar to the Florida earth and to have a rather low efficiency, Mr. Ruprecht spent considerable time in devising a suitable process for its improvement. His efforts were finally crowned with success and he and his associates obtained options on the land. In order to demonstrate the value of the earth, the Illinois Fuller Earth Co. was organized, a mill was erected and the prepared earth was marketed.

The mill has been in successful operation for more than a year, and during most of that time it has been running steadily day and night. The Sinclair Refining Co. of Chicago has now taken over the mill and 55 acres of land. In August the Standard Oil Company of Indiana purchased, according to press reports, 155 acres of land, for which $23,512.50 was paid, and Mr. Ruprecht and his associates received $100,000 for their patents and rights to processes for the treatment of the earth.

Fullers earth is a variety of clay which has the peculiar property of possessing high absorbent power due to its high colloid content. Formerly it was imported chiefly from England, but a few years ago deposits of suitable material were found in Florida and adjacent parts of Georgia. Since then deposits have been located in other states, so that in 1920 the following were reported by the U. S. Geological Survey in the order of their rank as the producing states: Florida, Georgia, Texas, Alabama, Nevada, Arkansas, California and Massachusetts. The total quantity of material produced in 1920 was 128,487 tons, valued at $2,506,189. During the same period 19,235 tons valued at $221,893 was imported.

FIG. 1—FULLERS EARTH DEPOSIT AT OLMSTEAD, ILL.

Working the Deposit at Olmstead

The most important use of fullers earth is in the bleaching of mineral, animal and vegetable oils. Other applications are the removal of grease from cloth and in the preparation of soap.

The deposit at Caledonia Landing, as the riverfront at Olmstead is called, belongs to the Midway Formation of the Tertiary System. As already stated, it appears as a bluff about 112 ft. high extending along the shore of the river for about 2 miles. The pit of the Sinclair Refining Co. is situated about 500 ft. back from the river.

The earth is being dug in an open pit (Fig. 1), which covers an area of about 2 acres. The overburden of 10 ft. of sand and loam is loosened by shooting and then removed in wheelbarrows. Below this there is a working face of 34 ft. which is the best quality fullers earth. The earth presents a distinctly jointed structure and is readily dislodged by prying with bars and shooting. Below this face there is 30 ft. of an inferior grade of earth which has only about 80 per cent of the efficiency of the upper portion. The earth thus loosened is loaded into small cars, which are hoisted by cable on an inclined track and dumped into a receiving bin at the factory.

Preparing the Fullers Earth for Market

As the raw material comes out of the pit it is in the form of large lumps of a dark brown color having a fair degree of hardness. These are reduced to cubes of 1 in. size by crushing with differential rolls having breaker bars on one roll. These small lumps are fed into a rotary oil-burning direct-flame drier 20 ft. long and 3 ft. in diameter. The maximum temperature reached in this drier is 900 deg. F. The earth passes through this drier in 12 minutes, and during its travel the water content is decreased to 3 to 5 per cent. This is accompanied by a brisk reduction in the size of the lumps due to the popping caused by the rapid removal of the water content. Further crushing is done in a "hummer" mill, where the grain is reduced to pass 10 mesh. The pulverized material is elevated and passed over inclined screens which are electrically vibrated. Three grades are separated: The 16-30 mesh, for the bleaching and filtration of mineral oil; the 30-60 mesh, for the same purpose; the 60-300 mesh, for filtering lard, vegetable oils, soap stock, etc.

The screened dry material is sacked and is then ready for shipment. It is very hygroscopic and takes up about 12 per cent of water during storage and shipping.

The plant has a capacity of about 350 tons per month.

It is reported that the Standard Oil Co. is to erect a plant of about the same capacity as the one described and that another oil company is interested.

Mr. Ruprecht estimates the total amount of fullers earth available as 4,000,000 tons.

The central location of this deposit with reference to the mineral and vegetable oil refineries, its easy accessibility by water and rail and the great quantity of the raw material will make Illinois one of the important producers.

Stability of Conducting Electric Furnace Hearths

By Frank Hodson

THE increasing interest that is now being shown in the use of electric furnaces for melting up iron borings and cheap scrap and also in the use of large-capacity electric furnaces for refining hot metal again brings to the fore the advisability of intending furnace users considering the many advantages of furnaces having a properly designed and proved bottom connection.

In the Greaves-Etchells furnace, as will be seen from the illustration, two phases of the three-phase power are taken through top electrodes and the third phase is connected directly to a copper plate lying underneath the lining, giving a definite source of power under the charge. No studs project into the lining and after putting a few inches of special carbon compound over the copper plate, the whole lining is rammed in of standard basic material—dolomite or magnesite, or mixtures of the two mixed with sufficient tar to bind. The lining is purposely made thick and highly resistive at the upper part where it is in contact with the charge. It is here the heat is generated by resistance, not in the copper plate, which always is cool enough to touch. In drying out the lining, the tar, before being burned out, helps to carry

GREAVES-ETCHELLS FURNACE
Dotted lines indicate tilting position

the current through and, once current has been put through, will continue to carry current. If the lining is kept reasonably free from slag or silicon from the roof, the furnaces will start up cold with the bottom functioning normally. In any case, even with a cold furnace, only a very few minutes suffice to get bottom connection. When it is obtained, the advantages are very pronounced. In addition to the top arcs considerable heat is generated in the charge by its resistance to the flow of current—more heat is generated by the resistance of the surface of the hearth and this is immediately absorbed by the charge in contact with the lining.

The charge comes down very evenly without the mechanical stirring or danger of burning the bottom, as when the electrodes of a top-connected furnace bore through the scrap. When molten, the heat generated under the charge keeps it moving slowly upward. This slow circulation from the bottom can be seen and has many times been proved. Temperature of metal at different depths in the bath, analysis of alloy steels at different depths, all prove that slow circulation does exist. In the refining of either iron or steel, this circulation not only carries away and usefully absorbs the intense top heat of the arcs, but also brings all parts of the bath into contact with the refining slags. Sulphur or phosphorus refining and deoxidizing are therefore very rapid and thorough.

The linings are usually constructed with a depth of solid basic refractory from 20 to 30 in., depending on the size of the furnace. As the heat generated at the top of the furnace lining is always absorbed as rapidly as made by the charge, there is no danger of weakening it. The metal comes out clean—a skull on the furnace hearth is practically unknown—no segregation of alloys on the bottom and no thickening up.

Over seventy furnaces with this resistive durable hearth are now in successful operation. A Greaves-Etchells furnace installed in June, 1917, has worked continuously with the production of thousands of casts and is still in operation on the original hearth. In one of the large works here the practice is followed of chipping out about 4 or 5 in. of the top surface of the hearths once a month and re-ramming new material in. This is done more as a metallurgical precaution to insure clean steel, but the real linings of these furnaces have not been changed for years. There is no doubt that a hearth of this type, having very distinct metallurgical and electrical advantages, when intelligently installed and maintained is practically permanent.

Dry-Cell Standards Proposed

FEWER sizes and revised specifications for dry cells will result, it is expected, from the recommendations of the Bureau of Standards on dry cells and dry-cell batteries. These recommendations are those drafted by the conference held at the bureau early in December, when representatives of manufacturers, commercial users and government department users met to plan for simplification and increased efficiency in this industry.

Sizes of Dry Cells

The conference considered first the different sizes of dry cells which are now being made. These included seventeen different sizes. As a result of the discussion, six sizes were adopted as standard, one additional size being included provisionally. The members requested the Bureau of Standards to take up the question of tolerances in the dimensions for these cells, and the bureau, therefore, in submitting this report calls attention to the fact that the exact dimensions of the cells and batteries as given in the following tables are subject to revision. The bureau invites criticisms of the dimensions and asks that the manufacturers furnish data for fixing the tolerances. The sizes of dry cells adopted as standard by the conference are shown in Table I.

Several other sizes of cell were considered to be of some importance, but not sufficiently so to be included in the standard list. These are the No. 8 cell 3½ x 8 in. for

TABLE I—SIZES OF DRY CELLS

Designation	Diameter of Zinc Can, Inches	Height of Zinc Can, Inches	Height Over All, Inches	Diameter Over Carton, Inches
No. 6	2½	6	6½	2⅝
No. 4	1½	4	4⅜	1⅝
Flashlight	⅝	1⅞	2	..
Flashlight*	¾	2¼	2¼	..
Flashlight	1 5/16	1 13/16	1⅞	..
Flashlight	1¼	2½	2⅝	..
Flashlight	1¼	2⅞	3	..

*Provisionally adopted; the use for this cell is decreasing and it probab'y will not be continued long as a standard size of cell; used in third battery of Table II.

export; a flashlight cell 9/16 x 1⅞ in. for small tubular flashlights; the cell 1 x 2⅞ commonly used in earphone batteries; and a flashlight cell 1¼ x 3½ in. which may become an important cell in the future.

Flashlight Batteries

The conference next considered thirty different sizes and kinds of flashlight batteries and adopted eight of

TABLE II—STANDARDIZED SIZES OF FLASHLIGHT BATTERIES

Assembly	No. Cells	Size of Cell — Diameter, In.	Size of Cell — Height, In.	Size of Battery — Length or Height, In.	Size of Battery — Width or Diameter, In.	Size of Battery — Depth, In.
Flat	2	⅝	1⅞	2½	1 5/16	11/16
Flat	3	⅝	1⅞	2¼	1 13/16	11/16
Flat	3	¾	2¼	2⅝	2 1/16	13/16
Tubular	2	13/16	1 13/16	3¾	1	....
Unit cell	1	1¼	2½	..	....	....
Tubular	2	1¼	2½	4 11/16	1 5/16	....
Tubular	3	1¼	2½	7	1 1/16	....
Box	3	1¼	2⅞	3	3⅛	1⅜

these as standard sizes. These standard sizes are shown in Table II.

The conference next considered batteries containing fifteen cells for radio use, and standardized two sizes of these batteries as shown in Table III.

TABLE III—BATTERIES FOR RADIO USE

Assembly	No. Cells	Size of Cell — Diam., In.	Size of Cell — Height, In.	Dimensions of Battery — Length, In.	Width, In.	Height, In.
Rectangular box	15	⅝	7/8	3¾	2	2½
Rectangular box	15	1½	2½	6⅝	4	3

The conference also considered batteries assembled from cells of the No. 6 size and selected from about

TABLE IV—ASSEMBLED BATTERIES

Assembly	Voltage	Length, In.	Width, In.	Height, In.
0000	6	10½	2¾	7½
00 | 00 ∫	6	5¼	5⅜	7½
00000	7½	13¼	2¾	7½
000 | 00 ∫	7½	7⅜	6¾	7½
000 | 000 ∫	9	7¾	5⅜	7½
00	3	5¾	2¾	7½

thirty different sizes and arrangements those in Table IV as standard.

Tests for Dry Cells and Batteries

The matter of tests for dry cells and batteries was discussed at length and the following conclusions reached: The test which has been commonly referred to as the A. T. & T. test is to be known in the future as the "light intermittent service test."

In the discussion of this test the fact was brought out that the resistance of the telephone circuit is more nearly 50 ohms than 20 ohms and that a 50-ohm test (as well as a 20-ohm test) is in use by the American Telephone & Telegraph Co. It was the opinion of the conference, however, that the characteristics of the cells are properly shown by the 20-ohm test which has been used in the past and the 20-ohm test should be contained as standard, since the 50-ohm test requires too much time to complete. The ignition test is to be known as the "heavy intermittent service test." The reasons for changing the name by which this test and the telephone test are designated were first that: the names "telephone" and "ignition" imply too limited an application of these tests, and second that the duration of the test is a more important factor than the current intermittently discharged. The heavy service intermittent test was modified by specifying a cut-off voltage rather than the impulse current which has previously been employed to define the end of the test. The cut-off voltage adopted was 0.85 v. per cell. The 10-ohm continuous test for large cells, the 2.75-ohm test for flashlight cells and the flashlight intermittent test were continued as in the past. As a standard test for the radio batteries of fifteen cells each, the conference adopted a continuous discharge through 5,000 ohms to a cut-off voltage of 17 v. for the battery of 1.13 v. per cell.

The conference considered the significance of the short-circuit current test and adopted a motion that this test should not be applied to telephone cells. The bureau was asked to investigate further the significance of the short circuit current test.

Work in Progress

The conference instructed the bureau (*a*) to obtain information from the manufacturers as to tolerances in the dimensions for each size of cell or battery, (*b*) to prepare specifications for delayed service tests of 3, 6, 9 and 12 months, (*c*) to revise the specifications which are contained in circular 79 of the Bureau of Standards, and (*d*) to take up with the earphone manufacturers the possibility of reaching an agreement on standard sizes of batteries for earphones.

In several cases the conference was unable to fix the required performance of certain sizes of cells on test and the matter is to be decided as a result of additional tests to be made on samples submitted to the Bureau of Standards by the manufacturers. Changes in the required performance of flashlight cells and batteries as recommended to the conference by the Bureau of Standards were adopted.

Several times during the discussion mention was made of the possibility of future conferences. No formal action was taken in this matter, but the bureau welcomes the suggestion, and will be glad to do its part in making future revisions and in maintaining the effectiveness of the standardization.

First Aid Treatment for CO Poisoning

The Bureau of Mines has recently issued a report of investigations on the treatment of carbon monoxide poisoning. Although a frequent cause of industrial accidents, there appears to be no uniformly recognized treatment for a person overcome by this gas. The treatment recommended by the bureau is as follows:

1. Administer oxygen as quickly as possible and in as pure a form as is obtainable, preferably from a cylinder of oxygen through an inhalator mask.
2. Remove from atmosphere containing CO.
3. If breathing is feeble, at once start artificial respiration by the prone pressure method.
4. Keep the victim flat, quiet and warm.
5. Afterward give plenty of rest.

Synopsis of Recent Chemical & Metallurgical Literature

Graphitization of White Iron.—In a paper "On Graphitization in Iron-Carbon Alloys"[1] Kotaro Honda and Takejiro Murakami present some new experimental results and a novel theory of the mechanism of graphitization.

For all experiments a white iron of the following composition was used:

	Per Cent		Per Cent
Carbon	3.75	Phosphorus	0.043
Silicon	0.063	Sulphur	0.01
Manganese	0.091		

This material was melted in a small alumina tube heated in a platinum-wound resistance furnace. Temperature measurements were made with a platinum-platinum rhodium thermocouple in a thin silica protecting tube dipped in the molten metal. Analyses made in some of the experiments showed the absorption of silicon by the metal to be less than 0.03 per cent, an amount which the authors consider too small to affect the graphitization. Weight of metal used in each experiment was 20 g., and the degree of graphitization was estimated by microscopic observation, analyses being reported in only a few cases.

Period of Graphite Formation

The stage at which graphite is formed during cooling was determined by quenching experiments. Having determined certain conditions of heating and cooling which would result in graphitization, melts were allowed to cool to various temperatures and were then quenched in water. No graphite was observable after quenching at the eutectic temperature (1,130 deg. C.), a temperature determined by the eutectic arrest in the cooling curve of the specimen. As the quenching temperature fell to 1,100 deg C. a small amount of graphite was produced, and when the quenching was done below 1,050 deg. C., the amount of graphite was nearly equal to that found after moderately slow cooling to room temperature. It was therefore concluded that graphite does not separate directly from the melt, but forms after solidification and largely between 1,130 to 1,050 deg. C.

Rapid cooling from the molten state produced white iron free from graphite even when the carbon content was raised by addition to almost the composition of cementite. In highly carburized alloys (hypereutectic) cooled somewhat slowly from 1,500 deg. C. two forms of graphite were observed—large straight plates and small curved flakes, as shown in Fig. 1. If the slow cooling was interrupted by quenching at 1,150 deg. C., the large plates were found, but the small flakes were absent. This result is seen in Fig. 2. The large plates are therefore held to be formed from primary cementite above the eutectic temperature, but the smaller flakes from ledeburite (the austenite-cementite eutectic) below this temperature. Fig. 3 shows the structure of a hypereutectic specimen cast at 1,500 deg. C. in an iron mold. It will be noted that the distribution of the primary cementite is similar to that of the large graphite plates in Fig. 1. The whole structure is on a smaller scale because of the more rapid solidification. A general conclusion that may be drawn regarding the period of graphite formation is that graphitization does not take place unless solid cementite is present.

[1] "On Graphitization in Iron-Carbon Alloys," K. Honda and T. Murakami, *Sci. Rep.*, Tohoku Imperial University, vol. 10, No. 4, September, 1921, p. 273.

Annealing of White Iron

It was found that the white pig iron used in this research always graphitized on annealing at temperatures above 1,000 deg. C. The graphite produced at such high annealing temperatures is flaky in form as distinguished from the rounded form found in malleable castings. The authors do not discuss the equilibrium relations of iron, graphite and cementite below the eutectic temperature nor do they report experiments bearing on this phase of the subject.

Mechanism of Graphitization

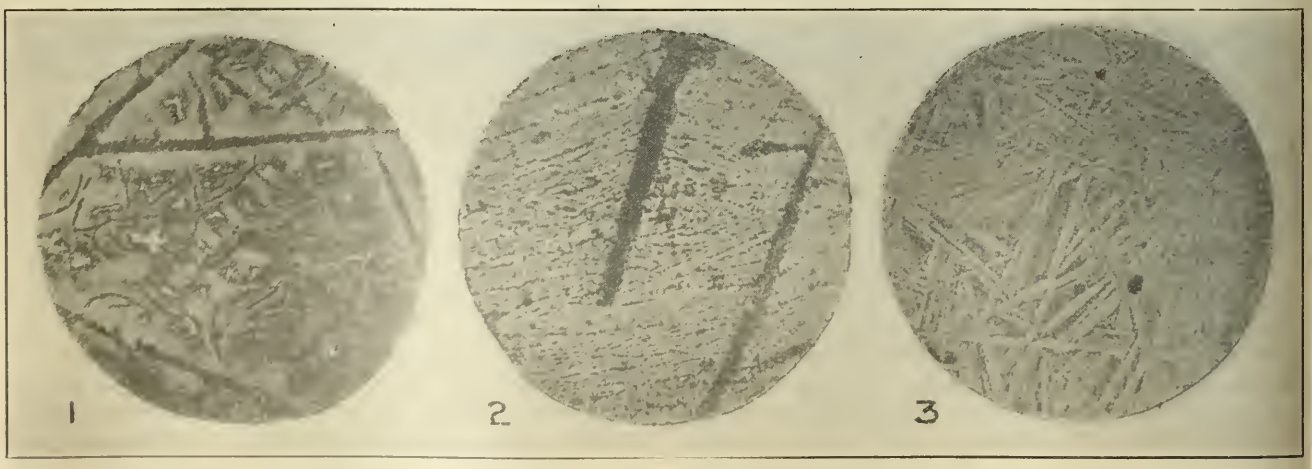
There are, according to the authors, two theories of the mechanism of graphitization: (1) the graphite is considered as a product directly separated from the melt; and (2) it is a secondary product formed by the decomposition of solid cementite, according to the equation

$$Fe_3C = 3Fe + C$$

The first theory is untenable in view of the quenching experiments which show that the graphite found in the solid alloy is formed only after solidification.

The authors also reject Howe's explanation, published in his "Metallography of Steel and Cast Iron," that graphite is less soluble in austenite than is cementite, being a more stable phase than the latter, and hence if there is a nucleus of graphite in austenite which is saturated with carbon, graphite is deposited on it, and the solution, becoming unsaturated with carbon, dissolves cementite.

In some of their experiments the authors dipped a graphite rod into the melt and found that the graphite formed during cooling appeared in other regions to a greater degree than at the surface in contact with the graphite rod. They also found that graphitization brought about by annealing did not appear to affect the extent of graphitization on remelting and cooling. From these observations they conclude that the nucleus theory is not probable. A final argument is given as follows:



FIGS. 1 TO 3.

Fig. 1. Straight and curved graphite flakes in high-carbon iron cooled somewhat slowly from 1,500 deg. C. × 80.

Fig. 2. Suppression of curved flakes by quenching from 1,150 deg. C. × 80.

Fig. 3. High-carbon iron cast at 1,500 deg. C. in an iron mold. × 100.

"According to the modern view of crystal structures based on the X-ray analysis, the atoms forming the molecules of a substance are separately arranged in the space-lattice of the crystal. A solid solution of carbon in iron has of course a crystalline structure, and therefore carbon atoms are uniformly distributed among iron atoms in the space-lattice. In the case of the solid solution of cementite in iron, carbon atoms must also be uniformly distributed among iron atoms. Since the crystal system is the same in these two cases and also iron and carbon atoms exert their own molecular forces on each other, the distributions of the atoms will very probably be the same in the two cases. If they were different, we must assume two modifications of austenite; but such modifications are not yet known. Hence there can be no difference between the solid solutions of carbon and cementite in iron and it is rather more correct to say that carbon dissolves in iron as solid solution. The above explanation as given by Prof. Howe is then untenable from the standpoint of the X-ray analysis of crystal structure."

Having thus dismissed the older explanations, the authors advance the hypothesis that graphitization is brought about by a catalytic action of carbon monoxide and dioxide according to these equations:

$$2CO = CO_2 + C$$
$$Fe_3C + CO_2 = 2CO + 3Fe$$

Thus graphite is produced by the decomposition of carbon monoxide which is regenerated from the carbon dioxide by reduction with Fe_3C. The process continues as long as the supply of cementite and gases holds out.

The evidence upon which this theory is based may be indicated as follows:

1. For a given rate of cooling, the extent of graphitization is less the higher the maximum temperature of the melt and the longer the time of exposure at this temperature. In metal heated to 1,200 deg. C., for example, and cooled at an average rate of about 12 deg. C. per minute, graphitization was about three-fifths complete regardless of the time of exposure of the melt. When the maximum temperature was 1,300 deg. C., the degree of graphitization diminished as the time of exposure increased, and no graphite was observable in specimens exposed at that temperature longer than 10 minutes. With a maximum temperature of 1,400 deg. C., no graphitization took place during cooling irrespective of the time of exposure. It was also found that the graphitization brought about by annealing was less in specimens previously heated at the higher temperatures. These facts are attributed to the decrease of the solubility of gases in the melt with rise of temperature.

2. Graphitization was found to be favored by the introduction of carbon monoxide, carbon dioxide, air or iron oxide into the melt. If the melt was exposed for some time after the addition of the oxygen-containing material, the graphitization became very small. No effect was obtained from passing hydrogen or nitrogen through the melt. These facts are also explained by the gas reaction theory.

3. The effect of air on graphitization was larger than that of carbon monoxide or dioxide. This is attributed to the formation of iron oxide which is supposed to remain in the metal and produce carbon monoxide more effectively than the direct addition of the gas.

4. If the pig iron was melted at 1,200 deg. C. and cooled at about 12 deg. C. per hour, graphitization took place. This treatment did not result in graphitization, however, if the iron was previously melted at 1,400 deg. C. and cast into an iron mold. This is consistent with the supposition that the heating at 1,400 deg. C. drove off the greater part of the carbon monoxide.

5. It was observed that graphite begins to develop from blowholes and cavities, which are regarded as containing the carbon monoxide or dioxide responsible for graphitization. The authors also found no graphite in metal cooled from the molten state in a vacuum unless the cooling was very slow.

6. In some specimens isolated spots were observed in which graphitization was complete. "The gas, which is initially found in their centers, diffuses outward, and owing to its catalytic action, graphitization takes place in spherical forms. The catalytic action gradually diminishes, as a definite amount of the gas is always distributed in an increasing surface, till the action ceases altogether when the gas density on the surface is reduced to a certain low value, or when the temperature becomes two low for graphitization."

7. The authors found that the ledeburite of hypereutectic iron graphitizes more readily than that of hypoeutectic irons. They consider that this is due to "an ample amount of free gases entered in the melt during the process of carburization by carbon powder."

Nature of Graphite Flakes

The authors disagree with the view of some metallurgists that the flakes are a form of graphite crystal, and hold that they are merely aggregates of fine graphite particles which take their form from the decomposed cementite crystals. They state that continued heating at high temperatures causes a rounding of the sharp corners of the flakes due to the surface tension of the austenite.

Magnetic Analysis[2]

The progress of graphitization can be followed by magnetic analysis. As the graphitization increases, the intensity of magnetization due to the cementite will decrease, but the total intensity will increase, owing to the formation of free iron. As the period of annealing increases (and hence the amount of graphite), the intensity of magnetization at room temperature gradually increases and the cementite transformation at 200 deg. C. decreases in magnitude. The ratio of the increase of deflection due to cementite to the total deflection at room temperature is taken as approximately proportional to the quantity of cementite undecomposed.

Some curves are given showing the rate of graphitization on annealing, as estimated by this method.

Dissociation of Ferric Oxide Dissolved in Glass.—In a paper read before the joint meeting of the Glass Division of the American Ceramic Society and the English Society of Glass Technology and published in the November *Journal* of the American Ceramic Society, J. H. Hostetter and H. S. Roberts describe the results of work on the dissociation of ferric oxide dissolved in glass and its relation to the color of iron-bearing glasses. It was shown that above 1,300 deg. C., Fe_2O_3 is dissociated appreciably with evolution of O_2 and the formation of the corresponding quantities of FeO. The same reaction is found to take the place in glasses. The following percentages of Fe as FeO based on the total Fe present illustrate the extent of this dissociation in glasses: Diopside glass ($CaSiO_3MgSiO_3$), 1,400 deg. C., 20 per cent; 1,500 deg. C. 30 per cent; 1,600 deg. C., 45 per cent. Glass having the composition $0.6K_2O$—$0.4CaO$—$2SiO_2$, 1,310 deg. C., 5.8 per cent; 1,555 deg. C., 10.1 per cent. Glass having the composition $0.3K_2O$—$0.3Na_2O$—$0.4CaO$—$2SiO_2$, 1,020 deg. C. 4.1 per cent. In the two latter glasses a dissociation of 10 per cent produced a bright green color; the glass with a dissociation of 4.1 per cent was yellow. Iron compounds in a glass may therefore be "reduced" by heating to a high temperature under oxidizing conditions. The intensity of the color due to iron is closely related to the composition of the glass, but data on this point are not sufficiently complete to warrant generalization.

Glaze Hardness on White Ware.—George Blumenthal, Jr., described in the November *Journal* of the American Ceramic Society the results of experiments conducted at the U. S. Bureau of Standards on the hardness of glazes for white ware and table porcelain. The enamels show the lowest and the porcelain glazes the greatest hardness, while the white ware glazes occupy an intermediate position. The difference in hardness between the enamels and the white ware glazes is quite marked. There is also a rather well-defined difference between the white ware and porcelain glazes, but not a sharp separation between the lower and higher fired porcelain glazes. Enough evidence has been accumulated to show that increased firing of the same glaze will increase the hardness. It appears also that increase in the alumina content brings about greater hardness.

[2]K. Honda, *Sci. Rep.* 5 (1916), p. 285; Honda and Murakami, *Sci. Rep.* 6 (1917), p. 235; etc.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Improvement of Patent Office Situation in Sight as House Passes Relief Bill

Despite the opposition of such influential members as Majority Leader Mondell and Chairman Madden of the Appropriations Committee, the House passed without amendment the Patent Office relief bill by the overwhelming vote of 305 to 44. The Senate Committee on Patents expects to consider the bill immediately and it is known that a majority favors reporting the bill to the Senate on the earliest possible date.

The opposition to the bill was based largely on the ground that increases in salary, in some cases amounting to as much as 50 per cent, are being allowed to one group of employees. If the same salary scale were applied to the 300,000 other employees of the government, outside the postal service, it would mean a tremendous increase in the federal expenditure.

The main three features of the bill are that it provides a substantial increase in salaries, particularly to the technical employees of the Patent Office; it provides for an increased personnel, and authorizes an increase in fees sufficient to cover the increased expenditures. Due to the low salary scale, the Patent Office has lost a large percentage of its more experienced examiners and workers with technical experience. During the last sixteen months there has been a turnover involving one-fourth of the total force of 437 examiners. As pointed out by Representative Vestal of Indiana, one of the active supporters of the measure, this has caused the work to be handled much more slowly, until the work of the office is 60,000 applications behind. It also was pointed out that the work in the Patent Office is increasing by leaps and bounds. During the calendar year 1919 the number of patent applications totaled more than 76,000—exceeding by 19,000 the number of applications filed in 1918. The 1918 total was exceeded by 24,000 applications in 1920, and 1921 exceeded 1918 by 30,000 applications. In 1921 there were 87,408 applications for patents, 5,596 applications for designs, and 16,234 applications for trade-marks, making a total of 109,238 applications. This is an increase in work during 4 years of 65 per cent. During those 4 years an increase of 5 per cent in personnel was allowed, but in many instances at a salary scale established in 1854.

Technical societies and other organizations are largely responsible for the pressure which forced the passage of the bill over the protest of House leaders. This support came principally from the National Research Council, American Engineering Council, Manufacturing Chemists Association, American Institute of Electrical Engineers, American Patent Law Association, National Association of Manufacturers, American Society of Civil Engineers, American Society of Mechanical Engineers, National Automobile Chamber of Commerce, Automotive Electrical Association, Electrical Manufacturers Club, American Institute of Mining and Metallurgical Engineers, American Bar Association and the American Chemical Society.

Marvin Appointed Chairman of Tariff Commission

The President has designated Thomas O. Marvin to be chairman of the United States Tariff Commission for the year beginning Jan. 15. He has been a member of the Commission since last March. He succeeds to the chairmanship held until this time by Thomas Walker Page, a Democratic member of the Commission. Mr. Page remains as a member of the body.

At the same time the President designated William S. Culbertson to be vice-chairman of the Commission. It is understood that Mr. Marvin will retire within a few months and that Mr. Culbertson will succeed to the chairmanship. Mr. Culbertson is the member of the Commission who has specialized on chemical matters.

New Sugar Refineries in Operation and Additional Expansion Contemplated

The Coca-Cola Co., Atlanta, Ga., has placed a new sugar refinery in operation in connection with its local plant, for the production of sugar exclusively for company service. The mill is equipped for a daily output of about 200,000 lb., and is of experimental character with view to ascertaining accurately the economies to be effected by individual production, rather than buying the commodity in the market. When success has been demonstrated, it is purposed to establish other such plants to furnish material to the fourteen factories of the company throughout the country.

The new refinery of the American Sugar Refining Co. at Baltimore, Md., is nearing completion and will soon be turned over to the company by the contractors. It is expected that this will take place about March 1, and that production at the plant will be commenced before the close of that month. The initial capacity will approximate 10,000 bbl. a day, or about 3,000,000 lb. Arrangements are now being made by the government for the installation of its department at the plant, to consist of electrical weighing machinery, chemical and other testing apparatus for sampling and revenue work. It is said that the government force to be engaged at the plant will total about seventeen persons, including chemists, inspectors, samplers, electricians and laborers. The equipment to be installed in this department is estimated to cost about $100,000.

Chemical Fellowships in Twenty Institutions Again Awarded by Du Pont Company

E. I. du Pont de Nemours & Co., have authorized the continuance of Du Pont chemical fellowships in twenty colleges and universities throughout the United States for the scholastic year of 1922-23 of the total value of $15,000. The fellowships are for post-graduate work and are placed in the institutions which have well-established post-graduate courses. The recipients are selected by the university authorities, the only condition made by the company being that the awards shall go to graduates who devote the major part of their time to the study of chemistry.

The object of the plan is to promote the study of chemistry and to assist deserving students, who have shown especial aptitude for chemistry, to pursue further work. It differs from the usual plan for industrial fellowships in that the company does not insist on the student carrying out an investigation on subjects in which the company is interested, but leaves him free, under the direction of his instructors, to follow whatever line of investigation seems to him most promising.

The institutions which receive these fellowships are Brown University, California Institute of Technology, University of California, University of Chicago, Columbia University, Cornell University, Delaware University, Harvard University, University of Illinois, Johns Hopkins University, Lafayette College, Massachusetts Institute of Technology, University of Michigan, University of Minnesota, Ohio State University, Princeton University, University of Virginia, University of Washington, University of Wisconsin and Yale University.

Leather Company Bans Alien Employees

Effective Jan. 1, the New Castle Leather Co., Wilmington, Del., has adopted a rule that no aliens will be employed at the plant. Employees who are not citizens or who do not take out citizenship papers at once will be dropped from the force. It is said that several months ago the company posted notices requesting that all aliens engaged at the plant become citizens, but the majority at that time declined. In the present instance, the company's decision has brought an influx of applications at the local District Court.

Steel Mills Set the Pace of Increasing Activities in Various Industries

Glass. The John B. Scohy Glass Co., Sisterville, W. Va., is arranging for the resumption of production at its plant, which has been closed down for more than a year past. Employment will be given to about 150 operatives.

Oil. The Denison Oil & Refining Co., Denison, Tex., is arranging for the immediate operation of its new local refinery, rated at a capacity of about 5,000 bbl. per day. The plant was completed several months ago, but production has been deferred until conditions in the industry warranted.

The Waco Refining Co., East Waco, Tex., will commence production at its oil refinery at once, following alterations and improvements in the plant, recently acquired from other interests. William Sacks heads the company.

The Owens Refining Co., Minerva, Tex., is completing the construction of a refinery on local site, with capacity of about 1,500 bbl. a day, and expects to place the plant in operation before Feb. 1.

Rubber. The Intercontinental Rubber Co. has resumed production at its mill at Torreon, Mex., following a shutdown dating from December, 1920.

Copper. The Anaconda Copper Mining Co., Anaconda, Mont., has fired the furnaces at its Washoe smelting plant, as a preliminary heating-up prior to the resumption of operations. The different properties of the company which will start up at an early date include the Leonard, Badger-State, Mountain View and Mountain Consolidated copper mines.

The Boston & Montana Development Co., Butte, Mont., has increased production at its concentrating plant from 50 to 100 tons a day.

The Davis-Daly Copper Co., Butte, Mont., is considering the early resumption of production at its plant, and will send shipments to the Washoe smelting works of the Anaconda Copper Mining Co. About 80 men are now employed for repairs and other miscellaneous operations.

The Utah Copper Co., Bingham, near Salt Lake City, Utah, is planning for the resumption of operations at its properties early in February. About 4,000 men will be employed.

Zinc. The Butte & Superior Mining Co., Butte, Mont., is arranging for the resumption of operations at its local zinc properties.

The Anaconda Copper Mining Co., Great Falls, Mont., has resumed production at its local zinc electrolytic plant.

Iron and Steel. Following the resumption of production at the plant of the Allegheny Steel Co., Brackenridge, Pa., Jan. 16, employment is being given to about 1,000 men.

The Ohio Steel Foundry Co., Lima, Ohio, has resumed production at its plant, following a shutdown since last November. About 500 men will be employed for the present.

The Youngstown Steel & Tube Co., Youngstown, Ohio, has increased operations at its local plant to include twelve of the seventeen furnaces in this district.

The United States Steel Corp. has resumed full operations at its Aetna-Standard plant at Wheeling, W. Va., making three of the company's mills in this district producing in all departments.

The Illinois Steel Co., Chicago, Ill., is maintaining operations at 11 of the blast furnaces at its works.

The Superior Sheet Steel Co., Canton, Ohio, has advanced to full production at its local plant. Since Dec. 1, the works have been running at from 50 to 75 per cent of normal.

The Crane Iron Co., Catasauqua, Pa., is completing the relining of its local blast furnaces, preparatory to the resumption of operations. No date has as yet been announced for blowing in the units.

Metric System Referendum to Be Considered

Whether or not the Chamber of Commerce of the United States will conduct a metric system referendum will be determined at the meeting of the National Council of the Chamber which will be held in Washington, February 8 and 9. The council is made up of one representative each from 1,400 business organizations.

Hearings Before Finance Committee on Cyanide Presage Its Removal From Free List

Unquestionably the controlling sentiment within the Senate Finance Committee favors a duty on cyanides. It is probable that a rate lower than the 33⅓ per cent duty requested will be prescribed in the bill which will be reported to the Senate next month. It may be predicted, however, with considerable certainty that cyanides will be removed from the free list.

The principal point made before the committee was that the gold-mining industry is in no position to add to the expense of producing its fixed-value product. It was shown that, in the case of the Homestake Mining Co. alone, the proposed duty would add $25,000 to its annual cost of cyanide.

Senator Smoot of Utah called attention to the fact that only 0.2 lb. of cyanide is used in treating a ton of ore at the Homestake mine. Since the price of cyanide for the past 8 years never has exceeded 25c. a pound to those using it in quantity, he expressed the opinion that it is not going to add greatly to the cost of production of gold, when the cost of the cyanide used would not exceed 5c. per ton of ore treated.

J. C. Hammitt, of the American Cyanamid Co., expressed the opinion that it would be greatly in the interest of the American consumer to permit a continuance of competition between cyanamide producers. The American Cyanamid Co. entered the American market in 1917 and, according to Mr. Hammitt, is now in a position to offer real competition and to break up the character of exploitation which he alleges existed prior to that time.

Circuit Court of Appeals Denies Petition in Minerals Separation Litigation

The Miami Copper Co. made an argument before the United States Circuit Court of Appeals at Philadelphia on Jan. 18 upon its petition for a writ of mandamus to instruct that the master exclude from the accounting proceedings further testimony as to certain processes which have been in use since those found to have been infringing. It was because of its continued use of these same processes that Minerals Separation, Ltd., sought to have Miami Copper Co. found in contempt of court. The Circuit Court of Appeals in an exceedingly detailed opinion sustained the lower court in its refusal to enjoin the Miami Copper Co. The action upon which the court rendered this lengthy opinion was not appealable, and therefore did not actually require from this court more than its statement of that fact, which it made. The Miami company believed, therefore, that this expression of opinion as to the court's views as to these processes could only have been addressed to the master and litigants, as a means of indicating the manner in which they should proceed. The master, apparently, did not accept this view, and so, in the absence of any guiding precedent, refused the petition that he exclude from the accounting further testimony as to these processes. The Circuit Court of Appeals' dismissal of this petition for a writ of mandamus would apparently simply decide that the reply of the defendants to the prima facie case which, during the past four years, has been set up before the master, shall, on account of the already voluminous record, be answered before the master, rather than by a new bill.

Rate of Duty on Odoriferous Substances Unfit for Use as Perfume

A Treasury decision has just been issued in which it is pointed out that odoriferous substances, shown to be unfit as such to use as perfume but which are used as bases in the manufacture of perfume, take an import duty of 20 per cent ad valorem rather than a duty of 60 per cent ad valorem, which applies to perfumery.

Two New Technical Publications

In response to demands from two of its fields, the McGraw-Hill Co., Inc., began, on Jan. 15, the publication of two new papers, *Bus Transportation* and *Electrical Review and Industrial Engineer.* The former will be published in New York and the latter in Chicago.

Senate Approves Resolution Calling for Detailed Alien Property Report

Since a considerable part of the property which came within the purview of the Alien Property Custodian was in the form of chemical patents and holdings in chemical companies, it is expected that the statement called for from that officer by Senator King's recently approved resolution will be of interest to those engaged in chemical industries.

The resolution calls for detailed information as to the names and compensation of all attorneys appointed or employed by the Alien Property Custodian, and of all attorneys, directors, managers and other agents appointed by the Custodian to administer property under his control. It also calls for the names and compensation of all attorneys of corporations, agents or individuals who have been acting as administrators for the Custodian; names of all attorneys who have represented claimants to property under the Custodian's control; names of all attorneys who have represented claimants to whom property has been returned under Section 9 of the trading with the enemy act, and the compensation allowed each out of the trust funds subject to such claims.

In addition the Alien Property Custodian is required by the resolution to furnish a statement and a description of all property which he has sold, together with the names of the purchasers, and the amount involved in the transaction. A statement of all property seized or demanded since the passage of the peace resolution also is requested.

Industrial Applications of Colloidal Chemistry Subject at Connecticut Section A.C.S.

A. W. Thomas, of the Division of Food Chemistry at Columbia University, addressed the January meeting of the Connecticut Valley Section of the A.C.S. in Springfield, Mass. Choosing as his subject "Rationalization of Colloidal Chemistry," Dr. Thomas spoke of some of the new work that is being done in connection with colloidal solutions, mentioning particularly the peptizing effect of ferric chloride and of hydrogen sulphide respectively in the case of colloidal solutions of ferric hydrate and arsenious sulphide. He also described the preparation of collodion membranes of various degrees of permeability and showed that this means of classifying colloids was unreliable unless a complete description of the method of preparing the dialyzing membrane was available. He spoke of the necessity of simplifying the study of colloid chemistry in order that its phenomena might be better understood and become available for use in the industry. In this connection is the instance of a number of reactions that are truly chemical in their nature, although they have been considered by previous workers to be manifestations of adsorption. Of special value to the industry in this connection is the bleaching of sirup solutions by means of bone black. This has been shown recently to be a case of chemical combinations between compounds in bone black and the colored bodies in the sirup and not a case of adsorption.

Engineering Society of Buffalo, N. Y., Established in Club Quarters

The establishment of permanent club quarters in the Iroquois Hotel has greatly stimulated the activities of the Engineering Society of Buffalo. A series of luncheon meetings has been organized, at each of which it is planned to have an address by some local engineer.

At the regular meeting of the society on Jan. 10, E. B. Neil of the Pierce-Arrow Co. spoke on "Progress in Worm-Gear Designing" and Captain George H. Norton of the Buffalo City Planning Commission outlined the activities of the commission in civic improvement.

R. H. McKee, professor of chemical engineering at Columbia University, will address the meeting on Feb. 14 on the subject "Gasoline From Oil Shale."

Evening Course in Metallography

An evening course in metallography, comprising fifteen lectures and fifteen 2-hour laboratory exercises, will be given at the Brooklyn Polytechnic Institute, commencing Feb. 3. The class will be limited to thirty men.

Technical Societies of Detroit Combine Interests in Newly Formed Association

After several years of thought and discussion along similar lines, the movement for the affiliation of the architectural, engineering and other technical societies of Detroit was taken up seriously in June, 1921, by the organization of a temporary council composed of two delegates from each of the several societies interested. The affiliation has become an accomplished fact, taking effect Jan. 1, 1922, by the ratification of the proposed constitution and bylaws, acceptance of membership and election of councillors by the following twelve societies: Detroit Section, American Society of Civil Engineers; Detroit Chapter, American Association of Engineers; Michigan Chapter, American Society of Heating and Ventilating Engineers; Detroit Post, Society of American Military Engineers; Detroit Section, American Society of Mechanical Engineers; Detroit-Ann Arbor Section, American Institute of Electrical Engineers; American Institute of Chemical Engineers; Detroit Engineering Society; American Chemical Society and Detroit Chemists; Michigan Chapter, American Institute of Architects; Detroit Section, Michigan Society of Architects; Detroit Chapter, American Society for Steel Treating.

The permanent council met and organized Dec. 13, 1921, and elected officers for 1922 as follows: Chairman, P. W. Keating; vice-chairman, A. A. Meyer; secretary-treasurer, Walter R. Meier.

The Associated Technical Societies of Detroit will provide one meeting each month which will be under the management of one of the member societies. This member society will provide the speaker on a broad subject of interest to the members of all the technical societies.

Prize Offered by French Society for Gasoline Substitute

Vice-Consul Davis B. Lewis, of Bordeaux, announces in the Jan. 2, 1922, issue of *Commerce Reports*, the organization of a competition with the object of discovering a practical and economical motor fuel with alcohol as the basis of its composition.

At the recent annual meeting of the Agricultural Society at Beziers, in the neighboring Department of Herault, prizes totaling 200,000 fr. were placed at the disposition of the committee, of which amount 100,000 fr. will be awarded to the competitor whose product gives the best results. The competition will be open from January to March, 1922, and the points to be covered will embrace comparative facility of production of the various substances used; increase or decrease of average power obtained compared with petroleum and gasoline; the possibility of blending the proposed product with gasoline for use in motor engines; the percentage of alcohol and other substances of French origin that are used; average horsepower cost per hour; and the originality of the process.

Complete details of the competition may be obtained from the general secretary of the Committee of Organization, 11 Rue d'Assas, Beziers, Herault, France.

Civil Service Examinations

The Civil Service Commission announces open competitive examinations for the following positions. Vacancies exist in the Chemical Warfare Service, Edgewood Arsenal, Edgewood, Md.

Chemical technologist, $3,600 to $5,000 a year. Associate chemical technologist, $2,500 to $3,600 a year. Assistant chemical technologist, $1,800 to $2,500 a year.

Applications will be received on Form 2118 until Feb. 14, 1922.

Announcement is also made of competitive examinations on Feb. 8, 9 and 10 and March 22, 23 and 24, 1922, for assistant examiner, Patent Office. Applications should be filed at once on Form 1312.

Washington Chemical Society Elects

The Chemical Society of Washington, D. C., has elected officers for 1922 as follows: R. C. Wells, Geological Survey, president; J. B. Reed, Bureau of Chemistry, secretary; H. W. Houghton, Hygienic Laboratory, treasurer.

Cotton Linters for Paper T.A.P.P.I. Subject

The January meeting of the Connecticut Valley Section of T.A.P.P.I. was addressed by S. E. Seaman of the Stamsocott Co. on the subject of cotton linters. Mr. Seaman described in detail the operation of a modern plant producing paper stock from linters.

New Chemistry Building at University of Missouri

The University of Missouri, Columbia, Mo., has received an appropriation of $125,000, to be used for the construction of a new two-story chemistry building.

Obituary

JEAN DUBOIS, business manager of the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J., died suddenly at his residence in that city, Jan. 12, following a lingering illness of nearly a year. He was born at Le Locle, Switzerland, on Nov. 24, 1869, and spent his early years in that country. Following a residence of 8 years in South Africa, he came to the United States and engaged in the phosphate business in Florida. Later, he returned to France to superintend the construction of a large chemical plant. In 1911 he again came to the United States and became connected with the Roessler & Hasslacher company, with which he remained until his death. He was a member of the Atlantic Waterways Association and other organizations, and president of the American Terminal and Waterways Association. His wife, a son and daughter, and both parents, survive him.

THOMAS E. DWYER, president and general manager of the Lead Lined Iron Pipe Co., Wakefield, Mass., died Dec. 26, 1921.

JOHN C. PENNIE, of New York City, died on Dec. 23, 1921. By his death the legal profession lost one of its ablest and best known members. Mr. Pennie had not been in good health since the summer of 1921, when he returned from Paris after service of 6 months as a member of the American Commission to Negotiate Peace. However, he was active in the work of his profession up to a few weeks before his death.

Mr. Pennie was born on Aug. 29, 1858, and was graduated from the Albany High School in 1874. He entered Union College at Schenectady and was graduated in June, 1877, with degrees of Civil Engineer and Bachelor of Arts. Then he attended the Albany Law School and received the degree of Bachelor of Law. In the summer of 1878 he went to Europe and pursued his study at the Universities of Breslau and Göttingen. On his return to this country he was admitted to the bar of the State of New York but decided to devote himself to the patent profession and went at once to Washington, D. C., where he entered the Patent Office as an assistant examiner in January, 1881. He remained in the Patent Office until Dec. 3, 1883, serving as assistant examiner of applications relating to metallurgy and later as assistant and acting examiner of interferences. He resigned from the Patent Office in December, 1883, and entered upon the practice of patent law in partnership with John A. Goldsborough, who had been a primary examiner in the Patent Office, and this partnership was continued until the death of Mr. Goldsborough. In 1904, Mr. Pennie moved to New York and continued his practice there in association with D-Cady Herrick and Judge James J. Farren of Albany. During recent years he was the senior partner of the firm of Pennie, Davis, Marvin & Edmonds.

The high position which Mr. Pennie had attained among the members of the bar specializing in patent law led to his selection as the adviser of the American Peace Commission on patent matters, and he spent the first 6 months of 1919 in Paris advising with the representatives of other countries on the provisions of the peace treaty relating to patents. In appreciation of his work as a member of the commission, King Albert of Belgium commissioned him a Commander of the Order of the Crown. After Mr. Pennie's return to the United States a representative of the King presented to him a medal and certificate of his appointment.

Throughout his professional life Mr. Pennie made a host of friends, all of whom held him in highest esteem for his estimable qualities of heart and mind. His strong characteristics were a broad catholicity of spirit, a genial kindliness toward all men, and a sterling integrity, coupled with a broad faith in and a comprehensive charity for his fellow men. He was a man of rare mental attainments, remarkably sound judgment, and an indefatigable worker in the many fields into which he directed his wonderfully fertile intellect. Even in the busiest intervals of his most exacting profession, he was ever ready to give of his time, knowledge and experience to help anyone less fortunately situated, either professionally or socially.

Personal

FRED P. BAKER, for the past year and a half assistant director of the Boston station of the School of Chemical Engineering Practice of the Massachusetts Institute of Technology, has resigned to accept a position as chemical engineer with the Procter & Gamble Co., Cincinnati, Ohio.

Dr. FRANK R. ELDRED, for 20 years director of the scientific division of Eli Lilly & Co., of Indianapolis, has resigned to engage in consulting work under the firm name of Eldred & Aitkinson. Mr. Aitkinson was formerly chief chemist of the American Hominy Co.

F. M. FEIKER, who went to Washington 8 months ago as assistant to Secretary of Commerce Hoover, and on leave of absence from the McGraw-Hill Co., is now back in his old position as editorial director. He has not, however, completely severed his relations with the Secretary or the department, but has been appointed a special agent of the Bureau of Foreign and Domestic Commerce, to continue in a consulting capacity the work he has been rendering. Under the direction of Mr. Feiker and Dr. Julius Klein, Director of the Bureau of Foreign and Domestic Commerce, the industrial and business contracts of that bureau have been enlarged, business relations with trade association committees have been established and the so-called Commodity Divisions of the bureau created. During Mr. Feiker's stay with the department, *Commerce Reports*, the government's official foreign trade paper, has been changed from a daily to a weekly publication and the monthly "Survey of Current Business" was brought into existence. Mr. Feiker's services extended to the Bureau of Standards, the Bureau of the Census and other parts of the department. He served as editorial adviser on the department's board of editors.

LLOYD A. HALL has severed his connection as manager of Vodin, Inc., to establish a business on his own account under the name of the Chicago Chemical Products Co., Chicago, Ill.

ABEL HANSEN, Perth Amboy, N. J., head of the Fords Porcelain Works of that city, has been re-elected president of the Fords National Bank, Fords, near Perth Amboy.

GEORGE A. MACINTOCH, secretary of the Butterworth-Judson Corporation, New York, has been elected a director of the company to succeed M. F. Chase.

CHARLES A. MAY, head of the Maddock Lamberton Works, Trenton, N. J., has been elected a director of the local Mechanics National Bank.

WILLIAM D. MAINWARING, for the past 11 years connected with the Detroit plant of the Railway Steel Spring Co. as chemist and metallurgical engineer, has opened a consulting business at 866 Rockefeller Bldg., Cleveland, Ohio, as a production engineer. Mr. Mainwaring was formerly connected with the open-hearth department of the Pencoyd plant of the American Bridge Co., during the installation of the continuous process of the manufacture of steel.

E. J. VOSS, of the Graham Brothers Soap Co., Chicago, Ill., has been elected president of the local Perfumery, Soap and Extract Association.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

When Does a Currency Collapse?

How much can a currency depreciate before it becomes worthless? To what low level can the mark sink before Germany becomes bankrupt? These questions and the circumstances from which they have arisen have caused us to revise many of our fundamental notions of political economy and national finance.

Take, for example, the Polish mark, which has a nominal gold value of 23.82 cents in our money, and is now worth but 0.03$\frac{2}{3}$ of a cent. This is a depreciation of 99.9 per cent from par. An even more striking case is that of the Russian ruble, formerly worth 51.45 cents, but with a present value so small that it is no longer handled in the old denominations. Notes of 50,000 and 100,000 rubles are in common use.

The Austrian crown, with a nominal gold equivalent of about 20 cents, can be bought for 0.03$\frac{3}{5}$ cent, and the Hungarian crown of the same par value is worth 0.12$\frac{2}{5}$ cents. That such depreciation is not limited to the nations of central and western Europe is attested by the fact that the escudo of Portugal can be purchased at a discount of 93.5 per cent and the Chilean peso at a discount of 71.8 per cent. It is natural that the question should be asked: How long will a people cling to a currency which is tottering on the very verge of extinction?

One phase of the situation which is not always appreciated is the very great effect caused by even the slightest fluctuation in the values of these depreciated units. When the mark, for example, fell from 1$\frac{1}{2}$ cents in June to about $\frac{1}{3}$ of a cent in December, 1921, there must necessarily have been a tremendous reduction in its purchasing power. Since Germany is importing much of her foodstuffs and raw materials and paying for them at high rates of exchange, commodity prices (except in cases of government subsidy) have risen with the decline in the value of the mark. Wage advances, on the other hand, are comparatively slow, and in the meantime strikes and other evidences of internal industrial disorganization are a natural consequence. The recent report of the U. S. Tariff Commission includes some pertinent comment on the relation between wages and prices:

> A comparison of wages in the United States, England, France and Germany shows that they are less adjusted to a gold basis than are prices. In May, 1921, the standard wage in Germany for factory workers was, roughly, 10 cents per hour in gold as compared with 20 cents to 25 cents in France, 30 to 40 cents in England, and 50 to 75 cents in the United States.

There is a discrepancy of slightly more than 2 to 1 between the internal purchasing power of the mark and its gold value in foreign exchange, according to the commission. This is obviously to the very great advantage of the German exporter who sells in dollars but pays for his labor and materials with marks.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	143.50
Last week	143.75
January, 1921	181
January, 1920	242
April, 1918	286

This index number, which is based on the wholesale prices in the New York market for a group of twenty-five representative chemicals and related commodities, continued its decline during the past week. Slightly lower prices for caustic soda, formaldehyde, salt cake and citric acid were principally responsible for the change in this week's index number.

RATES OF EXCHANGE OF SOME OF THE PRINCIPAL FOREIGN CURRENCIES AT NEW YORK

Par of Exchange	Foreign Currencies	Federal Reserve Exchange Rates Certified Jan. 18, 1922	Per Cent Depreciation from Par
Cents		*Cents*	
486.65	British pound	422.35	13.21
19.3	French franc	8.15	57.71
23.82	German mark	0.5147	97.8
19.3	Belgian franc	7.80	59.6
23.82	Polish mark	0.0344	99.9
19.3	Greek drachma	4.37	77.5
19.3	Italian lire	4.35	77.6
19.3	Spanish peseta	14.96	22.5
19.3	Swiss franc	19.42	.....
20.26	Austrian crown	0.0316	99.9
20.26	Czechoslovakian crown	1.6803	91.7
20.26	Hungarian crown	0.1244	99.3
26.8	Swedish krona	24.88	7.5
40.2	Netherlands florin	36.71	8.7
108.0	Portuguese escudo	7.42	93.5
51.45	Russian ruble	0.1125	99.7
32.44	Brazilian milreis	12.51	61.5
36 50	Chi ean peso	9.75	71 8
100	Canadian dollar	94.75	5.3

Brief Market Notes About Chemicals and Related Commodities

Naval Stores. The estimate of the Department of Agriculture for the production of gum turpentine during the 1921-22 season is 427,000 casks of 50 gal. each. The estimate for gum rosin is 1,320,000 bbl. of 280 lb. The corresponding production during the 1920-21 season was 488,690 casks and 1,577,390 bbl.

Paradichlorbenzene. A bulletin recently issued by the Bureau of Entomology of the Department of Agriculture describes the use of paradichlorbenzene as a means of preventing or lessening the ravages caused by the peach borer. Experiments begun in 1915 and carried on largely under the direction of E. B. Blakeslee and A. L. Quaintance of the bureau showed "paradichlor" to be particularly effective in preventing the peach borer from attacking and seriously injuring the trees. It is applied in the fall of the year around the base of the tree and about 2 in. from the trunk. One pound is said to be sufficient for 16 trees.

A large-scale demand for paradichlorbenzene would be welcomed by chemical manufacturers.

Chemical Glassware. Exports of chemical glassware for the 11 months ended Nov. 30, 1921, were valued at $215,294. During the month of November the exports, which amounted to $12,692, were shipped to twenty-one different countries.

In amount this may seem but a trivial item, but it is extremely significant that the United States, formerly entirely dependent on a foreign source of supply for all chemical and scientific glassware, has now developed an industry which is capable of competing with the German and Austrian manufacturers not only in the United States but in many of the principal foreign markets of the world.

Wholesale Prices in December

Reference was made in these columns last week to the price indexes of the Bureau of Labor Statistics, the most recent figures being those for the month of November. On Jan. 19 the bureau announced that the index number for all commodities stood at 149 for December, the same as in the previous month. Farm products and foods again showed a downward tendency. Chemicals and drugs fell off slightly, the index number changing from 162 to 161. Metals remained constant at 119.

The New York Market

NEW YORK, Jan. 23, 1922.

The consuming industries have shown some interest in the chemical market during the past week, although the actual volume of business has been rather small. Large-lot buying was exceptional and most of the consumers were contracting only for actual requirements. Prices along the entire list have remained quite steady. The interest in prussiate of soda has continued and high prices have been maintained, with very little offered either for spot or contract purchases. Prussiate of potash, however, has been in increasing demand, both for the red and yellow. Orders have been in the market for the former as high as 32c. per lb., but holders have advanced prices to 33@34c. per lb. The yellow has sold at 25c. per lb., ex-store. The market for arsenic continued very strong. Leading factors are of the opinion that large quantities will be extremely difficult to locate in the very near future, because of the scant importations. Domestic producers are not anxious to supply the trade at present prices, but are waiting for a substantial rise in the market. Their quotations range from 7@7½c. per lb., while odd resale lots sold as high as 8c. per lb. on the spot.

Producers of chlorate of soda have reduced prices to 7c. per lb. Imported material can be bought as low as 6¼c. per lb. Makers of chlorate of potash are still quoting 12c. per lb. on the powdered, but it is commonly known that shading on firm business is being done by leading dealers. Importers are generally holding their material at fairly high prices to make purchases under 6@6¼c. per lb. on spot. Shipment material from abroad is offered at 5¾c. per lb. Manufacturers of barium chloride quote $50 per ton for quantity shipments. Importers are having difficulty in competing with the domestic quotations at present. Additional sales of solid caustic soda for export were reported at $3.60 per 100 lb. Small-lot sales have gone through at 3¾c. per lb. Producers quote the market for contract at $2.60 per 100 lb., basis 60 per cent, f.o.b. works. Small-lot trading in light soda ash, single bags, was reported at $1.90@$1.95 per 100 lb. on spot. Dealers stated that carload quantities have been moved at $1.75 per 100 lb. Offerings were rather scarce and producers stated that contracts were being booked at the works at $1.35 per 100 lb., basis 48 per cent. Makers of bichromate of soda quote 7½@8c. per lb., with only a moderate demand from consumers. Bicarbonate of soda is quoted at 2c. per lb. f.o.b. works for barrels and 2¼c. for kegs. Offerings on spot in carlots have been heard at $2.15 per 100 lb., and smaller quantities at $2.30. The buying movement is rather quiet at present, although a steady call on contract shipments is reported. The tartaric acid market has shown signs of weakness and prices at the close were decidedly lower for imported material. The demand has not been active and considerable competition has developed among holders. Final quotations were 24@25c. per lb. for crystals and 25@26c. per lb. for the powdered. Domestic prices remained quotably unchanged.

COAL-TAR PRODUCTS

The coal-tar products market has undergone some revision in prices since the beginning of the year. Evidence of keen competition is reflected in the course of many prices. Consumers are not buying freely, because the market is flexible enough to suggest that future prices may be more attractive. Benzene continues to command considerable attention and refiners are holding prices firm at the recent advance. The c.p. grade is quoted at 29@35c. per gal. in tank cars and drums. Naphthalene is another item receiving attention and prices in refiners' hands are held steady at 7½@8½c. per lb. for the flake. Inquiries are resulting in placing a moderate amount of business for the coming season. A steady absorption of spot supplies of phenol has placed this commodity in a stronger position. A price of 12c. per lb. was considered a very attractive figure for the U.S.P., while the range extended all the way up to 16c. A fair inquiry for domestic consumption was recorded.

The St. Louis Market

ST. LOUIS, Mo., Jan. 20, 1921.

There has been a noticeable improvement in the chemical line since Jan. 1 in this section, although reports from other quarters do not disclose any real change. It is not expected that there will be any sudden expansion in business, but that there will be a steady increase from week to week.

ALKALIS

Caustic soda remains firm at the same price as last week, $3.40 per 100 lb. for 76 per cent solid in drums in carlots at point of production, single drums at $4.25 per 100 lb. f.o.b. St. Louis. The 76 per cent flake is quoted at $4 per 100 lb. at point of production in carlots, while single drums are held at $4.87½ f.o.b. St. Louis. Contracts are being executed at this price with protection against decline. Bicarbonate of soda is moving slowly at $2.90 per 100 lb. in single barrels, $2.65 per 100 lb. in 10-bbl. lots. Salsoda at buyer's command, at $2 per 100 lb. in single barrels.

GENERAL AND SPECIAL CHEMICALS

Acid citric fails to show any increase. Gallic and pyrogallic acids are in better demand. Phosphoric acid is moving more freely. While the demand for tartaric acid at the close of last year was practically nil, the demand since the beginning of this year has been very gratifying. Ammonium sulphate is moving fairly well, but the demand is not as large as expected. A larger volume of business is being passed on barium sulphate; furthermore, the inquiries for blanc fixe are increasing. Cream of tartar continues to move in a routine way. The market on glycerine is very firm at 16c. in drums, and a further raise of ½c. is expected. Demand is strong. Sulphur is moving slowly, and the price is getting weaker.

VEGETABLE OILS AND NAVAL STORES

Turpentine reached the highest price for some time when it sold for 97c. in single barrels last week. It can now be obtained for 93c. The demand is strong. Linseed oil is keeping step with the flaxseed market, and is now being held at 75c., basis raw oil in cooperage. Contracts for future delivery after May 1 are being taken at the prevailing price of 75c. Castor oil is entirely in the producers' hands and is being held firmly at 13c. per lb.

PAINT MATERIALS

Lithopone is being held at 6c. for carlots and 6½c. in less than carlots by the producers in this locality. Only one of the three plants in this district is in operation. Imported goods are a disturbing factor. Barytes is still holding at $23 in ton lots. This has been shaded on carlot inquiries. Demand is only fair. Whiting of all grades and all prices is being offered in this market at $11 per ton in carlots for air floated, with as high as $15 for water ground and water floated.

The Iron and Steel Market

PITTSBURGH, Jan. 20, 1922.

Demand for steel products in the past week has been of decidedly moderate proportions. The volume of business is perhaps heavier now than in the first two weeks of January, but it can scarcely be regarded as showing as much improvement as would be expected, now that the holidays and the annual inventory date are left behind. There is not a reversion to the conditions of October and November, when buying was sufficient to support steel production at the rate of fully 23,000,000 tons a year. This was not a high rate, generally speaking, but it was the highest rate shown since February. The average rate of production during December was 20,000,000 tons a year, the rate being above this at the beginning of the month and lower at the close. It is doubtful whether the rate now is as high as 20,000,000 tons. This, by the way, is about 38 per cent of the entire capacity in existence and somewhat under 50 per cent of the capacity of the strongest companies, those with the best facilities for economical production.

The demand for steel that has come out in the past week would scarcely be a safe criterion as to what is to be expected in the next few weeks or months, the period since the

first of the year being too short for guidance, but there is some contributory evidence in the attitude of the mills. This attitude has been very aggressive. All orders of any size are strenuously contested for by every available means, including price concessions.

Regular prices are no lower in the case of any important finished steel product, there having indeed been no change in this respect for a month, or since the formal reduction in wire prices by the leading interest. The change in the week is simply that prices below the regular level are being made on somewhat smaller tonnages, and thus the average of the entire tonnage sold is slightly reduced. The majority of orders placed are at full prices. This can easily be the case without its meaning much as to market stability, for the reason that the majority of buyers are ordering in single carloads. Regular prices are as follows: Bars, shapes and plates, 1.50c.; hoops, 2c.; plain wire, 2.25c.; wire nails, $2.50; standard steel pipe, 71 per cent basing discount; blue annealed sheets, 2.25c.; black sheets, 3c.; galvanized sheets, 4c.; tin plate, $4.75.

Manufactured steel products continue to show a general declining tendency, but in this they are merely following the rolled steel materials from which they are made. Generally speaking, the manufactured products have been rather tardy in their response. In most cases these materials are at higher percentages above their pre-war levels than are rolled steel products. The base price of chain, on 1-in. proof coil, has been reduced from 5.90c. to 5.50c., and differentials have been so revised that greater reductions have been made on some descriptions of chain, such as BB. Railroad spikes are down from 2.25c. to 2.15c. or 2.10c., depending on size of order, and small spikes, boat and barge spikes are down to 2.35c. or 2.40c. even on quite moderate sized orders. Rivets remain at 2.25c. for structural and 2.35c. for boiler, but are far from firm at these figures. Cold-finished steel bars are quite irregular and present no well-defined market price.

Pig Iron and Coke

Pig iron continues decidedly quiet and prices are unchanged, perhaps partly because there has been no inquiry of sufficient importance to develop competition. The market is quotable at $19.50 for bessemer, $18.25 for basic and $19.50 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

These prices are all below the current cost of production, basing cost on present market prices for Connellsville coke and last season's prices on Lake Superior ore. Basic iron is particularly low. Its decline seems to have been due to the selling of iron by steel works, not necessarily because of steel works having a lower cost than merchant furnaces, but in part at least because the steel works had unfortunately accumulated the iron and it is more economical for them to make fresh molten iron than to melt the stock iron. Some of the steel works, however, have byproduct coke ovens and a lower production cost, other things being equal, than merchant furnaces that buy their coke.

Connellsville coke for spot shipment, reported stiffer a week ago, has softened again, as odd lots can be picked up at $2.75. Probably not much could be found at $2.75, but there is at least as much as the market is disposed to absorb. The blast furnaces rarely buy any spot coke nowadays, since deliveries on contract are ample, and the buying is restricted to the miscellaneous consumers, brick yards, bakeries, etc., whose purchases are always relatively small. Contract furnace coke shows no developments, the business for the current quarter being all done, with the last contract reported at $3.10, the lowest price done in the contract movement.

Spot foundry coke is easier, and is quotable at $3.75@$4.25, against a range of $3.75@$4.50 formerly quoted. The $4.50 coke is practically out of the market. There have been offerings at $3.50 in the past week, but they scarcely justify inclusion of the price in the market range. One set of offerings is of a coke that is not selected according to standard practice, while other offerings were by a producing interest whose ovens are idle, the object apparently being to accumulate a tonnage that could be offered in a lump to producers in hopes of getting a special price.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots		Less Carlot	
Acetic anhydride	lb.	.....	.....	$0.40	$0.4
Acetone	lb.	$0.12½	$0.12½	.13	.1
Acid, acetic, 28 per cent	100 lbs.	2.50	2.60	2.65	3.0
Acetic, 56 per cent	100 lbs.	5.00	5.25	5.30	5.5
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.50	9.75	10.00	10.5
Boric, crystals	lb.	.12½	.12¾	.13	.1
Boric, powder	lb.	.12¾	.13	.13¼	.1
Citric	lb.	.....	.....	.43	.4
Hydrochloric	100 lb.	1.50	1.60	1.65	2.0
Hydrofluoric, 52 per cent	lb.	.12½	.12¾	.13	.1
Lactic, 44 per cent tech	lb.	.09½	.10	.10½	.1
Lactic, 22 per cent tech	lb.	.04	.04¼	.04½	.0
Molybdic, c.p.	lb.	3.00	3.25	3.30	3.7
Muriatic, 20 deg. (see hydrochloric)		.....	.....	.....	.....
Nitric, 40 deg	lb.	.06½	.06¾	.06¾	.0
Nitric, 42 deg	lb.	.06¾	.07	.07¼	.0
Oxalic, crystals	lb.	.14	.14½	.14¾	.1
Phosphoric, 50 per cent solution	lb.	.10	.10½	.10¾	.1
Picric	lb.	.20	.25	.27	.3
Pyrogallic, resublimed	lb.	.....	.....	1.65	1.7
Sulphuric, 60 deg., tank cars	ton	.....	.....	11.00	12.0
Sulphuric, 60 deg., drums	ton	.....	.....	13.00	15.0
Sulphuric, 66 deg., tank cars	ton	16.50	17.00	.....	.....
Sulphuric, 66 deg., drums	ton	21.00	22.00	22.50	23.0
Sulphuric, 66 deg., carboys	ton	.....	.....	.....	.....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00	22.00	.....	.....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00	23.50	24.00	24.5
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00	32.00	33.00	34.0
Tannic, U. S. P.	lb.	.....	.....	.65	.7
Tannic (tech.)	lb.	.45	.50	.51	.5
Tartaric, imported crystals	lb.	.....	.....	.24	.2
Tartaric acid, imported, powdered	lb.	.....	.....	.25	.2
Tartaric acid, domestic	lb.	.....	.....	.....	.3
Tungstic, per lb. of WO	lb.	.....	.....	1.00	1.1
Alcohol, ethyl	gal.	.....	.....	4.75	5.5
Alcohol, methyl (see methanol)		.....	.....	.....	.....
Alcohol, denatured, 188 proof	gal.	.....	.....	.41	.4
Alcohol, denatured, 190 proof	gal.	.....	.....	.43	.4
Alum, ammonia, lump	lb.	.03½	.03¾	.04	.0
Alum, potash, lump	lb.	.03¾	.04	.04¼	.0
Alum, chrome lump	lb.	.07½	.08	.08¼	.0
Aluminum sulphate, commercial	lb.	.01¾	.02	.02½	.0
Aluminum sulphate, iron free	lb.	.02½	.02¾	.03	.0
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½	.07¾	.08	.0
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30	.30¾	.31	.3
Ammonium carbonate, powder	lb.	.07	.07½	.08	.0
Ammonium chloride, granular (white salammoniac)	lb.	.06½	.06¾	.07	.0
Ammonium chloride, granular (gray salammoniac)	lb.	.06¾	.07	.07½	.0
Ammonium nitrate	lb.	.07	.07½	.07¾	.0
Amylacetate tech	gal.	.....	.....	2.00	2.4
Arsenic oxide, (white arsenic) powdered	lb.	.07	.07½	.07¾	.0
Arsenic, sulphide, powdered (red arsenic)	lb.	.12	.12½	.12¾	.1
Barium chloride	ton	50.00	51.00	52.00	60.0
Barium dioxide (peroxide)	lb.	.21	.21½	.22	.2
Barium nitrate	lb.	.06½	.07	.07½	.0
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾	.04	.04¼	.0
Blanc fixe, dry	lb.	.04	.04½	.....	.....
Blanc fixe, pulp	ton	45.00	55.00	.....	.....
Bleaching powder (see calc. hypochlorite)		.....	.....	.....	.....
Blue vitriol (see copper sulphate)		.....	.....	.....	.....
Borax (see sodium borate)		.....	.....	.....	.....
Brimstone (see sulphur, roll)		.....	.....	.....	.....
Bromine	lb.	.20	.21	.21½	.2
Calcium acetate	100 lbs.	1.75	2.00	.....	.....
Calcium carbide	lb.	.04½	.04¾	.05	.0
Calcium chloride, fused, lump	ton	23.00	24.00	24.50	28.0
Calcium chloride, granulated	lb.	.01¾	.02	.02¼	.0
Calcium hypochlorite (bleach'g powder)	100 lb.	2.25	2.40	2.50	3.2
Calcium peroxide	lb.	.....	.....	1.40	1.5
Calcium phosphate, tribasic	lb.	.....	.....	.15	.1
Camphor	lb.	.....	.....	.90	.9
Carbon bisulphide	lb.	.06	.06¼	.06¾	.0
Carbon tetrachloride, drums	lb.	.10½	.10¾	.11	.1
Carbonyl chloride, (phosgene)	lb.	.....	.....	.60	.7
Caustic potash (see potassium hydroxide)		.....	.....	.....	.....
Caustic soda (see sodium hydroxide)		.....	.....	.....	.....
Chalk, precip.—domestic, light	lb.	.03¾	.04	.....	.....
Chalk, precip.—domestic, heavy	lb.	.03½	.03¾	.....	.....
Chalk, precip.—imported, light	lb.	.04	.04¼	.....	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06	.06¼	.06¾	.0
Chloroform	lb.	.....	.....	.38	.4
Cobalt oxide	lb.	.....	.....	2.00	2.1
Copperas (see iron sulphate)		.....	.....	.....	.....
Copper carbonate, green precipitate	lb.	.20	.20¾	.21	.2
Copper cyanide	lb.	.....	.....	.58	.6
Copper sulphate, crystals	100 lb.	5.60	5.65	5.70	6.2
Cream of tartar (see potassium bitartrate)		.....	.....	.....	.....
Epsom salt (see magnesium sulphate)		.....	.....	.....	.....
Ethyl acetate com. 85%	gal.	.....	.....	.58	.6
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	.....	.....	.93	.1
Formaldehyde, 40 per cent	lb.	.10½	.10¾	.11	.1
Fullers earth, f.o.b. mines	net ton	16.00	17.00	.....	.....
Fullers earth—imported powdered—net	ton	30.00	32.00	.....	.....
Fusel oil, ref.	gal.	.....	.....	2.50	3.0
Fusel oil, crude	gal.	.....	.....	1.50	1.7
Glauber's salt (see sodium sulphate)		.....	.....	.....	.....
Glycerine, c. p. drums extra	lb.	.....	.....	.16½	.....
Iodine, resublimed	lb.	.....	.....	3.80	3.9
Iron oxide, red	lb.	.....	.....	.12	.....
Iron sulphate (copperas)	ton	15.00	16.00	17.00	20.0
Lead acetate	lb.	.....	.....	.10¼	.....
Lead arsenate, powd	lb.	.15	.15½	.15¾	.....
Lead nitrate	lb.	.....	.....	.15	.....
Litharge	lb.	.07½	.07¾	.08	.....
Magnesium carbonate, technical	lb.	.06	.06½	.06¾	.....
Magnesium sulphate, U. S. P.	100 lb.	2.65	2.70	2.75	3.0
Magnesium sulphate, technical	100 lb.	.....	.....	1.05	1.2
Methanol, 95%	gal.	.....	.....	.61	.....

		Carlots	Less Carlots
Methanol, 97%	gal.	$.... - $.	$0 63 -$0 64
Nickel salt, double	lb.	..... -	11 - .11½
Nickel salt, single	lb.	..... -	12 - .12½
Phosgene (see carbonyl chloride)		..... -	..... - .....
Phosphorus, red	lb.	.45 - .46	.47 - .50
Phosphorus, yellow	lb.	..... -	.30 - .35
Potassium bichromate	lb.	.10 - .10½	10½ - .11
Potassium bitartrate (cream of tartar)	lb.	..... -	.24 - .26
Potassium bromide, granular	lb.	..... -	.14 - .18
Potassium carbonate, U. S. P	lb.	.11½ - .12	.12½ - .15
Potassium carbonate, 80–85%	lb.	.04½ - .04½	.05 - .06
Potassium chlorate, crystals	lb.	.05½ - .06	06½ - .12
Potassium cyanide	lb.	..... -	.43 - .45
Potassium hydroxide (caustic potash)	lb.	.06 - .06½	.06¾ - .06¼
Potassium iodide	lb.	..... -	2.90 - 3.00
Potassium nitrate	lb.	.07⅜ - .07½	.08 - .09
Potassium permanganate	lb.	.14 - .15	.16 - .22
Potassium prussiate, red	lb.	.33 - .33½	.33½ - .34½
Potassium prussiate, yellow	lb.	.25 - .25½	.25½ - .26½
Rochelle salts (see sodium potas. tartrate)		....	..... - .....
Salammoniac (see ammonium chloride)		....	.....- .....
Sal soda (see sodium carbonate)		..... -	.....- .....
Salt cake (bulk)	ton	17.00 - 20.00	..... - .....
Soda ash, light	100 lb.	1.75 - 2.00	2.05 - 2.40
Soda ash, dense	100 lb.	2.05 - 2.10	2.15 - 2.40
Sodium acetate	lb.	.04 - .04½	.04½ - .05
Sodium bicarbonate	100 lb.	2.25 - 2.30	2.35 - 2.75
Sodium bichromate	lb.	.07⅛ - .07½	.08 - .08½
Sodium bisulphate (nitre cake)	ton	4.75 - 5.00	5.25 - 6.00
Sodium bisulphite powdered, U.S.P	lb.	.04½ - .04½	.05 - .05½
Sodium borate (borax)	lb.	.05½ - .06	.06½ - 07
Sodium carbonate (sal soda)	100 lb.	1.70 - 1.80	1.85 - 2.10
Sodium chlorate	lb.	.06½ - .06½	.07 - .07½
Sodium chloride	long ton	12.00 -13.00	..... - .....
Sodium cyanide	lb.	.26 - .26½	.26½ - .27
Sodium fluoride	lb.	.10½ - .11	.11½ - .12
Sodium hydroxide (caustic soda)	100 lb.	3.70 - 3.75	3.80 - 4.20
Sodium hyposulphite	lb.	..... -	.03½ - .03¾
Sodium nitrite	lb.	.06½ - .06¾	.07 - .07½
Sodium peroxide, powdered	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic	lb.	.04¼ - .04½	.04¾ - .05¼
Sodium potassium tartrate (Rochelle salts)	lb.	..... -	.19 - .21
Sodium prussiate, yellow	lb.	.17½ - .17½	.17½ - .18
Sodium silicate, solution (40 deg.)	100 lb.	1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (60 deg.)	100 lb.	2.25 - 2.40	2.45 - 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.25 - 1.30	1.35 - 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ - .04½	.04¾ - .05
Sodium sulphite, crystals	lb.	.03½ - .03⅝	.03¾ - .04¼
Strontium nitrate, powdered	lb.	.10 - .11	.11½ - .15
Sulphur chloride, red	lb.	.05¼ - .05½	.05½ - .06
Sulphur, crude	ton	18.00 -20.00	..... - .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour	100 lb.	..... -	2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.	..... -	2.00 - 2.75
Talc—imported	ton	30 00 -40.00	..... - .....
Talc—domestic powdered	ton	18.00 -25.00	..... - .....
Tin bichloride	lb.	.08½ - .08¾	.09 - .09½
Tin oxide	lb.	..... -	.39 - .40
Zinc carbonate	lb.	.14 - .14½	.15 - .16
Zinc chloride, gran	lb.	.09 - .09½	.09½ - .10
Zinc cyanide	lb.	.42 - .44	.45 - .47
Zinc dust	lb.	.11¼ - .11½	.11¾ - .12½
Zinc oxide, XX	lb.	.07⅜ - .07¾	.08 - .09
Zinc sulpbate	100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.15 — 1.20
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.17 — .18
Aniline salts	lb.	.25 — .26
Anthracene, 80% n drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P	lb.	1.35 — 1.45
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P	lb.	.60 — .65
Benzoate of soda, U.S.P	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.27 — .29
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.30 — .32
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.24 — .26
Cresylic acid, 97–99%, straw color, in drums	gal.	.65 — .70
Cresylic acid, 95-97%, dark, in drums	gal.	.60 — .65
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.90 — 1.05
Dimethylaniline	lb.	.40 — .45
Dinitrobenzene	lb.	.21 — .25
Dinitroclorbenzene	lb.	.25 — .27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.38 — .40
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.31 — .35
Dipnenylamine	lb.	.60 — .70
H-acid	lb.	.95 — 1.05
Meta-phenylenediamine	lb.	1.05 — 1.10
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.30 — 1.40
Naphthalene crushed, in bbls	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — .08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.85 — 2.90
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1 25 — 1.30
Para-amidophenol, HCl	lb.	1 45 — 1.50
Para-dichlorbenzene	lb.	17 — 18
Paranitroaniline	lb.	77 — .80
Para-nitrotoluene	lb.	70 — .75
Para-phenylenediamine	lb.	1 60 — 1.65
Para-toluidine	lb.	1 10 — 1.15
Phthalic anhydride	lb.	37 — .40
Phenol, U. S. P., drums	lb.	.12 — .16
Pyridine	gal.	1.75 — 2.75
Resorcinol, technical	lb.	1.40 — 1 50
Resorcinol, pure	lb.	2 00 — 2 25
Salicylic acid, tech., in bbls	lb.	.20 — 21
Salicylic acid, U. S. P	lb.	23 — .24
Salol	lb.	.75 — 77
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.26 — .28
Tolidine	lb.	1 20 — 1 30
Toluidine, mixed	lb.	.32 — .38
Toluene, in tank cars	gal.	.25 — 28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal	lb.	.40 — 45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.24 — .25
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.34 — .38
Candellila wax	lb.	.23 — .24
Carnauba, No. 1	lb.	.45 — .46
Carnauba, No. 2, North Country	lb.	.22 — .22½
Carnauba, No. 3, North Country	lb.	.13½ — .14
Japan	lb.	.19 — .20
Montan, crude	lb.	.04½ — .05
Paraffine waxes, crude match wax (white) 105-110 m.p	lb.	.04¼ — .04¾
Paraffine waxes, crude, scale 124-126 m.p	lb.	.03¼ —
Paraffine waxes, refined, 118-120 m.p	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p	lb.	.03½ — .03¾
Paraffine waxes, refined, 128-130 m.p	lb.	.04 — .04¼
Paraffine waxes, refined, 133-135 m.p	lb.	.04½ — .05
Paraffine waxes, refined, 135-137 m.p	lb.	.05½ — .05½
Stearic acid, single pressed	lb.	.09¼ — ...
Stearic acid, double pressed	lb.	.09½ — ...
Stearic acid, triple pressed	lb.	.10½ — .10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.25	— 5.30
Rosin E-I	280 lb.	5.35	— 5.40
Rosin K-N	280 lb.	6.00	— 6.70
Rosin W. G.-W. W	280 lb.	7.00	— 7.25
Wood rosin, bbl	280 lb.	6.25	— .....
Spirits of turpentine	gal.	.91	— .....
Wood turpentine, steam dist	gal.	.89	— .....
Wood turpentine, dest. dist	gal.	.88	— .....
Pine tar pitch, bbl	200 lb.	.....	— 6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	— 10.00
Retort tar, bbl	500 lb.	.....	— 9.00
Rosin oil, first run	gal.	.36	— .....
Rosin oil, second run	gal.	.39	— .....
Rosin oil, third run	gal.	.46	— .....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	$2.30	— 2.60
Blood, dried, f.o.b., N. Y	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00	— 32.00
Fish scrap, dom., dried, f.o.b. works	unit	2 90	— 3.00
Nitrate soda	100 lb.	2.37	— 2.40
Tankage, high grade, f.o.b. Chicago	unit	2.75	— 3 00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50	— 7.00
Tennessee, 78-80%	ton	8.50	— 9.00
Potassium muriate, 80%	ton	34.00	— 35.00
Potassium sulphate	unit	1.00	—

Crude Rubber

Para—Upriver fine	lb.	$0.23	— .23½
Upriver coarse	lb.	.13½	— 14
Upriver caucho ball	lb.	.13	— 13½
Plantation—First latex crepe	lb.	18½	— 18¾
Ribbed smoked sheets	lb.	18½	— 19
Brown crepe, thin, clean	lb.	.15	— .
Amber crepe No. 1	lb.	.17½	— ..

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13¾ —	.13½
Coconut oil, Ceylon grade, in bbls.	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls.	lb.	.10 —	.10¼
Corn oil, crude, in bbls.	lb.	.08½ —	.08¾
Cottonseed oil, crude (f. o. b. mill)	lb.	.07 —	.07¼
Cottonseed oil, summer yellow	lb.	.09 —	.09¼
Cottonseed oil, winter yellow	lb.	.09¾ —	.10
Linseed oil, raw, car lots (domestic)	gal.	.70 —	.71
Linseed oil, raw, tank cars (domestic)	gal.	.65 —	.66
Linseed oil, in 5-bbl lots (domestic)	gal.	.73 —	.74
Olive oil, denatured	gal.	$1.15 —	$1.20
Palm, Lagos	lb.	.08¼ —	.08¾
Palm, Niger	lb.	.06½ —	.06⅝
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07½ —	.07¾
Peanut oil, refined, in bbls.	lb.	.10½ —	.11
Rapeseed oil, refined in bbls.	gal.	.82½ —	.83
Rapeseed oil, blown, in bbls.	gal.	.87 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08¾ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 —	....

FISH

Light pressed menhaden	gal.	$0.46 —	....
Yellow bleached menhaden	gal.	.48 —	....
White bleached menhaden	gal.	.50 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise States

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$23.00 —	23.50
Barytes, ground, off color, f.o.b. Kings Creek	net ton	15.00 —	17.00
Barytes, crude, 88% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude, first grade, Missouri	net ton	6.00 —	7.00
Casein	lb.	.15 —	.16
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50 —	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	12.00 —	20.00
China clay (kaolin), imported, powdered	net ton	25.00 —	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00 —	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00 —	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00 —	....
Graphite, Ceylon lump, first quality	lb.	.05½ —	.06½
Graphite, Ceylon chip	lb.	.04 —	.05
Graphite, high grade amorphous crude	lb.	.00¼ —	.02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00 —	....
Kieselguhr, f.o.b. N. Y.	per ton	55.00 —	60.00
Magnesite, calcined	per ton	50.00 —	65.00
Pumice stone, imported	lb.	.03 —	.40
Pumice stone, domestic, lump	lb.	.05 —	.05½
Pumice stone, domestic, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.68 —	.70
Shellac, orange superfine	lb.	.71 —	.72
Shellac, A. C. garnet	lb.	.58 —	.60
Shellac, T. N.	lb.	.65 —	66
Soapstone	ton	12.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50 —	11.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton		$50.00
Carborundum refractory brick, 9-in.	less than carlot	1,000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton		52–55
Chrome cement, 40-50% Cr_2O_3	net ton		30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton		33–35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		35–40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		30–35
Magnesite brick, 9-in. straight	net ton		65–76
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000		40–42
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000		42–45
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000		35–38

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½—	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport	gross ton	54.00 —	58.35
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00 —	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	21.00 —	22.00
Coke, foundry, f.o.b. ovens	net ton	3.50 —	3.75
Coke, furnace, f.o.b. ovens	net ton	2.75 —	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24 —	....
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.48 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½—	.13¾

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	35.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	32.25
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375–4.40
Zinc, spot, New York	5.15–5.175
Zinc, spot, E. St. Louis	4.70–4.725

OTHER METALS

Silver (commercial)	oz.	$0.66¼
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.85@1.95
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	93.00–105.00
Iridium	oz.	170.00@200.00
Palladium	oz.	60.00–65.00
Mercury	75 lb.	50.00–51.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.25
Copper bottoms	28.75
Copper rods	19.75
High brass wire	17.45
High brass rods	14.75
Low brass wire	18.75
Low brass rods	19.25
Brazed brass tubing	25.50
Brazed bronze tubing	30.50
Seamless copper tubing	21.25
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	9.75@10.25
Copper, heavy and wire	9.25@9.50
Copper, light and bottoms	7.50@8.00
Lead, heavy	3.50@3.75
Lead, tea	3.00@3.25
Brass, heavy	4.25@4.50
Brass, light	3.25@3.50
No. 1 yellow brass turnings	4.00@4.25
Zinc	2.00@2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.63	$2.78	$2.78
Soft steel bars	2.53	2.68	2.68
Soft steel bar shapes	2.53	2.68	2.68
Soft steel bands	3.13	3.28	3.28
Plates, ¼ to 1 in. thick	2.63	2.78	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES — The Southern Pacific Railroad Co., 65 Market St., San Francisco, has completed plans for the construction of a new creosoting plant at Wilmington, Los Angeles Harbor, to consist of five 1-story buildings, estimated to cost about $150,000 with equipment. The erection contract has been let and work will be placed under way at once.

BURBANK — The American Aluminum Products Co., Los Angeles, care of Richard D. King, 519 Van Nuys Bldg., architect, has taken bids for the erection of its proposed new plant at Burbank, to consist of a group of 7 buildings, estimated to cost in excess of $75,000.

Connecticut

NEW LONDON—The Robert Gair Co., 45 Washington St., Brooklyn, manufacturer of paper boxes, containers, etc., is considering the erection of a new plant in Connecticut, on site in the vicinity of its New London works. The company has arranged for a mortgage of $6,000,000 on its properties, to provide for increased working capital and expansion, including the proposed new mill.

NEW HAVEN—Fire in the 4-story factory at 138-44 State St, occupied by a number of industrial concerns, destroyed a portion of the works of the Elm Novelty Mfg. Co., manufacturer of paper boxes, with a loss estimated at about $20,000; C. H. Pulkin, paper goods, with loss of about $15,000, and the plant of the Central Brass Co., with loss of about $8,000.

Florida

MOORE HAVEN—The City Council is planning for the installation of a new filtration plant at the municipal waterworks.

Georgia

CAMILLA — Fire recently destroyed a portion of the plant of the Camilla Cotton Oil & Fertilizer Co., with loss estimated at about $20,000.

Iowa

DUBUQUE—The Globe Portland Cement Co., 416 McKnight Bldg., Minneapolis, Minn., will break ground about March 15 for the erection of its proposed new cement plant at Dubuque, consisting of a number of mill buildings, estimated to cost about $1,500,000. The C. L. Pillsbury Co., 1200 Second Ave., South Minneapolis, Minn., is engineer.

Maryland

BALTIMORE — The American Concrete Tile & Products Co., 305 Gaither Bldg., recently organized with a capital of $250,000, has preliminary plans under way for the erection of a new plant on local site, estimated to cost about $70,000, including machinery. The company will specialize in the manufacture of brick, tile, blocks and kindred products. John E. Springer is president, and John W. Ritter, secretary and treasurer.

BALTIMORE — The Consolidated Gas, Electric Light & Power Co, Lexington Bldg., has filed plans for the construction of a new steel gas holder at its gas-manufacturing plant, 278 ft. in diameter, and 225 ft. high, to cost $860,000. The Bartlett-Hayward Co., Scott and McHenry Sts., has the erection contract.

BALTIMORE — In connection with the enlargement of its oil refinery in the Canton district, now under way, the Standard Oil Co., Pratt and Commerce Sts., purposes to make this plant the second largest works of its kind in the country, with capacity for handling about 56,000 bbl. of crude oil per day, the larger amount of which will be from the Mexican fields of the company. Extensive storage facilities will be provided.

Massachusetts

SPRINGFIELD — The Strathmore Paper Co. has awarded a contract to the Casper Ranger Construction Co., Holyoke, Mass., for the construction of an addition to its plant.

WALTHAM — The Elastoid Fiber Co., Norman and Marshall Sts., is arranging for the early occupancy of its new 1-story plant addition, 72 x 180 ft., now in course of erection, to include a 1-story power house. All miscellaneous contracts have been let. The plant will cost about $35,000.

ASHLAND — Fire, Jan. 10, destroyed a portion of the plant of the Angier Mills, Main St., manufacturers of waterproof papers, with loss estimated at about $200,000. The plant consisted of three main buildings.

MALDEN—Wadsworth, Howland & Co., Inc., 139 Federal St., Boston, manufacturer of paints, etc., has awarded a contract to Coleman Bros., Charlestown, Mass., for the construction of a 4-story addition, 40 x 80 ft., to its plant on Green St., Malden, estimated to cost about $27,000.

Michigan

CLAWSON—The Clawson Brick & Tile Co. has acquired a local site for the construction of a new plant, to be equipped for the manufacture of brick, tile and other burned clay products.

CADILLAC — Construction has been inaugurated on a new 1-story and basement foundry, 87 x 100 ft. on local site, to be owned and occupied by a new company now being organized by R. J. Teetor of the Mitchell Digging Iron Co., Cadillac. It will be equipped for the manufacture of iron, steel and other metal castings, and is estimated to cost in excess of $100,000. Frank D. Chase, Inc., 646 North Michigan Ave., Chicago, Ill., is architect and engineer.

Missouri

CAPE GIRARDEAU — The Cape Girardeau Portland Cement Co. is planning for extensions and improvements in its plant, including the remodeling of certain portions of the works and the installation of new grinding and other machinery. It is purposed to develop an output of about 2,400 bbl. per day. New equipment will be installed at the power plant. The work is estimated to cost about $150,000. Charles L. Harrison is president.

ST. LOUIS—The Obear-Nester Glass Co., 25 North 2nd St., is considering preliminary plans for the construction of a 1-story addition to its glass manufacturing plant at Broadway and Belt Sts., East St. Louis, Ill., estimated to cost approximately $75,000.

MONETT — The Hammond Dehydration Co. has plans under way for the construction of a new 2-story dehydration plant on local site. Hickenlively & Marks, Landers Bldg., Springfield, Mo., are architects.

New Jersey

CROSSWICKS — The General Rendering Co., a subsidiary of Wilson & Co., U. S. Stock Yards, Chicago, Ill., will make a number of alterations and improvements at its local plant, and has temporarily discontinued operations for this purpose. The machinery will be modernized and capacity increased. Wylie E. Brown is manager.

PERTH AMBOY — The Raritan Copper Works, foot of Elm St., a subsidiary of the Anaconda Copper Co., 25 Broadway, New York, is perfecting plans for the manufacture of copper shingles and affiliated products at its plant, and machinery for this purpose will be installed at an early date. It is planned to manufacture, also, copper leaders, gutters, etc.

New York

LONG ISLAND CITY — The Standard Sanitary Mfg. Co., Bessemer Bldg., Pittsburgh, Pa., manufacturer of sanitary ware, has acquired the plant of the Goodyear Tire & Rubber Co., Jackson Ave. and Honeywell St., Long Island City, for an eastern works. It consists of a 6-story building, aggregating about 63,000 sq.ft. of floor space, and was secured for a consideration said to be $500,000. Operations will be inaugurated at an early date.

Oklahoma

OKMULGEE—The Highway Oil Refining Co. is completing plans for the rebuilding of its local gasoline plant, recenty destroyed by fire with loss estimated at about $25,000. W. E. Burke is secretary and manager.

TULSA—The Brite-Lite Polish Co., 411 Robinson Bldg., recently organized, has plans in preparation for the construction of a new local plant, 50 x 75 ft., for the manufacture of polishes. Machinery will be installed for an initial capacity of about 500 bottles per day. S. S. Bassett is vice-president, and P. G. Hefflefinger, secretary and treasurer.

Ohio

TOLEDO — The Electric Glass Co., 505 St. Clair St., has awarded a contract to Otto C. Hoelzer, 706 West Central St., for the erection of a new 2-story plant at 1310 Front St., to be used for the manufacture of glass specialties. Henry Pingen is president and treasurer.

Pennsylvania

PHILADELPHIA — The Boice Folding Box Co., Inc., a new organization, manufacturer of paper folding boxes and containers, is completing plans for the construction of a new plant at Ogden and Hutton Sts. E. L. Rothschild, 1420 Chestnut St., is architect. Wilson Scott Boice, 4020 Spruce St., is president of the company.

POTTSTOWN — The Vulcweld Rubber Co., manufacturer of automobile tires and other rubber products, is having plans prepared for the construction of a new 2-story plant, 60 x 260 ft., on site recently acquired on West High St. A 1-story power house, 40 x 65 ft., will be erected, also. The plant is estimated to cost about $200,000. E. W. Smith heads the company.

PITTSBURGH — The Thermatomic Carbon Co., a new organization, headed by R. H. Uhlinger, 3612 Bates St., is arranging for the erection of a new plant on site selected in Louisiana, for the manufacture of carbon black and affiliated products. A permit has been granted by the Louisiana State Department of Conservation for the new works.

Tennessee

CHATTANOOGA — The Signal Mountain Portland Cement Co., James Bldg., will break ground early in March for the construction of its proposed new plant in the vicinity of Chattanooga. The mill will consist of a number of buildings, and is estimated to cost in excess of $500,000. J. L. Senior is president.

KNOXVILLE — The Knoxville Cement Products Co., manufacturer of cement bricks, tile, blocks and kindred products, is planning for the installation of additional machinery at its plant. The company was organized recently under state laws. C. P. Koehn is president and manager.

CHATTANOOGA — The Ocoee Copper Co., 1135 Volunteer Life Bldg., will take bids early in February for the construction of its proposed new flotation plant at Ducktown, near Chattanooga, on site recently acquired. It will be completely equipped for the treating of copper ores, and is estimated to cost about $200,000. J. I. Carter is president, and L. P. Hope, engineer in charge.

Washington

VANCOUVER—The Pacific States Rubber Co., recently organized by A. M. Elliott, Vancouver, and associates, is arranging for the purchase of a local site for the construction of a large plant for the manufacture of rubber products of various kinds. The initial plant unit will cost about $500,000, and later extensions will bring the investment up to more than $1,000,000. Plans for the plant will be prepared at an early date.

West Virginia

NITRO—The Seydel Mfg. Co., 86 Forrest St., Jersey City, N. J., manufacturer of chemical products, is arranging for the establishment of a large plant on site recently acquired at Nitro, and for which purpose a company of similar name has lately been organized with capital of $1,500,000, effecting a merger between the Seydel company and the Nitro Products Co., manufacturer of like specialties. Operations will be concentrated at the new location and the present plant removed to this point. Herman Seydel heads the company.

New Companies

THE TEXALO OIL CORP., Buffalo, N. Y., has been incorporated with a capital of $300,000, to manufacture oil products. The incorporators are B. Rumsey, J. Argue and B. F. Milsom. The company is represented by Abbott & Abbott, Iroquois Bldg., Buffalo.

THE PHILADELPHIA PORCELAIN CO., Woodlynne, N. J., has been incorporated with a capital of $50,000, to manufacture porcelain ware of various kinds. The incorporators are William T. Allen, William A. Leiser and John Tuthill, Woodlynne.

THE ANDERSON MAGNESIA PRODUCTS CO., Boston, Mass., has been incorporated with a capital of $100,000, to manufacture magnesia and asbestos goods. James G. Anderson, 47 Harvard St., is president and treasurer; John G. Anderson is secretary.

THE DAWSON BRICK CO., Dawson Springs, Ky., has been incorporated with a capital of $20,000, to manufacture brick and other burned clay products. The incorporators are Lee O. Dixon, Charles F. Cato and I. N. Day, all of Dawson Springs.

THE NATIONAL PRODUCTS CO., 3058 West Harrison St., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Max Schwartz and Harry Robbins.

THE CARBON FIREBRICK & COAL CO., Carbon, Ind., has been incorporated with a capital of $25,000, to manufacture firebrick and other refractory products. The incorporators are J. L. Sydenstricker; E. L. Strader and Benjamin Simpson, all of Carbon.

THE PHOENIX RUBBER CO., Brockton, Mass., has been incorporated with a capital of $25,000, to manufacture and deal in rubber goods. Charles D. Wener is president; and Charles D. Burnes, 100 Columbia St., Brookline, Mass., treasurer.

THE THOMPSON CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $1,000,000 under Delaware laws, to manufacture chemicals and chemical byproducts. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE MERVYN LABORATORIES, Brooklyn, N. Y., has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are S. W. Green, S. Richardson and B. Rafkin. The company is represented by Bertrand Ettinger, 50 Court St., Brooklyn.

THE MARYLAND STEEL CORP., 4th and C Sts., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture steel, nickel, copper and other metal products. The incorporators are Irving Reynolds, Louis H. Reuter and A. Arthur Jenkins.

THE IMPERIAL POLISH CO., Philadelphia, Pa., has been incorporated with a capital of $10,000, to manufacture polishes and kindred specialties. Henry C. Watt, 618 North 43rd St., Philadelphia, is treasurer.

THE CARBON DIOXIDE PLANT FOOD CO., St. Augustine, Fla., has been incorporated with a capital of $4.500, to manufacture fertilizer specialties. W. B. Guy is president; Bobert Ranson, vice-president and R. D. Crawley, St. Augustine, secretary and treasurer.

THE UNITED RUBBER CORP., Portland, Me., has been incorporated with a capital of 1,000 shares of stock, no par value. to manufacture rubber products of various kinds. Edgar J. Warren is president and treasurer. Doris I. Laffin, Portland, is representative for the company.

THE DRY COLOR CORP., Wilmington, Del., has been incorporated under state laws with capital of $2,050,000 to manufacture colors, chemical products, etc. The company is represented by the United States Corporation Co., Dover, Del.

THE CREAM CITY MIRROR PLATE CO., Milwaukee, Wis., has been incorporated with a capital of $50,000, to manufacture mirrors, glass products, etc. The company will succeed the company of the same name, with local plant, recently dissolved. The incorporators are H. R. Seidel, Edward H. Smith and William Mauthe. The company is represented by Bloodgood, Kemper & Bloodgood, Mitchell Bldg., Milwaukee.

THE MERIDIAN FIBRE CO., Meridian, Miss., has been incorporated with a capital of $35,000, to manufacture fiber products. The incorporators are A. J. Lyon, R. L. Tinsley and Stanton Brown, all of Meridian.

THE R. W. SHEETS PAPER BOX CO., 1008 Mulberry St., Rockford, Ill., has been incorporated with a capital of $100,000, to manufacture paper boxes and kindred products. The incorporators are R. M. Anderson, R. W. and C. A. Sheets.

THE MATE CORP. OF AMERICA, Huntington, L. I., N. Y., has been incorporated with a capital of $350,000, to manufacture chemicals, drugs and affiliated products. The incorporators are T. J. Doran, F. P. J. Crowley and H. Quick. The company is represented by John Boyle, Jr., 570 East 161st St., New York.

THE AMERICAN RADIUM APPLIANCE CO., Morristown, N. J., has been incorporated with a capital of $100,000, to manufacture radium specialties. The incorporators are Ernest B. Rubsamen, Samuel C. Cutler and Francis H. Glazebrook, 171 South St., Morristown.

THE WALLINGFORD STEEL CO., Wallingford, Conn., has been incorporated with a capital of $200,000, to manufacture steel and other metal products. The incoroprators are C. W. Leavenworth, F. A. Wallace and E. B. Cleborne, all of Wallingford.

THE DESOTO OIL AND GAS CO., Jacksonville, Fla., has been incorporated with a capital of $100,000, to manufacture petroleum products. J. E. Johnson, Orange, Tex., is president and manager; P. V. Summers, Jacksonville, vice-president; and Herschel Ehlert, Houston, Tex., secretary and treasurer.

THE MEAKER SPARK PLUG CO., Detroit, Mich., has been incorporated with a capital of $10,000, to manufacture porcelain spark plugs. The incorporators are Ralph H. Meaker, Edward F. Loud and Harry L. Pierson, Jr., 7939 Lafayette Ave., Detroit.

THE STERLO DRUG & CHEMICAL CO., Richmond, S. I., N. Y., has been incorporated with a capital of $50,000, to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are W. P. and P. F. Tiernan, and J. S. Minogue, Jr. The company is represented by J. H. Tiernan, Cedar Grove Beach, Dongan Hills, S. I.

THE PALMETTO OIL CO., Tulsa, Okla., has been incorporated with a capital of $50,000, to manufacture petroleum products. The incorporators are Stanley D. Campbell, Ray S. Fellows and Albert H. Bell, all of Tulsa.

THE NORTH RIVER BRICK CO., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture bricks. The incorporators are F. Demovitch, M. M. Sherower and F. Raab. The company is represented by Joseph, Demov & Feinstein, 277 Broadway, New York.

THE HOLLAND TILE & GRAVEL CO., Holland, Mich., has been incorporated with a capital of $25,000, to manufacture burned clay drain tile, sewer pipe and cement products. The incorporators are George J. Huntley, W. E. Dunn and H. E. Dunn, all of Holland.

THE MODERN CHEMICAL CO., Wilmington, Del., has been incorporated with a capital of $100,000, under state laws, to manufacture chemicals and chemical byproducts. The incorporators are William B. Clark and Mark R. Yates, Washington, D. C. The company is represented by Charles G. Guyer, 826 Market St., Wilmington.

THE SWITZER-PARKE CO., Houston, Tex., has been incorporated with a capital of $30,000, to manufacture baked enamels, drying paints, etc. The incorporators are Homer E. and S. J. Switzer, Melville B. and W. M. Parke, all of Houston.

THE JOHN H. WALSH CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture leather specialties, bookbinders' paste and other kindred products. The incorporators are John H. and F. G. Walsh, and W. A. Smith. The company is represented by Guggenheimer, Curtin, Coyle & Glynn, 233 Broadway, New York.

THE MOCKLAIR CORP., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture fiber products. The incorporators are H. A. Mocklair, H. May and G. E. McArdle. The company is represented by Butcher, Tanner & Foster, 1 Madison Ave., New York.

THE CHEMICAL INK CO., Brooklyn, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are J. A. Selas, K. Dyer and W. H. Stieglitz. The company is represented by M. J. Moore, 141 Broadway.

THE DUMONT FERTILIZER CO., INC., Wilmington, Del., has been incorporated with a capital of $500,000, to manufacture fertilizer products. The company is represented by the Corporation Service Co., Wilmington.

THE ENAMEL PRODUCTS CO., INC., Indianapolis, Ind., has been incorporated with a capital of $15,000, to manufacture vitrous enamel products. The incorporators are L. B. Mosiman, B. C. Street and R. C. Street, Indianapolis.

Capital Increases, Etc.

THE SHAFFER OIL & REFINING CO., Oklahoma City, Okla., manufacturer of refined oil products, with office at 208 South La Salle St., Chicago, Ill., has arranged for a bond issue of $1,500,000, for general financing, operations, etc.

THE JOHNSTON CHEMICAL CO., Shepherd, Mich., has filed notice of dissolution under state laws.

THE NEW YORK QUEBRACHO EXTRACT CO., 80 Maiden Lane, New York, N. Y., has filed notice of change of name to the Tanni Corp.

THE CORONA CHEMICAL CO., 16 East 40t St., New York, N. Y., has filed notice of in crease in capital from $25,000 to $500,00

THE KING PHILIP OIL CO., New Bedford, Mass., has filed notice of increase in capita from $3,000,000 to $6,000,000.

THE SOUTH PORTO RICO SUGAR CO., 6 Cedar St., New York, N. Y., has disposed a bond issue of $6,000,000, for financing general operations, etc. F. A. Dillingha is president.

THE MESABI IRON CO., 25 Broad St., Ne York, N. Y., has arranged for an increas in capital from $33,000,000 to $53,000,000.

THE CALUMET OIL CO., El Paso, Tex has filed notice of increase in capital fro $50,000 to $150,000.

THE WILLIAM E. DEE CO., 30 North L Salle St., Chicago, Ill., manufacturer firebrick, tile, sewer pipe and other burne clay products, has filed notice of increase capital of $750,000 to $2,000,000, to cove the merger of a number of subsidiary com panies.

THE WAUGH CHEMICAL CORP., 2 Rect St., New York, N. Y., has filed schedul in bankruptcy with liabilities stated $211,276, and assets, $182,994.

Percival Wilds and Walter S. Wyma both of Augusta, Me., have been appointe receivers for the KENNEBEC PAPER CO. an the CUSHNOC PAPER CO., both of that cit under bond of $25,000 in each instance.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold twenty-fourth annual meeting at St. Lou Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold spring meeting at Birmingham, Ala., Ap 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY w hold its spring meeting in Baltimore, Ap 27, 28 and 29, 1922.

AMERICAN FOUNDRYMEN'S ASSOCIATIO will hold its next convention and exhibit Cleveland, O., during the week of Ap 24, 1922. Meetings will be held in t spring instead of in the fall as heretofo

AMERICAN INSTITUTE OF MINING A METALLURGICAL ENGINEERS will hold spring meeting in New York the week Feb. 20, 1922.

AMERICAN SOCIETY FOR TESTING M TERIALS will hold its twenty-fifth annu meeting June 26 to July 1, at Atlan City, N. J. Headquarters will be at t Chalfonte-Haddon Hall Hotel.

NEW JERSEY CHEMICAL SOCIETY holds meeting at Stetters Restaurant, 842 Bro St., Newark, N. J., the second Monday every month.

NORTHWEST MINING ASSOCIATION w hold a convention in the Chamber of Co merce Bldg., Spokane, Wash., Feb. 14 to

STAMFORD CHEMICAL SOCIETY, Stamfo Conn., holds a meeting in the lecture ro of the local high school on the fourth Mo day of each month, except June, Ju August and September.

The following meetings are scheduled be held in Rumford Hall, the Chemis Club, New York: Feb. 10—Americ Electrochemical Society (in charge), S ciety of Chemical Industry, Société Chimie Industrielle, American Chemi Society, joint meeting; March 10—Am ican Chemical Society, Nichols Med March 24—Society of Chemical Indu try, regular meeting; April 21—Soci of Chemical Industry (in charge), Ame can Electrochemical Society, Société Chimie Industrielle, American Chemi Society, joint meeting; May 5—Americ Chemical Society, regular meeting; May —Société de Chimie Industrielle (in charg American Chemical Society, Society Chemical Industry, American Electroche ical Society, joint meeting; May 19—Soci of Chemical Industry, regular meetin June 9—American Chemical Society, re lar meeting.

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

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CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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A Word To the Foolish

THESE words, alas, are designed for a gentleman who, probably, will never see them, because he does not read the chemical journals. He is in the chemical business, but not in the chemical profession. His money is in the works, but his heart is neither there nor in the laboratory. It is in the counting house. What we have to say to you, sir, is something you do not know. Your leading chemist, on whom you set such great store, wants to leave you. You can't understand why? Of course you can't, and we doubt if you could even if you were right here, sitting across the table from us. But now we shall make it harder still for you to understand. He is anxious to get another engagement even at a reduction of income. He is satisfied with the salary you pay him. In fact, you give him everything he asks for. His work, as work, suits him, and there is every reason to believe that it suits you.

Then what is the matter? We fear it is nothing you can remedy. You see, you are not as young as you were and your habits of mind are settled. You are a man of affairs, and that is a reputable calling. But although you are engaged in the chemical business you are not a chemist. To you chemistry means money, profit and sales, but it has not entered into your soul the way, let us say, your ambitions for your son have entered into your soul. You think, probably, that because the Doctor goes to the laboratory every day and draws his big check at the end of every month, he is satisfied. Well, now, we tell you, he is not satisfied at all. He has his dreams, just as you have yours. When he was young he heard his own tune sounded in the offing, and that was the call of chemistry, which he followed. He made good, and having done so you tendered him his present post, which he accepted. But because you are ignorant and narrow-minded and scientifically blind and deaf you can't understand that the call he heard was neither your whistle nor the clink of your coin. It was something infinitely bigger. It was the call of Science. It was the privilege, the distinction, to contribute something to human understanding. It was impersonal.

Now let us tackle the situation from another angle. That chemist of yours is dotty. He's got wheels. He wants to help humanity! Isn't that absurd? But that's his game. When he gave up pure science and embraced industry he thought that the larger purpose of industry was to augment human welfare, and that your dividends would come along on the side as some sort of honorarium. He never learned that antique slogan of yours that "Business is war." It never worried him to think that if information leaks out of the works, some competitor may profit by it, although you are very keen to forbid all communications that might lead to this. But it stands to reason that your competitors are in about the same position as yourself, and that they know some things that you don't. Slowly, whatever any one of you knows percolates through, and in the end the whole industry has it; but so long as you and your competitors are obstinate, the industry is retarded—seriously retarded.

We know some concerns that have given up having trade secrets. There are not many of them, but they are successful, and clear out of your class. Their chemists go to meetings and tell nearly everything they know, to the amazement of competitors who straightway profit by it. But they keep ahead of the game.

Don't you think it is about time for you to rest on your laurels and retire? Then you may get someone who knows the profession as well as the business of chemistry to take your place. That will raise the class of your whole institution. It will make for progress and even greater profit in the long run. But there's no use in trying to explain it to your directors. They don't understand, either. Like you, they are, scientifically speaking, ignorant men.

Mr. Ford and Muscle Shoals

WHAT will Mr. FORD do with Muscle Shoals if he gets it? Speculation has been rife for some time as to the purpose of the automobile manufacturer in acquiring this power and industrial project. Undoubtedly his primary interest is in power, because it will enable him to produce such metals as aluminum and magnesium, which might conceivably find extensive use in automobile manufacture. That he will make nitrogen fertilizer in some form or other is a part of his proposed contract with the government, though it is not expected that he will operate the nitrate plants solely along the lines for which they were designed and built. Phosphate fertilizer undoubtedly would be included in his program. Rumor has it that he will experiment with cotton for the production of a fiber board or similar material for automobile bodies, with the object of producing a car light in weight throughout its construction. All of these are rational proposals and would logically grow out of the acquisition of an industrial and power plant situated in a country that produces minerals and cotton.

Congress will soon have an opportunity to show whether it was sincere in disapproving the plan for the United States Fixed Nitrogen Corporation on the score that it did not believe in the government going into business and that it preferred to see the Muscle Shoals properties acquired and operated by private interests. We do not favor Mr. FORD'S proposal as far as it has been disclosed, for reasons which we have already set forth. It remains to be seen whether he has modified the objectionable items in the definite form of contract which he is understood to have signed.

Developing Chemists In the Industries

RECENTLY we have discussed several phases of the chemist's education as he obtains it in college. This is but the preparatory groundwork for the training that he will receive in his first few years of industrial experience, for it is in this period that he will usually discover his aptitude and fitness for his life's work. When he gets his first job in industry he cannot be sure at that stage of his training just what bent his ability will take nor what line of work he is most desirous of pursuing. If he chooses then, he does so blindly. He is likely to be influenced by a minor thing, by his admiration for some particular man who has been successful in his field or by the first job which offers an income. He is uninformed as to the range of opportunities. His college training usually will not help him to visualize the business world. But in order eventually to advance in the industry he must be able to picture in his mind the operations and processes in the manufacturing departments.

He can do no better then than seek a laboratory job in plants manufacturing heavy products from raw materials, such as acids, alkalis, coal products, metals, petroleum, oils, crude rubber or animal products. His choice among these is not so important, but may be governed by an estimate of the possible future growth of the particular one in question. If he has in the latter years of his college course been a consistent reader of technical and trade papers reflecting the economics of the technical industries, he will have some measure of information on which to base his decision.

These industries in turn may look upon their laboratory man as a raw material for other departments. While analyzing the materials, intermediate and finished products of the plant in his routine control or research operations, he must, by virtue of necessary contact with the processes and equipment, pick up considerable information on construction details, mechanical design, engineering features and business methods. He may be unobserving by nature, lazy of mind and learn very little, or he may be alert and obtain a large amount of information. His attitude at this point will largely determine his fitness to survive and develop in the field. The wise executive must eventually notice his bent and bring him into one of the departments as foreman, construction boss, engineer or efficiency man.

True, some plant managers are themselves lacking in ability to recognize human qualifications. In this case the alert chemist will seek employment elsewhere while either the manager or plant ultimately fails and falls behind in the business field; for the development of the human is far more important to the success of a business enterprise than any consideration of machinery or material.

Having eventually arrived at a better position in a department outside the laboratory, with the background of first a good character and second a technical education, the student rapidly passes the old-time operating man and is soon ready to become plant executive or salesman or fill some other coveted position. For he has now added to other experience the one most valuable of all—namely, a knowledge of the mechanism of plant apparatus and production. Knowledge based on actual physical contact with the things of industry and close association with the humans who work with them is the greatest essential to success in all branches. The salesman, for instance, can no longer succeed by a worship of the deity of well-turned words, better known as "hot air." For the salesman who is sure of his own knowledge and strong in his own heart must succeed. No argument coined by the keenest of buyers can disturb his solicitation.

Climbing then from the first step in industry as a laboratory man, up to the second as a "straw boss," and on to the third as a department foreman, the chemist of industry is standing where he may look over the nearer landscape and get a glimpse of the peaks of executive control beyond.

Does Business Want The Soldier Bonus?

OPPOSITION to the so-called soldier bonus proposed by Congress is admittedly an unpopular rôle to assume at this time. But the situation is fraught with such vital consequences to business and industry in this country that we deem it a reasonable duty to voice our protest against the scheme and point out its economic folly. At a time when thrift and economy have been urged upon the individual and promised by the dominant political party on behalf of the government, it is proposed, for reasons purely political, to fasten upon the country the burden of raising a sum estimated at not less than $1,500,000,000 and as much as $5,250,000,000.

This is proposed in the name of compensation for veterans who gave their services in the late war. We would be the last to deny those men any reasonable favor, courtesy or preference. But we are wholly unconvinced that the veterans as a whole are behind the demand for the bonus to which Congress claims it is bowing in submission. Approximately two million veterans went abroad and about two million more were in the service for 6 months' prior to the Armistice, making a total of about four million men under arms. Of these, 20 per cent, or 800,000, are in the American Legion, which is sponsoring the bonus on behalf of the soldier, claiming to represent his sentiment in the matter. But it is to be noted that four times that number of veterans are inarticulate as a body, to which we can add with certain knowledge that not all the American Legion favor the bonus.

Secretary MELLON has sounded a timely warning to Congress showing the necessity of reducing expenditures in order to balance the budget for the next fiscal year. Already there is in sight a deficit of $300,000,000 which must be met by either reducing our expenses or increasing our income. The adoption of the bonus plan would only aggravate this financial situation, because it would augment the deficit and necessitate still further taxation. Where is the money coming from? We cannot commit the folly of Europe and produce it on the printing press. We must raise it in cash by taxation. Subterfuges will avail us nothing. As for the American Legion, it dismisses the matter with neatness and despatch by observing that it is not concerned with the method of raising money.

Our own analysis of the situation leads us to believe that Congress will commit an economic blunder if it passes legislation for a soldier bonus. It will still further unbalance our national budget and delay the return to normal business conditions. It will add to the burden of taxation which it is pledged to lighten. And all this on account of political expediency and an unwillingness on the part of Congress to risk its precious politic

neck by standing for sound business as opposed to sentimental clamor. We admit there is some popular sentiment in favor of the soldier bonus, but we are inclined to believe that if the question were submitted to popular vote with the understanding that those who cast a ballot in the affirmative were at the same time to drop a $10 bill in the ballot box, the bonus would rapidly lose support. And yet a contribution of many times $10 will be levied on every voter if the legislation is passed. Business of the country should make a concerted effort to deter Congress from taking an unwise step, the consequences of which we shall suffer for many years.

Deflation in Coal-Mining Cost

ANNOUNCEMENT by coal operators of the Pittsburgh district of the wage rates they expect to pay after the termination of the present biennial scale of the United Mine Workers, which runs to April 1 next, furnishes occasion for study of the situation as to deflation of bituminous coal-mining costs.

While it is traditional that it requires two to make a bargain, the probabilities are that the wage scale now proposed will actually be effective without important modification.

For pick mining in the thin vein mines of the Pittsburgh district the proposed rate is 77 cents per net ton of mine-run, against $1.1164 in the existing scale, a reduction of 31 per cent. That is a moderate reduction, seeing that the high scale has diverted nearly all the business formerly enjoyed by the Pittsburgh district to nearby non-union districts, such as the Connellsville region, where wages have been deflated. The proposed rate is substantially the same as the 77.64-cent rate given the miners April 16, 1917, when the miners displayed an indisposition to work under the 67.64-cent scale signed as of April 1, 1916, for 2 years. The "pre-war" rate may be taken as the 64.64-cent rate obtaining for two biennial periods, April 1, 1912, to April 1, 1916. Back in 1896, when the men were paid on a screened coal basis, to keep down the production of slack, the rate was 54 cents, which by the ratio recognized some time ago would be equal to about 85 cents if the run-of-mine were paid for, as at present. Thus the proposed rate is more than double the rate of a quarter century ago.

Fears that there will be a serious shortage of coal on account of wage disputes by the United Mine Workers are probably unfounded, although there may be a strike with temporary disturbance of supply. These disputes have been very serious in the past. Reference to the large amount of time that has been lost by coal strikes in the 21 years 1899 to 1919 inclusive was made in CHEMICAL & METALLURGICAL ENGINEERING Jan. 4, 1922. Conditions now are different, however. One point is that mining suspensions in the past have sometimes been attended by advances in the market price of coal, making feasible the payment of wage rates in dispute, while no such policy would be countenanced now.

While only approximations can be made of the various factors involved, close enough guessing can be done to indicate that the United Mine Workers are not able to produce a mining suspension that would cause anything like an acute shortage of coal. Anthracite may be omitted from the reckoning. In bituminous coal the mining organization has hitherto controlled between 60 and 70 per cent of the mining capacity. The maximum production, 579,385,820 tons, in 1918, was well under the present capacity, being, say, between 80 and 90 per cent. The current requirements are only 65 or 70 per cent as great. Taking these factors together, it becomes evident that the current requirements could very nearly be supplied by the non-union capacity. It must be considered that some of the non-union capacity does not produce good coal, merely coal that is in demand when coal is very scarce, but it must also be considered that not a few mines have turned non-union recently, because the union scale did not enable the operators to meet the market, and the men wanted to work. And more of this may occur between now and April 1, and immediately after that date. Altogether, it seems fairly certain that there is going to be deflation in the cost of mining coal to something like a reasonable basis comparable with the cost of conducting other industrial enterprises involving the employment of labor. With deflation also in railroad and building trades labor, the country would be in fairly good shape.

Chemical Contribution To Agricultural Efficiency

THE Congressional commission of agricultural inquiry reported during December on causes of the agricultural crisis, and during the past month there has been a conference in Washington on the agricultural problems of the country at which these same matters have been publicly considered. But in all of the discussions there has been too great a tendency to subordinate or ignore altogether matters of efficiency in agricultural production.

The report of the Congressional commission presented about a dozen recommendations bearing upon co-operative combinations, credit extension, warehouse systems, freight rates, statistics, foreign trade attachés, grading of products, record keeping, better roads, price adjustments, etc. But it said almost nothing about those means which the chemical industries offer to agriculture for increasing production. A somewhat similar neglect of this question occurred in the public conference, though some attention was there given to the question of fertilizers.

Industry as it proceeds to organize itself almost invariably starts first at the point of production to get the maximum attainable efficiency before seeking support for its activities by auxiliary economic factors. In a few branches of agriculture this principle has been partly recognized and the use of fertilizer for increasing the productivity of the land is regularly and widely practiced. As a basic industry upon the welfare of which we all depend, agriculture stands in the first rank. No sound thinker dare ignore all of these economic factors which must be set right for the good of agriculture. But agriculture has a duty of its own in the management of its internal affairs. And the rest of the community may well insist that this responsibility for obtaining maximum productivity from given areas of land with a given expenditure of human labor shall be observed.

Agricultural chemistry has not yet reached the flower of its perfection, nor has the fertilizer industry yet taken advantage of all that chemistry has to offer in order to put it on a scientific basis. A vast amount of educational work has been done, but much remains to be accomplished in increasing the productivity of the soil before we can feel satisfied that economic aids will solve the problems of the farmer. First aid in the form of chemistry has not been sufficiently applied.

Readers' Views and Comments

Omnia Mutantur, Nos et Mutamur in Illis

To the Editor of Chemical & Metallurgical Engineering

SIR:—It was my fortune to be present at the Pittsburgh meeting of the American Chemical Society in 1902, referred to in your editorial of Jan. 18.

The "well-dressed chap" (he *must* have been well dressed if Dr. Baskerville thought so, although his clothes made no such impression on me) was waiting for us when we came out; he had his machine set up and invited some of us to inspect it. It was simply a microscope for observing the Brownian movement and we were excitedly urged to believe that the dancing particles were the atoms themselves. As I recall it, the man's announcement in the meeting was decidedly in the nature of an interruption, being addressed to the auditors generally and not to the chair. Dr. Remsen correctly sized him up as a crank and acted promptly and neatly in heading him off.

Xenia, Ohio. AUSTIN M. PATTERSON.

Oil-Shale Distillation in Situ in New South Wales

To the Editor of Chemical & Metallurgical Engineering

SIR:—The oil-shale industry of New South Wales is of long standing, having been started in 1865 by a short-lived enterprise which recovered oil from oil shale in the Kembla Valley in the southern coal fields. Following this a company distilled oil shale successfully for some years following 1878 at Hartley Vale, but oil recovery was later eclipsed by export of high-grade shale for gas enrichment, and finally exhaustion of the deposit caused the industry's discontinuance.

About 1905 the Commonwealth Oil Corporation came into existence, and £1,200,000 of capital was raised and expended, but the company has never paid a dividend. In July, 1919, this company entered into an agreement with John Fell, of Sydney, under which he is to operate the property for the joint account of the company and himself for a 10-year period, and at the present time the shale in the Newnes district is being worked under this agreement.

Now comes a report, published in the Sydney *Morning Herald* of Oct. 27, 1921, that Mr. Fell has succeeded in distilling oil from the shale in the Wolgan Valley by setting fire to the oil shale in an old working which has been so protected and confined by brickwork that the combustion can be controlled by regulating the supply of air. It is reported that, after starting the fire on a Monday, on Thursday, when the chamber was tapped, the amount of oil which flowed out exceeded the available storage capacity.

The experiment seems to have great significance for the Australian oil-shale industry, as the costs of mining and retorting the oil shale and of refining the crude oil have exceeded the landed cost of American petroleum products, and the industry has been enabled to survive only through a graduated bonus paid by the commonwealth government on home-produced oil. Other possibilities of gas and power production have been opened up by Mr. Fell's experiment which will be further developed.

It is interesting to note that the idea of gasifyin and distilling materials *in situ* is an old one,[1] althoug this seems to be the first large-scale trial made wit promising results. It should be borne in mind that th experiment here reported was carried out with the ric "kerosene shale" of New South Wales, and it is n probable that many of our American shales could b treated by similar methods, even though the principle d distillation *in situ* should prove successful in the com monwealth.

CHARLES L. JONES,
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University of Pittsburgh,
Pittsburgh, Pa.

To Assist Legitimate Users of Industrial Alcohol

To the Editor of Chemical & Metallurgical Engineerin

SIR:—Because of the difficulty various manufacturer have experienced in obtaining their requirements o alcohol for industrial purposes the Committee on Indus trial Alcohol of the American Chemical Society believe it advisable to call to the attention of manufacturers th fact that there is such a committee and that this com mittee stands ready to co-operate with them in ever possible manner. This service is without any expens to those who require this essential chemical raw mate rial.

During the past several months manufacturers re quiring alcohol for legitimate industrial purposes hav been experiencing many difficulties. Numerous change in rules and regulations and the issuance of new one have caused considerable delay and expense.

The Committee on Industrial Alcohol was appointe at the Rochester meeting of the American Chemica Society. This committee offers its services to the chem ical industry to assist in obtaining permits, shipments etc.

Chemical manufacturers who wish to take advantag of this offer should communicate with the chairman o any member of this committee. Their names and ad dresses are as follows:

Dr. Martin H. Ittner, chairman, Colgate & Co Hudson St., Jersey City, N. J.

Dr. Raymond F. Bacon, 50 East 41st St., New Yor City.

Dr. Charles Baskerville, College of the City of Nev York, New York City.

Dr. George F. Rosengarten, Powers, Weightman & Rosengarten Co., P. O. Box 1625, Philadelphia, Pa.

Dr. Frank R. Eldred, Eldred & Atkinson, Inc., 48 E 41st St., New York City.

Dr. Edward Mallinckrodt, Jr., Mallinckrodt Chemica Works, St. Louis, Mo.

Dr. Burnell R. Tunison, secretary, U. S. Industria Alcohol Co., 27 William St., New York City.

It is believed that publicity to the above statemen will be appreciated by manufacturers who may be bene fited by the services of the committee.

New York City. B. R. TUNISON.

[1] On "Gasifying Coal at the Mine," see Hamor, *Scientific Amer can* for Nov. 2, 1912. A number of patents have been issued o various schemes for distillation and gasification of various ma terials *in situ*, among which are U. S. Pat. 1,342,741 to David T Day, and British Pat. 162,337 (1919) to D. Diver.

The Technical Paper and Its New Relation to Industry*

In Order Better to Fulfill Its Functions of Service and Leadership the Modern Technical Paper Has Extended Its Scope of Usefulness and Supplemented Its Technology With the Economics and Business of the Industry It Serves

By H. C. PARMELEE

[F WE ATTEMPT to analyze the elements that have contributed to the evolution of modern civilization in all its variety and complexity, we are likely to ome to the conclusion that the most powerful single orce has been the rapid development in means of com- unication among individuals, communities, cities and ations. To such a degree of perfection have these eans been developed, and so complete has been their onquest of conditions on our own earth, that intrepid ioneers are already attacking the problem of interworld ommunication.

Great industries have been founded in the course of ese developments. Ships sail the seven seas to the ttermost parts of the earth; railroads cover the con- nents like networks of steel; aircraft cruise their outes regularly with incredible speed; the telephone nd telegraph are known in the humblest village; radio ommunication is almost a commonplace; and finally the roducts of the printing press have long since lost the lement of novelty and are accepted as an integral part f our daily life. These agencies have brought about ne great transition from primitive society in which uman intelligence was transmitted by word of mouth. hey have at once simplified and complicated modern fe; simplified it by bringing the peoples of the earth nto closer contact, and complicated it by extending our elationships and increasing our duties and obligations. hey have unified nations in war for a great cause, and ney have given an impetus to peaceful industrial rowth unparalleled in the history of the world.

Development of Civilization Dependent on Printing

But though all these agencies have contributed largely o the development of modern society, it is certain they ave not been of equal value and importance. Ships, ailroads and aircraft may be developed ever so highly nd yet be limited as means of communication if they ransport only men from place to place. Important as re the telephone, telegraph and radio in the quick ransmission of intelligence to and from all parts of the orld, they are still restricted to communication between xed points and a small number of individuals. Obvi- usly some other agency in combination with these has een responsible for that wide distribution of human nowledge and intelligence that characterizes modern ociety and which has been responsible for its develop- ent. Some other means has been evolved to reproduce or thousands and millions of individuals the product f the world's great intellects and lay it regularly be- ore all who want it. It is in the discovery and perfec- on of printing and paper that we find the essential ement in all this marvelous development. Modern ivilization, said Lord Avebury in addressing an inter- national gathering of paper manufacturers, depends upon the discovery of cheap paper and rapid printing for the wide distribution of information.

This we may accept without demanding exhaustive proof, for it requires no stretch of the imagination to visualize the influence of printing on the wide dissemination of knowledge. By this means industrial, political and economic information has spread with amazing rapidity. By it the intelligence of one nation has become the property of the whole race, and the intellect of a great leader has been able to influence the trend of thought of the entire world. In short, we may accept the press as the means of communication par excellence, and proceed to examine one of its comparatively small but important branches—namely, the industrial press, that has just begun to sense and exercise its power.

Growth of the Industrial Press

Industrial publishing has reached its highest development in the United States, where more than 1,200 periodicals are now devoted to industry in all its phases. The growth of this great publishing business has been coincident with the industrial expansion of the country itself. The first industrial paper of which we have record in this country was founded in 1846. In the next decade two more were established, but no great impetus was given to the business until after the Civil War, when the country went through its marvelous period of growth and development. Industries of all kinds invited leadership, and industrial magazines sprang up to point the way. The result was that from one paper in 1846, three in 1856 and twenty-five in 1869, the number grew to 800 by the end of the century and to well over 1,200 at the present time. Including Canada, it is estimated that there are in America between 1,200 and 1,400 industrial publications, the number varying with the method of classification.

An important group of the industrial press comprises what are known as technical papers because they deal with the technology of industry, with the application of science and engineering principles to the problems of production and management. It is in this group that you, as chemists, are most interested, and since both you and I have a still narrower interest in technical magazines devoted to the chemical industry, we may confine further observations to papers of that class.

My topic, "The Technical Paper and Its *New* Relation to Industry," suggests a contrast with an earlier relation, and so we may go back for a moment and sketch that former relation briefly in order to emphasize the new order that must be expanded and developed if the technical paper is to live up to its opportunity for service and leadership.

Technical papers for the chemical and allied industries are of comparatively recent development in this country, but if we examine the early files of such papers

*An address delivered before the Chicago Section of the American hemical Society, Nov. 18, 1921.

we will find that they were devoted almost strictly to matters of technical interest. They recorded the results of scientific research and investigation and of progress in the arts. Processes and products were discussed in their scientific and technical aspects. The contributions were of a high order of merit, and the contributors were recognized scientists of learning and ability. On the whole the publication was maintained on a high plane of scholarship and was a credit to the profession. Its reliability and integrity were above reproach and its subscribers bore testimony to its value and influence in all technical matters. It was a tool of the profession rather than of the industry.

The *raison d'être* for such a magazine is not far to seek. It was a product of its time and it served its purpose well. Technical industries were in a state of rapid evolution, and the latest developments in technology were of primary importance. It was essential that the scientific foundation of industry be carefully laid in order that the superstructure might endure. In short, industry being more interested in, and most in need of, technical leadership and guidance, the function of the technical paper was plainly to serve along these lines.

New Responsibilities for the Technical Paper

But excellent as this service was, and adequate though it proved for its time, it will not suffice today. New elements have entered into our national industrial life and by presenting new problems to industry have at the same time laid new and additional responsibilities on the technical paper. It is no longer enough for it to treat of technology; it must consider the business and economic problems of industry as well. The technical paper can no longer fulfill its function if it merely discusses processes and products; it must also be the business exponent and mouthpiece of its industry, reflecting its needs and guarding its interests. It must become an integral part of its industry, serving all its needs. It must be of the industry as well as for it.

The perception of this new responsibility was quickened during and immediately after the war, when we faced industrial and economic problems that far transcended in importance the problems of technology. The Government itself was confronted with industrial problems of the greatest magnitude, and as a result of the war was involved in the most intimate relations with business and industry. There was the greatest need for some public agency to reflect the needs of industry to the Government and to interpret the intentions and acts of the Government to industry. In this condition industry found itself without a mouthpiece or exponent unless the technical press threw itself into the breach, which it promptly did.

Washington became a great center for technical and industrial news, requiring the closest daily contact on the part of the business press; and as a consequence of the early recognition of this fact, industry was served with pertinent Government news through its technical papers.

The necessity for this arose mainly from the fact that the daily press in all its excellence was not equipped to meet the need. It was not and could not be intimately familiar with the details of industry, and consequently could not sense its needs. The whole country was face to face with a brand new crop of problems, and since industry had learned to follow its own technical papers in matters of science and technology, it naturally turned to the same source for leadership in these new conditions. The technical paper promptly sensed and accepted the situation. It became a magazine of opinion on labor problems, on the tariff, on wages, the cost of living foreign trade, Government policies, the patent system revenue legislation and finance and many other matters formerly regarded outside its editorial scope. It discussed industrial waste in all its forms: the necessity for better cost accounting, for greater safety in industry, for improved housing and sanitation, for more skillful management, for more research. It expressed its opinion on the regulation of business by the Federal Trade Commission and the Interstate Commerce Commission. It took up industrial relations between employer and employee and devoted much space to the numerous phases of that many-sided subject. It spoke with authority and competence on such matters as reorganization of Government departments because some of its editors had been drafted from Government service and knew whereof they spoke.

These things were invaluable because they reflected to the industry the opinions of men familiar with the industry itself and sympathetic with its needs. Speaking from a chemical point of view, it was not enough to discuss the technology of the industry; somebody had to present the economics as well. For example, coincident with the technical problem of fixing nitrogen was the question of Government ownership and operation of nitrate plants and its effect on business. Of quite as much importance as how to make dyes was the question of establishing an industry in the face of foreign competition. The tariff was a paramount issue. We had the brains for dyemaking, but we needed the economic basis for an industry without which our technical brains would avail us nothing. The alcohol industry likewise was, and is, much more concerned with fanatical legislation than with methods of manufacture. All of these things were consistently presented in the technical press for the benefit of industry and the education of Government officials.

Technical Press Supplies Industry With Vital Statistics

In the matter of new development there was the constant necessity of keeping the economic and industrial as well as technical aspect clearly in mind. For this reason the technical press has brought to industry vital statistics on consumption and production, on imports and exports. It has shown the close relation of plant location to industrial success. It has featured the importance of markets for new products and sources for raw materials. It has acquainted industry with pertinent activities of the Government, sometimes approving and sometimes condemning.

In its relation to the Government the technical paper has been constructive and helpful. Witness its service since the war in aiding in the disposal of surplus property; in suggesting new uses for materials held in large quantities by Government departments; in discussing the function of the Government in research; in advocating reform in the Patent Office; in supporting the Chemical Warfare Service and creating public sentiment that resulted in establishing this branch of the service on a scale somewhat commensurate with its importance.

Probably the greatest stimulus to this new function of the technical press as an intermediary or connecting link between the Government and industry was the action of Mr. Hoover inviting the editors of the business

press of the country to assist him in solving many of the problems with which he was confronted in the Department of Commerce. This was at once the greatest recognition of the importance of the industrial press and a challenge to prove its usefulness by showing its intimate knowledge of industrial matters. What body of men in the country should be better able to reflect to the Government the needs of industry, and carry to industry the story of the Government's intention to aid and assist rather than hamper and restrict? So argued Mr. Hoover, and accordingly the memorable Hoover editorial conferences began in Washington last spring.

Technical Press as an Aid to Government

They have resulted in laying before the Secretary of Commerce plans for elimination of waste, for standardization of sizes, types and styles of industrial products, for correlating the bureaus and agencies in his department and making them function more directly for the benefit of industry. They have resulted in the first effort ever made in this country to publish monthly vital statistics on consumption, production and stocks of critical commodities in the basic industries. Finally, they have been helpful in the reorganization of the Department of Commerce by finding men from the industries to head the new commodity divisions that have been created. And all of these things, mark you, have been done by technical industrial papers that formerly devoted themselves wholly to matters of science and technology, because they have seen clearly the need of this new service to their respective industries. Much of the best work has been done quietly through committees, questionnaires and researches, but it has been none the less effective. Mr. Hoover has generously recognized the value of this service in a message to the editors in which he said in part:

> The editors of the business press have shown a fine spirit of service. Your opportunity for leadership is unique and unchallenged. Upon you rests in large measure the responsibility of the control of industrial thought and opinion in the detail of the industrial, economic and technical problems which confront us.

I have mentioned the inadequacy of the daily press in presenting to industry such matters as have just been discussed. They are essentially technical and hence not within the grasp nor the province of the daily newspaper. They will not be adequately presented for business and industry except through the medium of the industrial press. This is no reflection on the daily press, but merely a recognition of its limitations and the consequent need for the industrial press. We may consider a few examples.

Examples of Technical News Service

As an industrial disaster the explosion of the nitrate plant at Oppau, Germany, was of such magnitude as to interest the entire world. And due to its marvelous mechanism for transmitting intelligence, the daily press gave us immediate reports of the occurrence. But the explosion had a far greater and deeper significance to chemical industry, and in all its attempts to give precise information that might be helpful the daily press failed utterly due to its manifest limitations. Not only did it fail as a purveyor of precise, accurate and reliable news of the event, but it exemplified the blind as leaders of the blind in its editorial comment. So great a newspaper as the New York *Times* drew the conclusion that German chemists had been experimenting with new and deadly gases, in violation of the terms of the treaty, and had wrought their own destruction through their discoveries. It called upon the Badische company to show clean hands in the matter, and it looked frankly with suspicion on the whole affair. Mystery surrounded the explosion and consequently mysterious conclusions were drawn as to its cause and significance. The press dispatches having said that the disaster was due to "the decomposition and subsequent explosion of a large quantity of ammonia and sulphate of saltpeter," the *Times* suspected "experimenting of a secret nature," and thought it "not inconceivable that the disaster at Oppau may have been due to covert experimenting by those chemists." All of which was of no help or consequence to the chemical industry, and it devolved upon the technical press through its enterprise and intelligence to inform the industry of the facts as nearly as they could be ascertained.

Examples might be multiplied. Chemical warfare was first condemned in the daily press, and first supported by the technical paper. Reports of such conventions as President Wilson's first industrial conference and the recent unemployment conference were more reliable and pertinent in the industrial than in the daily press, for the reason that the latter was inclined to feature spectacular incidents and subordinate substantial accomplishments.

All of these things are in the nature of a service to industry and the public welfare now performed by the technical press. It is not spectacular, but far-reaching. It influences the intelligent leaders of industry to blaze the way to new reforms, initiate constructive policies and establish sound principles and practices in industry.

This service to industry by the technical press is a leaven that eventually leavens the whole of society. Through the leadership of the technical magazine in its own industry, it spreads information and serves as a clearing house for new ideas that eventually are translated into economies for the benefit of society as a whole. The service to industry is direct, and to society indirect.

Functions and Standards of the Technical Press

From this general portrayal of the activities of the modern technical paper we may proceed to summarize its functions in industry and study the mechanism through which they are performed.

1. The modern technical paper is still a magazine of information pertinent to the technology of the industry it serves. This is an important function that cannot be subordinated without jeopardizing industrial progress. Economies resulting in cheaper production must still be worked out through scientific research and the application of the results in the factory. But this is not service enough.

2. The modern technical paper also treats of the economics of its industry, informing its readers on the relation of the tariff, finance and other legislation to business.

3. It is the newspaper of its industry, gathering weekly the items of personal and business intelligence on which its readers should be informed. Market movements and trade tendencies are reflected in reports gathered at first hand. Foreign as well as domestic news is obtained regularly by cable and wire.

4. The modern independent technical paper is a magazine of opinion—the mouthpiece of its industry. And herein lies one of the distinctive differences be-

tween it and the technical society magazine. The editorial independence of the industrial paper, its freedom from domination by any interest or allegiance to any group, make it possible to adopt policies in the interest of the industry as a whole. Obviously this is denied to the society publication, which must serve primarily its own membership. Editorial opinion cannot be expressed with freedom on a wide variety of topics for the evident reason that the magazine must speak for the society. An independent industrial technical paper, on the other hand, labors under no such handicaps, being bound only to serve the best interests of its industry whether people agree with it or not. If subscribers do not like its policy they need not take the paper.

5. The modern technical paper sets a high standard of business ethics and practice in its industry. Both in its business and editorial departments it subscribes to a code of ethics that has been adopted by associations of business publishers and industrial editors. These standards are high and must be subscribed and adhered to by members of the association.

Enforcing Its Code of Ethics

The technical editor is pledged to consider first the interest of his subscriber. Truth and honesty must characterize his every activity. He is obligated to present the news of the industry free from personal bias and to determine the editorial contents of his paper independently of advertising considerations. The publisher also sets a high standard of business practice in the acceptance or rejection of advertising and in publicity regarding the character and extent of his circulation.

Periodical investigations are made to see that members are living up to these standards. This is one of the most powerful factors in making the technical paper a leader in its industry. With its own skirts clean it can consistently demand that its industry be free from unfair practices. Having adopted a high code of business ethics for itself, it can, both by precept and example, urge similar action upon its industry. The adoption of a code of editorial ethics and business practice has been of the greatest benefit in establishing the independence of the technical paper.

Recognition as an Essential Element of Industry

The exercise of all these functions results in a service, first to industry and then to society, that makes the modern technical paper an essential element of industry. It was so regarded by the Government during the war; and it must be self-evident that in times of peace publication of knowledge and intelligence is indispensable to the development of industrial literature. What then is the mechanism for exercising these functions? The answer is found in the editorial staff. And just as the technical paper's new relation to industry requires a broader service, so the modern editorial staff comprises a wider range of talent. In many respects it resembles a college faculty, being composed of men who are specialists in their respective branches of technology and industry. Papers covering the chemical and allied technical industries find it particularly necessary to have comparatively large staffs of qualified scientists, technologists, economists and industrial experts. They are called upon to judge the competence of articles that form our technical literature. They are expected to reflect sound opinion on matters of public policy in relation to their industries, and to take the lead in safeguarding those industries from ill-advised legislation or private practice. They must display enterprise and initiative in discovering sources of news and information so that their industries may be kept abreast of development. And it goes without saying that in addition to their ability they must be men of integrity with a keen sense of editorial ethics.

Editors Must Maintain Close Contact With Their Industries

Nor can these things be accomplished without close personal contact with the industry itself. Travel by the editors is a *sine qua non* of successful industrial journalism. Conventions must be covered and reported in their essential features, for hundreds and thousands of men are unable to attend and must rely on the published record for their information. That this service is appreciated is attested by the correspondence following the publication of convention proceedings, asking for more detail or further information. Plants must be visited and processes described in order that text book fundamentals may be amplified and brought up to date with practical details of current practice. In short, the modern technical paper cannot be edited from the desk, but it must show a familiarity with industry itself that is acquired only by personal contact. The consequence is that the industrial editor is enabled to see his industry as a whole and judge it impartially. This was strikingly exemplified at the last National Conference of Business Paper Editors in Chicago, when a résumé of conditions in ten basic industries was presented by as many editors of industrial magazines. These reviews were authoritative and could not have been pictured better, if as well, by industrial leaders themselves.

Relations to the Industry and to the Individual

Such, then, is the new relation of the technical paper to industry as seen by the technical editor. Such is the duty of the industrial and technical press, as well as its opportunity for service, as conceived by the publishers. It results in a service that is growing more and more expensive, but which yields results to industry that more than justify publishers' outlay. No single industrial unit could afford to maintain for itself the service thus rendered to industry at large. It is a service that is destined to be expanded rather than contracted, just as industry itself becomes more complex and needs broader vision and leadership.

This evolution holds its lesson also for the individual. Just as the technical paper must supplement its technology with the economics and business of industry, so must the individual broaden his scope in order to find his greatest usefulness. Science will never develop its greatest usefulness to society as long as it is translated into technology only. It must find expression also in sociology, in economics and in the management of industry. This will call for broader training and more diverse talents among scientists, some of whom will continue to enrich the records of research while others develop managerial ability or technical superiority or acquire skill in the practical application of economics and sociology. The ultimate aim—for the individual as well as for the industrial press—will be the perfection of our industrial processes, the elimination of waste, the stabilizing of labor and production, so that human happiness and standards of living may be increased. To such an end the modern technical paper is dedicated.

Colloidal State in Metals and Alloys. IV—Iron and Steel

Atomic Dispersion of Carbon in Austenite Is Unlikely, but Martensite, Troostite, Sorbite and Pearlite Contain Carbide Particles of Increasing Size—Martensite and Other Dispersions of Critical Size Are Hard Because of Enormous Surface Tensions Associated With Fine Grain*

By JEROME ALEXANDER
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THE enormous literature that exists regarding the iron-carbon alloys exhibits at once their great importance and exceeding complexity, and within the brief limits of this paper only a few of the most striking facts can be dealt with. Since the behavior of the iron-carbon alloys is greatly influenced by the allotropic changes of iron itself, it will perhaps be best, first, to consider what these are, according to the evidence available.

Allotropy of Iron

After freezing at about 1,505 deg. C., pure iron, upon further cooling, shows a large evolution of heat at about 900 deg., known as the thermal arrest point Ar_3, and a smaller evolution of heat at about 780 deg., known as the thermal arrest point Ar_2. It is generally accepted as a fact that above 900 deg. the iron exists in the γ from, which is non-magnetic, and below 780 deg. in another allotropic α form, which is magnetic and exhibits a different crystallization from γ iron. Rosenhain believes[1] that the weight of evidence shows that between 900 and 780 deg. the iron exists in a third allotropic form, known as β iron, which has the same crystal form as α iron, but resembles γ iron in being non-magnetic. Benedicks,[2] on the other hand, believes that the evolution of heat at 780 deg. indicates, not a transformation of a β allotrope into α iron, but the final disappearance of persistent γ iron molecules from the metal.

Considering the recent work on the allotropism of sulphur, it seems that these apparently conflicting views can be reconciled by regarding the iron between these temperatures (900 and 780 deg) as an allocolloid or allodispersoid, the so-called "β iron" being an α-γ adsorption compound (α iron dispersed in γ iron), whose break-up into the more completely oriented α iron sets free the relatively smaller amount of heat at the point Ar_2. This view accounts for the following facts: (1) that "β iron" has the same crystal form as its "dominant partner," α iron, but, unlike it, is not magnetic—for magnetism seems to depend upon a peculiar regular molecular orientation[3]; (2) that γ iron dissolves iron carbide, whereas "β iron" and α iron do not; for whatever γ iron exists in the β zone is adsorbed by or in some kind of loose combination with the dominant α iron and is not free to exert its solvent power on iron carbide; (3) that an increase in strength is noted when α iron is transformed into "β iron"; for the formation of some γ iron by increase of temperature over about 780 deg. results in the formation of the α-γ adsorption compound, which increases the free surface and strength of the system; (4) that the structure of "β iron" is finely acicular, indicative of crystallization in the presence of a colloid.

Does Austenite Contain Molecular Carbon or Cementite?

Leaving this moot question, however, let us consider the behavior as noted in the equilibrium diagram, Fig. 1, of a low-carbon steel, containing, say, 0.2 per cent of carbon, which dissolves in the liquid iron as Fe_3C. From freezing down to 840 deg. this steel consists of an apparently homogeneous "solid solution" or dispersion of iron carbide or cementite in γ iron.

[In a recent paper[4] entitled "The Slip Interference Theory of the Hardening of Metals" Jeffries and Archer state:

> "There is good reason to believe, however, that in all cases solid solutions are characterized by the *atomic* dispersion of their components." This is true only if the expression "solid solution" is limited to such dispersions; but most solid solutions contain aggregates, just as do many or even most ordinary solutions, especially if concentrated. Jeffries and Archer further state that "the carbon in austenite is present as individual atoms of carbon"; that "these atoms are undoubtedly held strongly to the neighboring iron atoms, but the union is not permanent. Diffusion must consist in a migration of carbon atoms and not of groups or 'molecules' containing several iron atoms. Such groups could not, on account of their size, diffuse through solid iron."

It seems to the present writer that there is no good reason to doubt the existence of Fe_3C, especially when the steel is semi-solid or solid. For there exists a condition of kinetic or dynamic equilibrium in which this compound is being continually formed and broken up, so that while a certain per cent of free carbon atoms may exist at any one moment, there is probably an enormously larger percentage of Fe_3C. Viewed from the standpoint of a kinetic equilibrium, all difficulty regarding the diffusion of Fe_3C disappear.[5]

With large amounts of carbon, as in cast irons, much of the C is thrown out on cooling and forms graphite, or under conditions of quick cooling or high pressure may form diamonds, as Moissan has shown.]

At any rate, at 840 deg. C. (Ar_3), the "solid solution" transforms into a α-γ dispersion ("β iron"), and at 750 deg. C. (Ar_2), the residual α-γ adsorption compound decomposes into α iron, the steel now consisting of α iron crystals dispersed in a "solid solution" of iron carbide in γ iron. With further cooling, the quantity of α iron crystals increases, until at a little below 700 deg.

The present series of papers was written mainly in the fall of 1919. Reduced to about half their original form, they were read before the Columbus meeting of the American Institute of Mining and Metallurgical Engineers, October, 1920, and will so appear in vol. 64 of its *Proceedings*. They are now given in full, together with some recent additions which are indicated by enclosure within square brackets [ ].

*Part I, on Molten Metal, appeared in Chemical & Metallurgical Engineering, vol. 26, p. 54; Part II, on Crystallization, in vol. 26, p. 119; Part III, on White Metal and Brass, in vol. 26, p. 170.

[1] "Introduction to Physical Metallurgy," p. 170.

[2] *J. Iron and Steel Inst.*, No. 2, 1912.

[3] The so-called Haeussler alloys are magnetic, although their constituents individually are not.

[4] Met. & Chem. Eng., vol. 24, p. 1059.

[5] See also p. 1065 of Jeffries and Archer's paper.

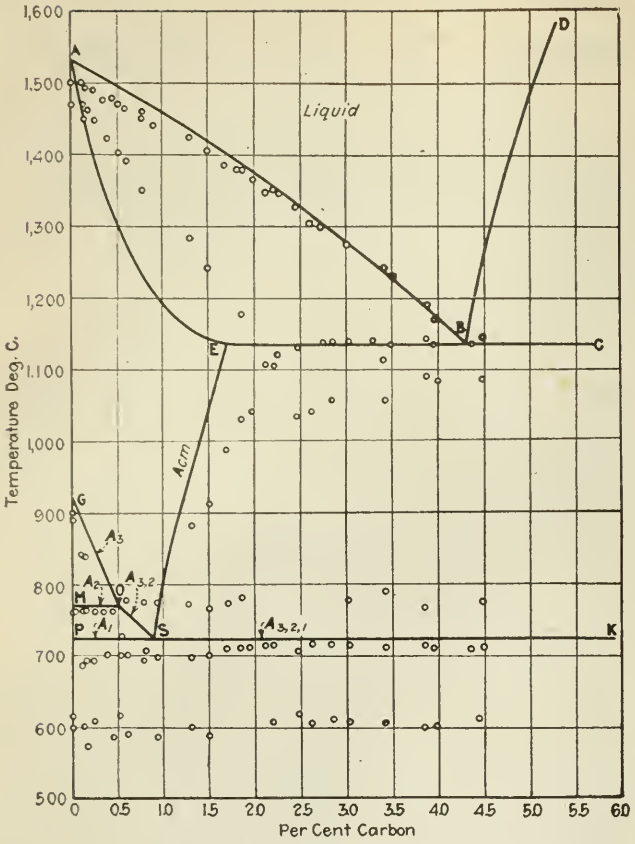


FIG. 1. EQUILIBRIUM DIAGRAM OF THE IRON-CARBON SYSTEM (AFTER HOWE. POINTS FROM CARPENTER AND KEELING)

C. (Ar_1), the remaining γ iron-carbide solid solution is transformed into a eutectoid mixture of α iron (ferrite) and iron carbide (cementite), with an evolution of heat.

Reactions at 690 Deg. C.

This last transformation seems to be the break-up of an adsorption compound between γ iron and iron carbide, the former transforming into α iron and the latter being set free to form aggregations of its own. This adsorption compound is the cause of the carrying over of some of the γ iron through the so-called "β iron" zone to the eutectoid point, where, with increasing carbon content, increasing quantities of heat are evolved, the allotropic transformation of the iron itself becoming practically negligible after the steel contains about 0.5 per cent carbon (equal to about 7.5 per cent Fe_3C). In fact, steel of "eutectoid composition" (about 0.9 per cent C, or about 13.5 per cent Fe_3C) exhibits only a single thermal arrest point, at which it glows visibly. This phenomenon is known as "recalescence"; it is indicative of a sudden large release of energy consequent upon the breakdown of the extensive metastable system built up of γ iron and cementite, two delayed transformations occurring simultaneously—the iron transforms from γ into α and at the same time the released cementite aggregates. The inhibition of the allotropic iron transformation shows that in eutectoid steel the large percentage of Fe_3C has carried over practically all the γ iron in metastable condition to the eutectoid point. The presence of such elements as silicon and manganese will perceptibly change the location of the eutectoid point, a fact which fits in with the easy disturbance of colloidal systems by foreign substances or "impurities."[6]

But whether this view is accepted or whether the charge is regarded as a separation of carbide from "γ iron solid solution," one thing is certain—there is suddenly released from some kind of solution or combination Fe_3C, an insoluble substance possessing considerable cohesion, which promptly causes it to attempt to aggregate against the interference offered by the now highly viscous iron. This is an ideal condition for the development of a colloidal system; but the cohesive power of the cementite is so great that in unquenched steel it usually appears as shown in Fig. 2*b*, interspersed with α iron, or ferrite, as fine plates or fibrils, yielding the finely laminated structure known as "pearlite" because under proper illumination it exhibits the iridescent luster of mother of pearl. This iridescence, reminding one of that of a diffraction grating, is evidence of the fineness of the pearlitic structure, which, like Pleurosigma, taxes the highest powers of the microscope for its successful resolution, the lamellæ being often less than 0.2μ apart.

Divorce of Cementite

As shown microscopically in Fig. 2, after Rawdon, eutectoid steel (approximately 0.9 per cent of C) when slowly cooled consists entirely of pearlite, thus corresponding to the pure eutectic of ordinary alloys.[7] But with very slowly cooled steel, or with steel reheated for a long time at about 900 deg., the cementite tends to group up still further into balls or globules, the liberated ferrite forming larger crystals at the same time (Fig. 2*d*).

The cementite when present as isolated balls or lumps is of very little use to the steel, which then possesses merely the properties of pure ferrite having a coarse structure—these, of course, being far from equal to those of a mild

[6] In the presence of protective colloids, insoluble salts (i.e., $CaCO_3$) become more soluble in water.
[7] Rosenhain, "Introduction to Physical Metallurgy," p. 175.

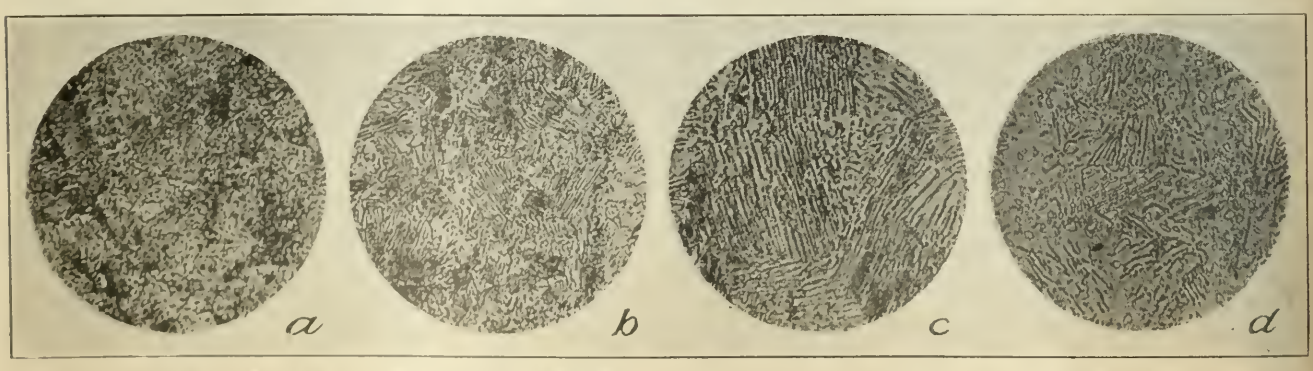


FIG. 2 MICROSTRUCTURE OF 0.85 C STEEL, HEATED TO 800 DEG. C. AND COOLED AT DIFFERENT RATES. × 500 ETCHED IN 5 PER CENT PICRIC ACID IN ALCOHOL
a—Cooled in air. *b*—Cooled in lime. *c*—Cooled in furnace. *d*—Cooled much slower in furnace.

steel having the correct structure. . . . When in the condition of pearlite or sorbite, where cementite is intimately associated with layers of ductile ferrite, the inherent brittleness of cementite is largely neutralized, and the hardness of the duplex consituent—pearlite—is well adjusted to stiffen and support the ferrite matrix of a mild steel. Cementite of itself, however, is not only excessively hard and brittle, as compared with ferrite, but it is also too small in quantity and bulk to serve as an efficient stiffener. Its presence in the isolated state thus becomes a source of weakness rather than strength. The behavior, both under test and in service, of steels having this "free cementite" structure is now well recognized as most unsatisfactory. (Rosenhain, p. 278.)

Quenched or quickly cooled steels, on the other hand, exhibit an entirely different set of microscopic pictures and mechanical properties from slowly cooled steel, which vary with the speed of chilling. Arranged in order of their formation on progressive cooling, the following constituent forms of the iron-iron carbide dispersion are recognized by metallurgists:

Nature of Structures in Hardened Steel

Austenite. White, apparently structureless γ iron solid solution, when preserved as such down to ordinary temperatures, either as the result of quenching or by the presence of a third alloying element inhibiting its decomposition—i.e., manganese in manganese steels.

Martensite. The first stage in the aggregation of the γ iron solid solution; the hardest constituent of hardened steels; it varies widely in the details of its structure, but is mainly acicular (Fig. 3).

When steel has been quenched from very high temperatures[8], the martensite is found to occur in large grains showing a rather coarse acicular structure. When, on the other hand, a steel of eutectoid composition is quenched at a temperature just above the critical point Ar_1, then the structure of the resulting martensite is exceedingly fine—so fine, indeed, that some workers, not perhaps provided with the best of microscopic appliances or employing unsatisfactory etching methods, have failed to detect the acicular structure, and have claimed that the best hardened steel contains a structureless "martensite," which they have sometimes distinguished by the term "'hardenite"—a purely local term whose general use is not to be recommended. The careful examination of samples of the best and most carefully hardened steels, however, has convinced both the author [Rosenhain] and the majority of impartial observers that martensite can always be shown to have an acicular structure, although in "properly hardened" steel that structure is exceedingly minute. (Rosenhain, p. 179.)

Troostite. A dark-etching constituent (Fig. 3) with characteristic rounded or woolly outlines, found particularly in hypo-eutectoid steels at the edges of martensite grains, especially where they border on ferrite. By a suitable rate of cooling, or by proper tempering, martensite can be entirely converted into troostite.

FIG. 3. MARTENSITE (LIGHT) AND TROOSTITE (DARK), AFTER HANEMANN. × 450

It is sufficient for our present purpose to regard troostite as a further step in the degradation of austenite into ferrite plus pearlite. The dark color appears to be due to the condition of the carbon in this stage; the separation of the dissolved carbide from the iron must have begun as soon as the first particles of γ iron became transformed into the β or α condition. In the martensite stage the separation makes itself felt only very slightly by the small difference of color between the various systems of interlacing needles. When the troostite stage is reached we are probably dealing with a material in which the separated iron carbide is present in slightly larger masses. According to Benedicks[9], the carbide in troostite is present as a colloidal suspension[10], and it is quite probable that troostite differs from martensite only by the slightly greater segregation of the carbide particles. (Rosenhain, p. 183.)

In the paper by Benedicks cited by Rosenhain, the Swedish scientist remarks:

> After studying some of the colloid literature, it was entirely clear to me as far back as 1905 that the nature of troostite is simply explained; it is a *solid colloidal "solution" of cementite in iron (a solid cementite ferrosol).* In other words, troostite may be conceived of as a highly dispersed intermediate between martensite, the true solid solution, and pearlite, the coagulum. . . . Troostite is a pearlite in which the constituent particles are ultramicroscopically small.

With steel containing 1 per cent carbon, Benedicks obtained the following results, the test-pieces being cylinders 50 mm. long x 6.5 mm. in diameter:

Temperature, of Steel, Deg. C.	Time of Cooling to 100 Deg. C. Seconds	Result of Microscopic Examination
950	3.07	Only martensite
848	4.32	Only martensite
750	4.11	Only martensite
715	5.33	Martensite with traces of troostite
695	6.2	Martensite with traces of trocstite
725	9.5	All troostite

The last specimen had been wound with 1 mm. iron wire so that its weight was increased from 12.3 to 27.5 g., thus lengthening the cooling period. From this it is evident that the speed of aggregation is so great that within a few seconds all the martensite may be transformed into troostite.

Sorbite

When the rate of cooling is further lessened or the temperature of reheating or tempering is further increased, the steel is permitted to progress somewhat further toward the final state of ferrite plus cementite. Instead of the troostite described above, we find a constituent still devoid of any visible detailed structure under the highest available magnifications (Fig. 2*a*), but not etching to such a deep color as troostite and without the peculiar rounded outlines. This is often called "sorbite," but it may be regarded as simply a variety of pearlite in which the two constituents are so finely divided that they cannot be microscopically separated. The dividing line between pearlite and sorbite, indeed, is simply a question of microscopic resolving power. (Rosenhain, pp. 182, 184.)

Pearlite. This microscopically resolvable dispersion of Fe_3C in ferrite has been previously dealt with.

Before discussing the facts above stated it will be convenient to tabulate the main features:

TABLE I. NATURE OF STRUCTURES IN HEAT-TREATED STEEL

Iron-Cementite Dispersions	Nature of Dispersion	Crystal Structure
Austenite	"Solid solution"	Structureless streaks.
Hardenite	Colloidal	Structureless martensite.
Martensite	Colloidal	Generally acicular; varies, may be very fine. (Fig. 3.)
Troostite	Coagulation begun	Rounded or woolly (globulitic), Fig. 3.
Sorbite	Coagulum	Fine pearlite, not microscopically resolvable. (Fig. 2a.)
Pearlite	Coagulum	Laminated; may seggregate into balls. (Fig. 2.)

Fig. 4, taken from Prof. H. C. H. Carpenter's paper on "The Hardening of Steel,"[11] shows graphically the

[8] The higher the temperature before quenching, the longer the cooling time, and therefore the greater the degree of aggregation.

[9] *J. Iron and Steel Inst.*, No. 2, 1912; *Koll. Zeit.*, vol. 7, p. 290 (1910).

[10] As will be seen later, in troostite the cementite particles have already grown almost or quite beyond the colloidal stage. In martensite, however, some of the carbide is so fine that the carbon released by the action of acid is reduced by the nascent hydrogen, forming a variety of hydrocarbons.

[11] *Engineering*, vol. 107, p. 341 (March 14, 1919).

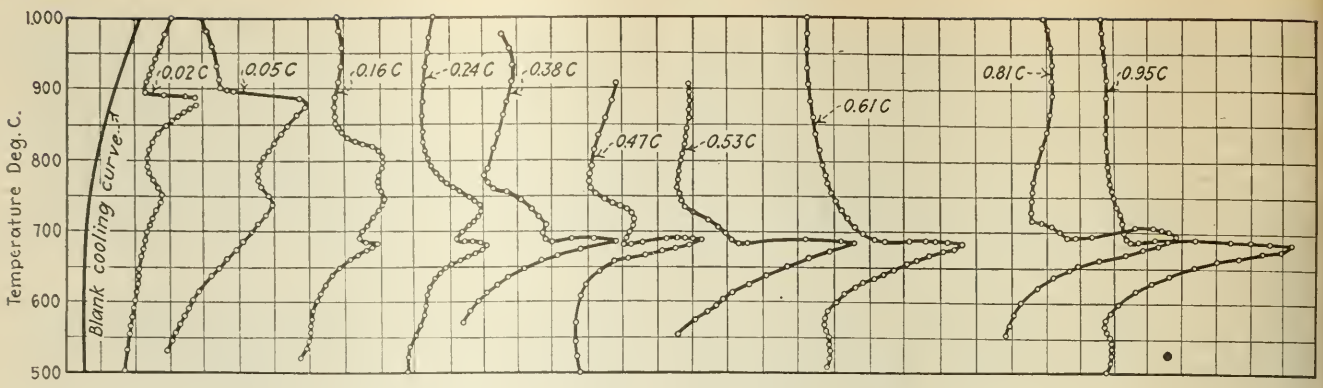


FIG. 4. COOLING CURVES OF IRON AND IRON CARBON ALLOYS

changes in the thermal arrest points in steel with gradually increasing carbon content, the point Ar_1 appearing at about 0.16 per cent C, and growing, while Ar_2 and Ar_3 diminish, until in eutectoid steel they have disappeared.

Granting that in austenite the cementite is in true molecular dispersion, which I consider very doubtful especially after solidification has begun, it seems evident that, of the remaining members of the iron-cementite dispersion systems, martensite and troostite are to be regarded as within or approaching the colloidal zone of dispersion, whereas sorbite and pearlite are coagula of the pre-existent colloidal systems, the latter visibly so. In the colloidal systems martensite and troostite,

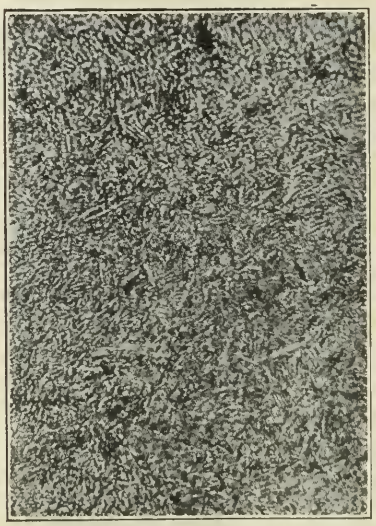
TABLE II. CONDITION OF STEEL AT VARIOUS TEMPERATURES

Pure Iron	0.2 per Cent Steel	0.9 per Cent Steel
γ Iron.....	γ iron-cementite solid solution.	This is eutectoid steel. So much cementite is present that no α-γ adsorption compound is formed, the γ iron being held in met stable condition by the cementite, down to Ar_1.
900 deg. C. γ iron forms α-γ adsorption compound (β iron). (Ar_2) Largest thermal point.		
	840 deg. C. (Ar_3) α-γ compound or β iron forms late because of cementite.	
Allocolloidal Zone		
	750 deg. C. (Ar_2) α-γ compound (β iron) changes to α iron.	
780 deg. C. α-γ compound (β iron) decomposes into α iron. (Ar_2)		
	700 deg. C. (Ar_1) γ iron-cementite "adsorption" compound decomposes, γ iron changes to α iron, and cementite is liberated and aggregates.	700 deg. C. ($Ar_{2,1}$) Sudden change of all the iron from γ to α, with liberation of all the cementite.
α Iron.	α iron and cementite.	Pearlite.

cementite (Fe_3C) is the dispersed phase and iron the dispersing phase; for this is shown by the nature of the pearlite coagulum, which consists of cementite interspersed in ferrite. In martensite, crystal formation is only incipient, inhibited by the high viscosity of the dispersing medium, and perhaps also by the adsorption of a small residual quantity of γ iron (consequent upon lag in its transformation), or of impurities. With troostite the globulitic stage is reached, often found in crystallization inhibited by colloids, and reminding one somewhat of the "clumping" of typhoid bacteria in the Widal test. It must be remembered that metal surfaces etched by various reagents are artifacts, from which the original detail of the unetched metal must be inferred.[12]

Variations in Dispersions

Athough theoretically there is no sharp line of demarcation between any of the members of the iron-cementite dispersion series, the sorbite-pearlite group shows the characteristics of coagulated colloids or gels, as opposed to the martensite-troostite group which represents higher dispersion, with troostite already appreciably on the road to coagulation. With milk, upon great dilution, the gradual aggregation of the actively moving ultramicroscopic particles of the casein sol may be watched in detail over a period of half an hour or more.[13] The ultramicrons first form occasional groups of two ("diplococci") and then larger and more numerous groups, until finally the whole casein lies quiet on the slide in large grape-like masses of curd, which under dark field illumination show the reticulated structure characteristic of such gels, and remind one forcibly of very fine martensite (Fig. 5), which, however, usually registers the high crystallization tendency present in its constituents, but absent in casein. The positive inhibition of the coagulation of the casein by "protectors" (gelatin, gum arabic, sodium citrate) may also be visually demonstrated. With clays, too, similar differences in aggregation may be noticed,[14] especially "diplococci" and the retriculated structure. But with metals, owing to the dense concentration of their particles, the rapidity of the changes and the high temperatures at which they occur and the practical impossibility of obtaining transparent sections[15] without disturbing the *status quo*, it will probably be impossible to settle moot points with



VERY FINE MARTENSITE IN QUENCHED MEDIUM STEEL. × 500. (RAWDON)

[12]See Bechhold, "Colloids in Biology and Medicine," Chap. XXIII, translation by J. G. M. Bullowa. D. Van Nostrand & Co., 1919.
[13]J. Alexander, *J. Soc. Chem. Ind., loc. cit.* (1909); Alexander and Bullowa, *J. Am. Med. Assoc.*, vol. 55, pp. 1196-1198 (1910).
[14]J. Alexander, *J. Am. Ceram. Soc.* (1920), "Ultramicroscopic Examination of Some Clays."
[15]Faraday and Beilby did this by floating gold leaf on cyanide solutions. *J. Soc. Chem. Ind.* (1903).

the ultramicroscope alone. Perhaps, as before indicated, the X-ray spectroscope will aid, small pieces or drops of fluid metal being drastically quenched in liquid air or other liquid gas; or an ultramicroscopic examination of gold, silver or other metal leaf or mirrors, or of films of mercury or amalgams; or the solution of metal by a differential solvent, in the presence of a "protector."

[Jeffries and Archer[16] report preliminary results with the X-ray spectrometer as follows:

(1) Non-magnetic steels show face-centered cubic lattices (γ iron).

(2) Magnetic steels show body-centered lattices (α iron).

"A 1.5 per cent C steel quenched from above the critical in iced brine showed both martensite and austenite under the microscope, and the X-ray spectrometer pattern showed both face- and body-centered lattices. A 0.35 per cent C steel quenched from above Ac_3 showed only martensite under the microscope and only a body-centered lattice with the X-ray spectrometer." These results confirm the views above expressed, and, as the authors state, they indicate that the transformation from austenite to martensite represents a substantially complete change from γ to α iron. They further show that quick chilling may save some of the iron in γ form. As Benedicks' work[9] shows, the speed of transformation is very rapid, so that only by the drastic chilling of small specimens as above suggested will much of the γ iron be maintained. Interesting results can be obtained, no doubt, with low melting point metals like mercury, gallium, and with Wood's and Rose's alloys, by quick chilling in liquid air, CO_2 or N, being followed by X-ray examination while cold.]

Hydrocarbons Formed on Dissolving Martensite

Meanwhile there is other distinct evidence of the colloidal nature of the cementite in hardened steel. Prof. H. C. H. Carpenter, speaking first of annealed or slowly cooled steel, says:[11]

> This carbide can be separated from the steel by appropriate solvents which remove the iron. On the other hand, it is not possible to separate any carbide of iron from a properly quenched tool steel. When the latter is treated with dilute acids, the steel dissolves without residue and liberates a complicated mixture of hydrocarbons, both liquid and gaseous. There is, therefore, a fundamental difference in the form of the carbide in a quenched as compared with an annealed steel. In the former it is wholly dissolved, in the latter wholly segregated.

This last statement is too dogmatic, and Prof. Carpenter, evidently appreciating the truth of the adage quoted by Ramsay, *Natura nihil fit per saltum*, retrieves it by continuing:

> When hardened steel is softened by annealing, the carbide of iron is gradually precipitated. If the annealing be carried out at low temperatures it is precipitated in the form of ultramicroscopic particles which are known as troostite. On raising the temperature the troostite passes into another variety known as sorbite, and at still higher temperatures well-segregated pearlite results. The gradual tempering and softening of hardened steel is caused by the precipitation of iron carbide in these forms, together with the soft α iron, and as to this no difference of opinion exists.

The formation of hydrocarbons upon the solution of hardened steel in acid shows that the particles of Fe_3C are so small that upon their decomposition the nascent hydrogen is able to combine with the liberated carbon, which must appear in particles approximating molecular dimensions and within the range of molecular attraction. The variety of hydrocarbons formed is evidence of the great diversity in the size of the carbide groups rather than of the existence of a number of different carbides, or "chemical compounds"—in other words, the carbide in properly hardened tool steel exists almost entirely in colloidal form. Great chemical activity is generally consequent upon colloidal dispersion—thus Raffo and Pierni showed that, while fine precipitated sulphur does not affect silver salts in the cold, and and does so only partly upon boiling, colloidal sulphur reduces them energetically even at ordinary temperatures. Fine lead, produced by heating dry lead tartrate in a tube, takes fire instantly in the air, as does the phosphorus left upon the evaporation of the solvent CS_2 or ether.

Colloids Prevent Tree-like Crystals

The strong tendency of metals to form adsorption compounds, especially when their molecules are aggregating, and the ease with which their crystallization forces may then be controlled are readily shown by a simple experiment.[17] A solution of lead nitrate is divided between two glasses, to one of which is added a "protector" (gelatin or gum arabic solution). On introducing into each glass a strip of metallic zinc, the pure nitrate solution promptly develops large glistening crystals of metallic lead—the well-known "lead tree"—whereas the protected solution yields an amorphous looking black deposit, which microscopic examination shows to consists mainly of aborted crystals, dendrites and globulites. The characteristic dendritic crystals of lead have elongated arms or processes, which in an interlocked mass may easily be mistaken for acicular crystals. I have also produced similar dendrites of iron by depositing the metal in the presence of a protector. Particulars regarding this will be given later in a paper on the effects of colloids on crystallization. The use of colloids to produce fine grain in the electrodeposition of metals is now familiar to you all.[18]

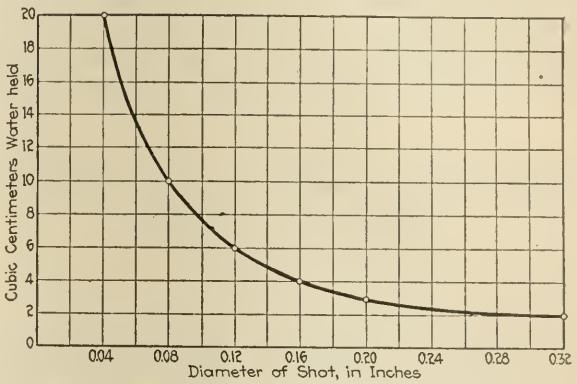


FIG. 6. RELATION BETWEEN DIAMETER OF SHOT AND VOIDS

The consequences of fine subdivision are far reaching, affecting solubility (Hulett), fusibility (Doelter), chemical activity, electrical conductivity (Fink), vapor tension, solution pressure, specific gravity, adsorption, including adsorption of gases, and energy content (Graham). The most striking results are consequent upon the enormous development of free surface. Thus

TABLE III. RELATION BETWEEN SIZE AND SURFACE AREA OR VOIDS

Grade of Shot	Dia., In.	No. per Oz.	Unit Area, Sq.In.	Area per Oz., Sq.In.	Vol. per Lb.	Water to Cover	Water Retained
Dust	0.04	4,565	0.005	22.8	76 c.c.	28 c.c.	20 c.c.
9	0.08	568	0.020	11.4	73	28	10
5	0.12	168	0.045	7.6	70	28	6
1	0.16	71	0.080	5.7	68	28	4
T	0.20	36	0.126	4.5	67	28	3
0 buck	0.32	9	0.322	2.9	67	35	2

[16] CHEM. & MET. ENG., vol. 24, p. 1065.

[17] J. Alexander, *J. Soc. Chem. Ind.* (1909), "Colloid Chemistry and Some of Its Technical Applications."

[18] See papers of W. D. Bancroft, A. G. Betts; also J. Alexander, *J. Soc. Chem. Ind.* (1909).

a cube of 1 cm. edge has a total surface of 6 sq.cm. (0.93 sq.in.); but if cut up into colloidal cubes of 0.01μ edge there would be a million million million such cubes whose combined surface area would be 646 sq.ft. (93,000 sq.in.).

The following simple experiments show to the naked eye some of the effects of subdivision with consequent increase in free surface. Uniform weights of several standard sizes of lead shot (1 lb. each) were measured in a 100-c.c. cylinder, just covered with water, and what water would leave the shot was poured off. Table III and Figs. 6 and 7 show the results.

Colloidal Dispersions Are Hard

Thus the amount of water held by the shot is substantially a linear function of the area, and will probably vary somewhat with the nature of the surface of the globules. While chemical attraction in the ordinary sense is out of question here, Bechhold has shown[19] that adsorption varies greatly with the chemical nature of the adsorbent. With the finest shot ("dust") the surface forces, adhesion and adsorption, are already great enough to cause the wet shot to "clump" or stick together noticeably, and we get an inkling as to the power and extent of the enormous forces called into

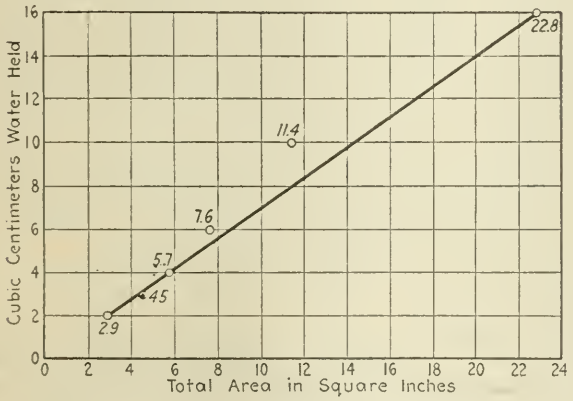


FIG. 7. RELATION BETWEEN AREA OF SHOT AND VOIDS

play by a great development in free surface. It is only natural, therefore, that colloidal dispersion should bring with it a great increase in hardness in metals.

Waiving the question as to whether the cementite in austenite is colloidal (and I think that at least as the steel freezes it becomes so), it seems that the very hard martensite is a colloidal dispersion of cementite in iron, a cementite ferrosol, with "hardenite" as its higher dispersion, troostite its incipient globulitic aggregation product, and sorbite and pearlite its successive coagulation stages. This view will perhaps reconcile the "allotropic" and "amorphous" theories which have been advanced to answer the question as to the constitution of martensite and the cause of its great hardness. According to the former,

> The hardness of martensite is due to the presence in it of a notable proportion of "hard" β iron. . . . the acicular structure of martensite would be due to the formation, on the cleavage planes of the originally homogeneous γ iron solid solution, of needles of β iron. Normally such β iron would be obliged to expel the carbon which it had held in solution before the transformation, but, during quenching, time for such separation would not be available, and the β iron would be compelled to retain in "forced" solution, or in very fine suspension, the carbon thus unavoidably retained *in situ*. The "amorphous" theory also explains the hardness of quenched steel by postulating the existence of an intrinsically hard but unstable transition product, which is formed when the transformation of the homogeneous γ iron solid solution into ferrite and carbide is hindered by quenching. Instead of identifying this hard substance with β iron, which has only a short range of stability in iron and low-carbon steels, the new (amorphous) theory ascribes hardening to the presence in the steel of amorphous layers similar to those which are believed to be the cause of the strain-hardening of ductile metals.[20]

Considering martensite as a cementite ferrosol, a colloidal dispersion of iron carbide in iron, it is "amorphous" in the sense that its particles, even if actually crystalline, are mostly not microscopically resolvable; and, especially in low-carbon steels on quick chilling, there is a tendency to carry over into the solid state some of the α-γ allocolloid or "β iron," so that the iron-dispersing phase itself may represent a colloidal dispersion, consisting mainly of minute α iron particles.[21] And because of the highly colloidal nature of the martensite and the consequent great development of free surface in it, it is extremely hard. Large percentages of oil colloidally dispersed or emulsified in water yield very firm stiff masses, although both phases are liquid.

[Jeffries and Archer[22] say:

> There is no conceivable way in which a few per cent by volume of a strong constituent in disconnected particles could impart a new element of cohesion of the magnitude actually obtained. Their action must consist in rendering more effective the cohesion latent in the aluminum. The logical inference is that this is accomplished by the elimination of extended planes of weakness—that is, by slip interference. . . . Under the action of an external load tending to produce slip along these planes, the hard particles of $CuAl_2$ must act as *keys*, mechanically obstructing any motion along the planes as a whole.

This mechanical comparison will undoubtedly appeal to engineers, but *the action of surface forces*, together with fineness of crystal grain (which in itself reduces the length of any one plane of slip), are quite sufficient to account for the phenomena observed. In making putty the addition of a few per cent of oil makes a viscous, "strong" mass with whiting; the finer the "filler" the stiffer the mass it makes with the same amount of oil—i.e., the more oil it "takes." Again, as S. V. Pickering[23] showed, 99 per cent of petroleum oil emulsified in 1 per cent of soap water makes an extremely stiff mass.

These illustrations indicate that a few per cent even of a *weak* constituent may produce relatively great hardness, *provided that it is very finely dispersed.* (See also discussion of the abbreviated form of the present series of papers by Prof. Le Chatelier and my reply thereto—*Proceedings*, Am. Inst. Mining and Metallurgical Engineers, vol. 64.)

This is quite contrary to what Jeffries and Archer state on page 1063: "We should not expect *soft* particles to produce hardening, because the 'keys' of soft substance would shear and thus assist rather than oppose slip. The term *soft* is used here in the relative sense only." Now, oil and water are certainly soft and scarcely act as "keys" that prevent slip in the cases above referred to. We must remember, however, that substances which are fluid *in mass* need not be so necessarily when finely subdivided. Thus the more

[19] "Colloids in Biology and Medicine," p. 29.

[20] Rosenhain, pp. 180-182.

[21] Jeffries and Archer (Chem. & Met. Eng., vol. 24, p. 1065) have just shown with the X-ray spectrometer that quick chilling can save some of the iron in γ form.]

[22] Chem. & Met. Eng., vol. 24, p. 1061.

[23] *J. Chem. Soc.*, vol. 91, p. 2002 (1902).

finely divided mercury is, the more it seems to act like a solid. With increasing subdivision, surface forces ordinarily negligible predominate.[24]]

Maximum Hardness Occurs at Less Than Maximum Dispersion

The fact that austenite, though harder than pearlite, is not as hard as martensite, indicates that the latter represents a point, or rather a zone, of maximum degree of colloidality[25]—that is, there appears to be a certain degree of subdivision or dispersion, not necessarily the same with all substances, in which the dispersion system exhibits colloidal or surface phenomena to the highest extent, this effect declining not only with increasing aggregation or coagulation, but also with further peptization and the approach of true molecular dispersion, or the formation of smaller molecules.

[Jeffries and Archer in their paper on "Slip Interference"[26] designate the point of maximum hardness as the "critical dispersion." It had been referred to by Merica, Waltenberg and Scott.[27] In the preliminary paper on the zone of maximum colloidality referred to above,[25] it is stated:

The *viscosity* of reversible, emulsoid, or hydrophile colloids, one of their marked characteristics, sometimes increases as the dispersed phase becomes *finer* (as in oil emulsions, homogenized milk) or sometimes as the dispersed phase becomes *coarser* (as with soaps, night-blue, butyric acid). In fact there seems to be with each dispersion a *zone of maximum colloidality*, above which viscosity decreases with coarser subdivision as the Brownian motion becomes sluggish (about 100$\mu\mu$), and below which it also decreases as molecular dimensions are approached (about 5$\mu\mu$), and the Zsigmondy-Brownian motion becomes violent. This zone has approximate limits and a crest or peak not necessarily the same with various substances—indeed we should expect specific variations[28].

The approach toward the zone of maximum colloidality from the side of coarse dispersion is illustrated by clays which hold increasing amounts of water as their particles become smaller. The approach from the side of molecular dispersion is illustrated by the experimental results of Martin H. Fischer[29] on the sodium salts salts of the fatty acids. The sodium salts of formic, acetic, propionic, butyric and valeric acids always give molecular dispersions with water. Sodium caproate (with 6 carbon atoms) begins to show signs of "holding" water, while the caprylate (with 8 carbon atoms) gives a jelly when one mol is mixed with 250 c.c. of water. With the higher acids in the series the water-holding capacity per mol of sodium soap increases rapidly as the molecules become larger: capric (C_{10}), 500 c.c.; lauric (C_{12}), 4 liters; myristic (C_{14}), 12 liters; palmitic (C_{16}), 20 liters; margaric (C_{17}), 24 liters; stearic (C_{18}), 27 liters; arachnic (C_{20}), 37 liters.

The appearance of a zone of maximum colloidality is not limited to the so-called emulsoid colloids. Thus with steel the Fe_3C-Fe dispersion reaches its maximum hardness in martensite, and becomes softer if the dispersion becomes greater (austenite) or less (troostite, sorbite, pearlite). A similar zone of maximum hardness exists in the dispersion of copper aluminide ($CuAl_2$)[27]].

The behavior of hypoeutectoid steels (containing less than 0.9 per cent C) is naturally complicated by the fact that the transformation of the excess γ iron (that in excess of the γ iron-cementite adsorption) into α iron, or the break-up of the α-γ adsorption ("β iron"), takes time and exhibits a lag which is most marked in the quickly cooled specimens. On the other hand, with hypereutectoid steels (containing more than 0.9 per cent C) the excess of cementite tends to crystallize out in slowly cooled specimens and to yield some undecomposed γ iron-cementite "solid solution" in quickly cooled ones. To consider these in detail, and also the high-carbon "cast iron," would unduly extend the limits of this paper; but I must comment on the observations of McCance,[30] who showed "that on adding carbon to iron, the hardness of the quenched steels increases up to 0.7 per cent C, and remains constant between this point and 1.18 per cent." This indicates a zone of maximum colloidal effect, which probably covers the zone of maximum degree of colloidality above referred to. The addition of manganese to steel, as Maurer has shown, retards the aggregation of the cementite so that ordinary slow cooling yields martensite, probably because the viscosity of the dispersion medium (iron) is increased by the manganese (melting point, 1,225 deg. C.), which by its surface or adsorptive action acts like a protector in opposing the aggregation of the martensite constituents; on the other hand, the manganese increases the speed of the transformation, when it finally does occur, because the manganese exerts its force then in the direction of the readjustment. Still larger percentages of manganese prevent any transformation at all, yielding austenite.

[24] See "Surface Tension and Surface Energy," by E. Hatschek, Second Ed., 1919. On page 28 *et seq.* is a discussion of phenomena in metals.

[25] This is the subject of a preliminary paper, since published, *J. Am. Chem. Soc.*, vol. 43, p. 434 (1921).

[26] Chem. & Met. Eng., vol. 24, p. 1057.

[27] "The Heat-Treatment of Duralumin," Bureau of Standards Bull. 150 (1919).

[28] It is interesting to note that the sun repels particles of colloidal dimensions, although smaller ones as well as larger ones are attracted. See J. Alexander, "Colloid Chemistry," D. Van Nostrand Co., 1919, p. 37.

[29] Fischer, *Chem. Eng.*, vol. 27, pp. 155-62 (1919).

[30] "A Contribution to the Theory of Hardening," *J. Inst. and Steel Inst.*, 1914, No. 1, p. 192.

Lignite Carbonization—Carbonized Residue Briquets*

By W. W. Odell

Fuel Engineer, Bureau of Mines

Of recent years interest in the development of lignite fields and the production of beneficiated fuel has become more general or widespread, simultaneously with the increase in price of high-grade fuel. Not only is it recognized that our supply of high-grade anthracite is limited, but cognizance is taken of the fact that in many localities the average quality of the fuel now being purchased is not so good as that bought under the same name a number of years ago. This difference is primarily due to the increasing amount of incombustible material that is permitted to pass into a coal shipment as coal. The natural result of this higher ash content and resulting lower heating value, in conjunction with a higher price for such fuel, is that the clean lower grade fuels automatically become relatively more valuable.

The development and utilization of low-grade fuels is not new, but on this continent conditions have not heretofore been favorable to such enterprises. The abundance of the available supply of lignite in this country in locations where other fuel is obtainable only by a long freight haul from distant sources has made the lignite problem a serious one for domestic consumers in such localities as the Dakotas and Texas.

For many years it has been recognized by Dr. E. J. Babcock, dean of the mining engineering department of the University of North Dakota, that the solution of the lignite problem is of vital importance to the state of North Dakota, and to the development of certain industries in that state. The studies made under his guidance include briquetting the raw lignite, briquetting the dried and partly carbonized lignite, drying and

* Reports of Investigations, Bureau of Mines.

carbonizing lignite in rotary driers, horizontal retorts, beehive ovens, kilns and inclined ovens.

If briquets are made simply from dried lignite, other complications are met with in handling the material, such as the strong tendency for the dried lignite to ignite spontaneously. Also, the dried lignite does not lend itself well to briquetting. The conclusion reached in the studies by Dr. Babcock was that the best manner of producing a highly beneficiated fuel from lignite is to briquet a carbonized residue. The aim in general is to produce a fuel for domestic use which, on combustion, will liberate the greatest amount of heat per unit weight of fuel compatible with an economic method for its manufacture. It is appreciated that a fuel approaching anthracite may be desired for some purposes, whereas briquets capable of giving a longer flame on burning are desired for other uses. The problem as taken up at the University of North Dakota is naturally divided into two phases: First, the carbonization of lignite, so as to make a suitable material for briquetting, and second, the briquetting of the carbonized residue with the minimum amount of a suitable binder to form a firm, resistant and even-burning fuel.

Experimental Plan

During the past summer (1921) experiments were conducted at the Hebron, N. D., substation under a co-operative agreement between the University of North Dakota and the U. S. Bureau of Mines, for the purposes of ascertaining what results might be expected commercially from a particular type of oven; what methods of control should be used; what yield of gas, tar and ammonia might be realized, and to learn more about the design of a carbonizer best suited for lignite. It is obvious that in erecting or designing a complete plant it is necessary to know the capacity of a unit carbonizer as well as that of the briquetting equipment, and in order to produce the finished product at the lowest possible cost, it is desirable to obtain the maximum capacity in the operation of the carbonizer. These and other important details were given particular consideration during the co-operative tests.

The plan of the work was to carbonize approximately 1,000 tons of raw lignite by continuous operation of the carbonizer, briquetting the residue into a firm, solid fuel, and to obtain meanwhile as many data as possible relating to the following:

1. Quality and quantity of gas obtained. 2. Quantity of gas required for carbonizing. 3. Behavior of lignite during processing. 4. Capacity of carbonizer. 5. Quality and quantity of residue obtained under various conditions. 6. Analyses of lignite, residue and the briquets made therefrom. 7. Binder requisites. 8. Character of briquets made. 9. Control methods. 10. Cost of briquetted residue. 11. Quantity of byproducts. 12. The design of apparatus suitable for carbonizing lignite.

This program was adhered to as nearly as possible throughout the experiments.

Various types and styles of retorts and carbonizers have been in use at different times during the previous investigations made by Dr. Babcock and associates at the University of North Dakota and the substation, the present construction being their most recent result of the continued study of the characteristic properties of lignite, and its behavior when heated.

The carbonizer used during the co-operative tests consisted of twelve inclined retorts (a double row of six), as shown in isometric perspective in Fig. 1. The upper ends are open, and a pile several feet high, of raw lignite, is maintained above them. The carbonized product is drawn off periodically from the lower ends, after being partly cooled by contact with the air ducts or recuperators at the bottom of the setting. Exhaust steam is used to complete the cooling, and is supplied so as to be in contact with the residue at the time it is discharged into the conveyor beneath.

The gas liberated is taken off into a hydraulic main (not shown in Fig. 1), where a uniform seal is maintained so as to keep a uniform and controllable pressure condition in the retorts. An exhauster draws the gas from this main and forces it through a cooling system, where the tarry vapors are removed, and on to a manifold supplying gas to heat the retorts. The gas is supplied to the lower flues, and preheated air is used for its combustion.

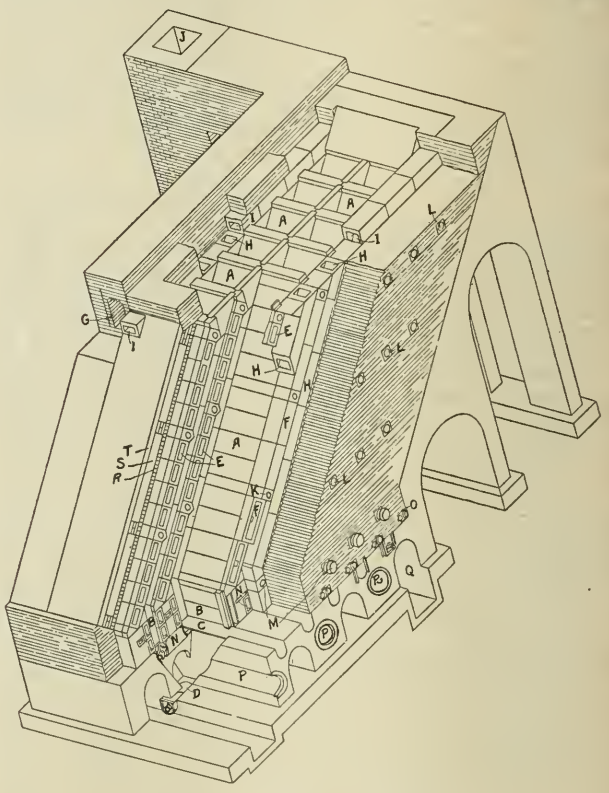


FIG. 1—LIGNITE CARBONIZER

A Inclined chambers. *B* Cooling chambers. *C* Discharging device. *D* Screw conveyor. *E* Heating flues. *F* Heating flues (end sections). *G* Waste heat flue. *H* Heating flues at sides of chambers. *I* Header for flues *H*. *J* Stock. *K* Gas offtakes, openings to chambers not shown. *L* Gas offtake blocks to receive iron pipes. *M* Poke holes. *N* Preheating flues for secondary air. *O* Dampers for secondary air supply. *P* Manholes. *Q* Tunnel for cross-conveyor. *R* Firebrick (set rowlock). *S* Ashes. *T* Reenforced concrete.

The capacity of such a carbonizer depends on the kind and quality of lignite used, as well as on operating conditions, size of retorts and other variables. Twenty tons per day of raw lignite was carbonized in this particular unit.

The briquetting equipment would briquet 2 tons of mix per hour. Belgian rolls were used, with 22-in. face, three rows wide, giving a pillow-shape briquet weighing approximately 2¼ oz. The briquets obtained held up nicely in the fire, burned evenly, and withstood severe tests.

A complete report of the results obtained during the experiments is now in preparation by the co-operators.

Some New Petroleum Products*

The Vapor-Phase, Low-Temperature, Catalytic Oxidation of Fuel Oil and Other Crude Petroleum Fractions Is Shown to Yield a Series of Novel Chemical Products Which Appear to Have a Broad Range of Possible Industrial Applications

By J. H. JAMES
Professor of Chemical Engineering, Carnegie Institute of Technology

VERY little chemistry enters into ordinary petroleum refining, the process on the whole being based on physical principles. Where chemistry is introduced at all, as in acid agitation or sulphur removal by the Frasch and other processes, it is only for the purpose of removing certain substances, the presence of which impairs the value of the main product. The "cracking" processes developed in recent years are, however, an exception to the foregoing statement, for they involve chemical changes. The various commercial products of petroleum in present-day practice are those mixtures of hydrocarbons, the sum of which made up the greater part of the original crude.

The purpose of this paper is to describe in rather brief outline some work done in an attempt to prepare certain new chemical products by starting with petroleum as the raw material. The industrial application of the products thus obtained appears to belong in part to the oil industry and in part to industries decidedly remote. The fundamental idea of the process involved is the vapor-phase, low-temperature, catalytic oxidation of the aliphatic hydrocarbons of the petroleum.

While references are numerous in the literature to the many attempts made to oxidize petroleum hydrocarbons in the liquid phase, the first recorded work in the vapor phase appears to have been that of Walther.[1] Walther's apparatus, his arrangement and selection of catalysts and his temperature (he worked at a glowing red heat), as well as his air ratio (which must have been very high, as he maintained self-sustained combustion) all show, as our experiments have proved, that his proposed process was bound to be a failure. In the one experiment cited in his patent, he claims to obtain a liquid of lower boiling point than the original material treated, although his description of the other products is noticeably incomplete.

Selection of Catalyst and Temperature Control

The author has found that the first requisite for success in obtaining yields sufficiently high and of satisfactory quality for industrial use is the selection of the catalyst. In this connection the oxides of certain metals of high atomic weight and low atomic volume, such as molybdenum and uranium, appear to be the most promising. Where compounds of closely related metals can be formed, such as diuranyl vanadate, very good results were obtained.

Numerous experiments have shown that many oxides have catalytic activity in this connection, but it is believed that for commercial development, all things considered, the best selection is within the group noted above. Good results have been obtained by passing the mixture of hydrocarbon vapor and air through a thin layer of uranium oxide and then on through two layers of catalyst consisting of the oxides of molybdenum. The reason for the three catalytic layers, or, as we call them, "catalytic screens," will be noted later. The uranium oxide is used in the first screen because this oxide has the specific property of catalyzing to a marked degree the aldehydic stage of oxidation, so that where acids are desired as the main product, this preliminary step brings about a higher yield of acids, the aldehydic bodies going over to acids in the second and third screens.

In this process the temperature at which any reaction between molecular oxygen and aliphatic hydrocarbons begins is about 240 deg. C. Owing to the fact that the oxidation is slight at this temperature, and also to the further consideration that more heat is required to vaporize heavy hydrocarbons even with air, or air and steam present, higher temperatures than this must be employed. In general, the temperature should be as low as is consistent with good vaporization and a sufficiently rapid reaction; this varies of course with different petroleum fractions, but in any case no results of industrial value can be obtained above 500 deg. C. The writer's experience here would dictate that rather than work at temperatures approaching such a figure (where very high molecular weight hydrocarbons are being treated) it is better to run a small amount of the heavy petroleum fraction—such as wax distillate, for example—with a large amount of a fraction of lower boiling range, such as gas oil or heavy kerosene, thereby effecting ready vaporization of the heavy portion and allowing a lower catalyst temperature for the reaction.

Although steam may be used with good results, too much steam hinders the reaction, so that with very heavy fractions it will not do to depend entirely on steam as an aid in vaporization.

Some Products of the O idation

The products formed vary somewhat with the catalyst and the temperature employed, but in general represent all the stages of the oxidation of aliphatic hydrocarbons from alcohols to oxygenated acids, together with hydrocarbons and oxidized bodies resulting from secondary reactions. These various bodies have not been studied in detail, but the acidic portion has usually been separated and the non-saponifiable portion, which we have chosen to call "congeneric oil," has been set to one side without any further treatment, except in a few instances, when it has been subjected to distillation. The acids are not true fatty acids, but are oxygenated acids, which are always aldehydic in character and respond to all the aldehyde reactions; and in fact their future industrial application may in some cases depend upon their

*A paper presented Dec. 9, 1921, at the Baltimore meeting of the American Institute of Chemical Engineers.

[1]Brit. Pat. 21,941 (1905).

aldehydic character. For example, if the saponification of the oxidation product of any petroleum fraction be carried out with caustic soda, so much resinification of these acids takes place that when the acids are liberated from the soaps by a mineral acid they appear as hard resin-like substances. In fact, it is not at all improbable that these resinified acids will find use as cheap varnish gum and paint film substitutes.

If the saponification be carried out with calcium hydroxide instead of caustic soda, insoluble lime soaps are obtained of good color, since this base has very slight resinifying action on the aldehyde acids. The problem of making soda soaps of good color from these acids must be solved, the writer believes, by first making the lime soaps, then the free acids and finally carrying out the soda saponification under conditions which do not permit resinification to take place.

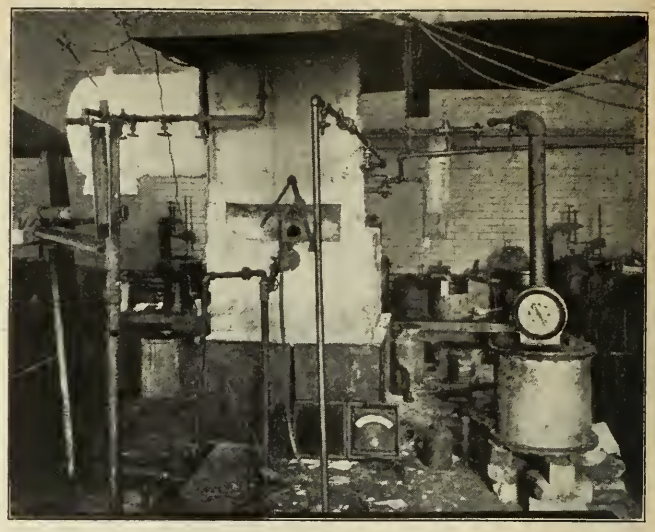
It is rather interesting to note that in the lime saponification it is very easy to make greases, the original components being lime soap, "congeneric oil" and water, and finally, if desired, only lime soap and congeneric oil. In fact there is always the problem of breaking up the grease, if it is desired to isolate the acids as noted above. It is believed that the best method for doing this is to remove the water by evaporation and then thin down the congeneric oil with one of the lighter petroleum fractions such as kerosene, filter off the lime soap and finally wash with a still lighter fraction, such as gasoline.

Development of New Fuel

Another phase of this work is the possibility of developing a new fuel from the cheaper fractions of petroleum by carrying out the oxidation at higher temperatures. These oxidized bodies thermally decompose to form both hydrocarbons or lower carbon content, and oxidized bodies of lower molecular weight. For example, with a fraction of Mexican fuel oil boiling from 300 to 360 deg. C. and running the oxidation process (by the three-screen method to be discussed later) so that the temperature is held between 380 and 400 deg. C. the liquid product obtained amounted to 80 per cent by volume of the oil treated. This product contained 30 per cent by volume of aldehydic fatty acids, 20 per cent by volume of other aldehydic bodies and the remaining 50 per cent consisted of other oxidized bodies and hydrocarbons. The latter were mostly of lower molecular weight than those of the original mixture, because of thermal decomposition of the oxygenated bodies. On distillation, 65 per cent of the product boiled under 300 deg. C. and of this fraction 18.4 per cent boiled below 200 deg. C. The oxygenated bodies are distributed through the entire range of fractions obtained by fractionally distilling the product, with more of the acids in the heavier fractions, and oxygenated bodies that have undergone thermal decomposition in the lighter fractions, along with hydrocarbons that have also been formed by thermal decomposition of the primary oxidation products. The distribution of the combined oxygen is shown by the following analyses made on a product obtained by the oxidation of a "pressure still tar," the residue from the "cracking" stills of one of the pressure cracking processes:

	Per Cent
Combined oxygen in fraction above 300 deg. C.....	4.1
Combined oxygen in fraction between 200 and 300 deg. C.	6.48
Combined oxygen in fraction under 200 deg. C.....	12.32

This fraction under 300 deg. C. might be called "oxidized" kerosene, and its properties certainly justify



VAPORIZER (RIGHT), CATALYST CHAMBERS (LEFT)

work in the direction of having it utilized industrially as a fuel in internal combustion engines. It may be used in kerosene engines, or blended with gasoline for use in gasoline engines. Although it has a somewhat lower fuel value than ordinary kerosene, owing to its oxygenated character, it undergoes much better combustion in the internal combustion engine.

A sample of "oxidized" kerosene made from Mexican gas oil, having a specific gravity at 15.5 deg. C. equal to 0.863, gave a calorific value of 18,210 B.t.u. per lb. A sample of Mexican kerosene that had been given a rather mild oxidation had a specific gravity at 15.5 deg. C. of 0.855 and gave a calorific value of 18,696 B.t.u. per lb. Three samples of ordinary kerosene from various sources gave for their calorific value in B.t.u. per lb. 19,827, 19,867 and 19,944, from which it would appear that the calorific value of these oxidized kerosenes is not seriously low.

The use of this oxidation mixture—such as is obtained from gas oil, for example—as a starting material in "cracking" processes has been studied to some extent. As far as these experiments have been carried, it is evident that low boiling mixtures, within the gasoline range, can be obtained by the thermal decomposition of this mixture. These experiments are, however, only in the laboratory stage.

Heavier Fractions Possess Lubricating Properties

The oxidation products obtained from the heavier fractions deserve attention from the standpoint of lubricant manufacture. Southcombe has recently brought forward the idea that a small percentage of free fatty acids added to a straight mineral oil lubricant would increase the lubricating character, particularly for those cases in which it has been necessary to use "blended" mineral and fatty oils. While this has been questioned, the writer ventures the opinion that at the present time the experimental evidence collected supports Southcombe.

The portion of the oxidation mixture that will be found suitable for use, either alone as a lubricant or as a blending agent, is the "congeneric oil" remaining after the acids have been removed. These high molecular weight oxidation products have valuable lubricating properties, a fact which appears to extend the Southcombe idea in another direction.

Although the idea is a daring one, the writer has suf-

ficient experimental evidence to make the claim that these oxidized oils will be found suitable for internal combustion engine lubrication. In this connection it should be remembered that the resinification property of these high molecular weight aldehydic bodies is brought out by treatment with the caustic alkalis. Under other conditions these bodies are really more stable than the fatty oils.

The sulphonation of the oxidation mixture has been carried out with a considerable degree of success. The acid portion sulphonates more readily than the other bodies present.

A promising application of the oxidation mixture in its entirety, just as it comes from the apparatus, is in the field of oil flotation. This mixture can serve primarily as a "frothing" oil in flotation mixtures, and numerous laboratory experiments have shown that it has, on the average, about one-half the frothing power of the best pine oil frother—that is, 2 gal. of this oxidized mixture will in general do the work of 1 gal. of the highest grade pine oil. When it is considered that this oxidized mixture can be made from fuel oil, available almost everywhere, and that pine oil f.o.b. New York costs $1.50 per gal., it would appear that this product may find use in the concentration of ores by oil flotation.

From experimental evidence it is the acid content of the oxidized mixture that gives this material its frothing character. However, for flotation work there would be no gain in separating the acids, as the congeneric substances dissolve readily in all oil mixtures. The frothing oil in flotation formulas is but a small percentage of the total oil, hence the congeneric oils do no harm, and being made from fuel oil, which is commonly used as a collecting oil, the whole proposition works out as a very economical means of getting fatty acids into flotation mixtures.

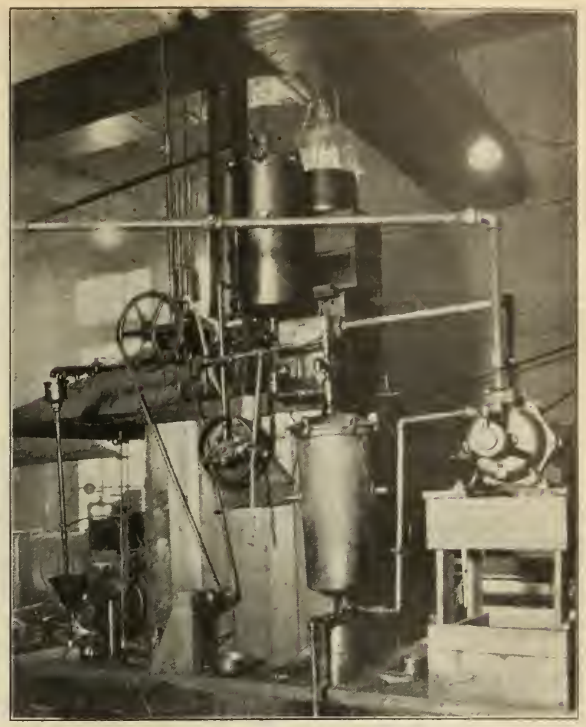
Developing the Apparatus

This process has been carried to what might be called the semi-industrial stage. In the laboratory of industrial chemistry at the Carnegie Institute of Technology there was set up a triple screen apparatus large enough to make about a barrel per day of the oxidized mixture from any petroleum fraction or blende that can be vaporized.

When the larger apparatus was first installed, one screen only of catalytic material was used, and the excess heat developed was carried off by a system of cooling pipes, the closed ends of which were imbedded in the catalyst.

Either air or water could be used as the cooling medium. In this oxidation of aliphatic hydrocarbons, the writer usually prefers to keep the temperature of the catalyst below 400 deg. C. (usually 280-380 deg. C.), hence in an apparatus larger than that used in the laboratory, the temperature tends to rise, because of the greater distance to any radiating surface and the nonconducting character of the catalyst and its carrier, which is usually asbestos.

The cooling tube apparatus worked fairly well, but later the double- and finally the triple-screen apparatus were developed. In the cooling tube system, one catalytic screen only was used, hence all the air that was to be introduced had to be given to the reaction at one time. With more than one catalytic screen, the air is introduced in portions before entering each screen, being distributed among the screens usually in equal amounts,



OIL FEED AND EXHAUST PUMP

but sometimes varying from this, if conditions demand it.

The triple-screen system also makes possible the use of different catalysts. It has been found that uranium oxide catalyzes the oxidation to the aldehyde stage, and at present uranium oxide is used for screen 1 and the molybdenum oxide mixture for screens 2 and 3.

The air is drawn into the system by a small pump, which in addition functions as a mechanical scrubber in aiding in the removal of the oil vapors from the gas stream. A parallel tube condenser placed about 15 ft. beyond the catalyzer (to allow for air cooling) is placed between the catalyzer and the pump.

Some Operating Data

The following example will serve to show the working of the apparatus:

Catalysts: three screens, all of molybdenum oxides, each 37.5 cm. in diameter and 1 cm. thick.

Oil used: Pennsylvania petroleum; a product sold at one time during the war as fuel oil by one of the Pittsburgh refineries: it showed the following on distillation:

First drop, 200 deg. C.	Per Cent by Vol.
200-250 deg. C.	11
250-300 deg. C.	51
300-350 deg. C.	34
Residue above 350 deg. C. and loss	4

Specific gravity of oil at 15.6 deg. C. was 0.819. Olefinic hydrocarbons (by the sulphuric acid test) was 7.5 per cent.

Time of run, 4 hours.

Average temperature of mixture leaving vaporizer, 310 deg. C.

Average temperature of first catalyst 335 deg. C.

Average temperature of second catalyst 370 deg. C.

Average temperature of third catalyst 370 deg. C.

Volume of air at room temperature and pressure passing into vaporizer and on into first catalyst, 70 liters per minute.

Volume of air added at second catalyst, 30 liters per minute.

Volume of air added before entering third catalyst, 30 liters per minute.

For the second half of the run, "fume" gas (50 liters per minute) was taken from exit line and added as diluent to lower the temperature at screen number two.

Rate of oil feed to vaporizer, approximately 6 liters per hour.

Rate of water feed to vaporizer, approximately 6 liters per hour.

Vacuum on system at vaporizer, 5 cm. of mercury.

Gas Analysis:

	Per Cent by Vol.
CO_2	2.9
O_2	2.9
C_nH_{2n}	2.5
CO	4.8
Undetermined (mostly N_2)	86.9

Volume of oil fed during run, 25.5 liters.

Volume of oily product (insoluble in water) recovered, 19.6 liters.

Specific gravity of product at 15.6 deg. C. was 0.86.

The product had approximately the following composition:

	Per Cent
Aldehydic fatty acids	31
Aldehydes (above 200 deg. C.)	20
Alcohols, volatile aldehydes and other oxidized bodies with hydrocarbons (by diff.)	49

The process works even better on oils having a lower market value than the Pennsylvania petroleum. For example, one of the easiest fractions to treat is what is commonly called "the gas oil fraction" from Mexican petroleum. The presence of sulphur compounds and of unsaturated hydrocarbons is no drawback to the application of the process, since the oils containing these bodies oxidize more readily. This therefore makes the process applicable to many refining wastes that now find their way into the fuel oil tank.

Patent applications covering the main process as well as its various ramifications have been filed in the United States and foreign countries.

Carnegie Institute of Technology,
Pittsburgh, Pa.

Atmospheric Nitrogen Production in Germany

The present extent of the production of nitrates in Germany by atmospheric fixation is discussed in *Commerce Reports* for Jan. 16, 1922.

Previous to the Oppau explosion in September, 1921, it was claimed that Germany was ready to supply, using the Haber-Bosch method alone, a combined production of 300,000 tons of nitrogen fertilizer, or enough with its other resources to take care of the most urgent needs of its agriculture. The aim of the industry, however, is to develop a production of 500,000 tons annually by this process alone, or sufficient to yield the maximum of vegetable produce from Germany's arable land, an amount estimated as adequate to feed a population of 100,000,000.

On account of the explosion, production ceased in the first plant in Germany to undertake the production of nitrogen by the Haber-Bosch process. The estimated output of this plant has been placed at 100,000 tons of nitrogen fertilizer per year.

Before the war Germany imported vast quantities of Chilean nitrates, together with various industrial by-products in the shape of nitrates of lime. In 1900 South America supplied Germany with 350,000 tons of nitrates; in 1909 with about 480,000 tons, containing 76,000 tons of pure nitrogen, valued at 95,000,000 gold marks. In 1913 German agriculture absorbed about 200,000 tons of nitrogen, sufficient to supply about 83 per cent of its population of 60,000,000 with cereals but insufficient to supply fodder for cattle.

Calcium-cyanamide factories in Germany have an output now of approximately 500,000 tons, with a nitrogen content of about 100,000 tons. Production of nitrogen fertilizers by the coke and gas industries before the war amounted to about 580,000 tons, with a nitrogen content of about 116,000 tons.

Corrosion Patterns on Cold-Worked Tin and Zinc

By Henry S. Rawdon, Alexander I. Krynitsky and Julius F. T. Berliner*

SPECIMENS of high-grade tin intended for pyrometric standards[1] were used in a brief study of the properties of tin after deep corrosion. The cross-section was reduced by cold-rolling from 2 by 4 cm. to a strip approximately 0.15 cm. thick, and the metal was then annealed for period of 2½ hours at 150 deg. C. Acidified solutions of stannous chloride were the corroding liquids used, alcoholic solutions rather than aqueous being employed on account of the influence of water in decomposing the salt. For reagents, a normal solution of stannous chloride to which hydrochloric acid was added to form solutions of the approximate concentrations 0.52*N*, 0.78*N*, 1.2*N* and 2.2*N* were used. The temperature was that of the room and varied between 12 and 30 deg. C.

The attack was distinctly more severe along the grain boundaries than in the interior of the grain. After a prolonged attack, it appeared that some of the grains had been detached bodily along the margin of the corroded specimen as is shown in Fig. 1. Corrosion was permitted to proceed for a period of 87 days and on sharply bending the corroded specimens, no evidence of intercrystalline fissures throughout the material was obtained except a suggestion of them in one case. In general, the metal appeared to retain its initial ductility

Some of the specimens of tin exhibited a very peculiar and striking pattern upon corrosion which was independent of and superimposed upon the granular or crystal structural pattern. This is shown in Fig. 2, and it appears to be related to the rolling that the material received. That it is not entirely a surface roughening caused by adherence of corrosion products or by convection or diffusion currents within the corroding liquid appears evident from the fact that very slight corrosion (1 hour) was sufficient to reveal it and also that it was still very prominent after 4 days' attack. The regularity of this cellular pattern is striking.

No explanation as to its meaning can be offered from the evidence in hand, though it can be stated that the properties of the tin after corrosion do not appear to be affected to any appreciable extent by this feature of the structure. The fact that the metal was annealed would indicate that the etch pattern cannot be attributed to the uneven removal of a relatively hard "skin" on the surface of the metal.

Zinc

The material used for experiment was a high-grade sheet[2] zinc furnished for the purpose by the New Jersey Zinc Co. The sheet was stated to be in the annealed condition when received; the microstructure indicated, however, that all the effects of the mechanical working had not been removed, so an additional annealing was given to some of the material. The small specimens, after being cut to size for the corrosion

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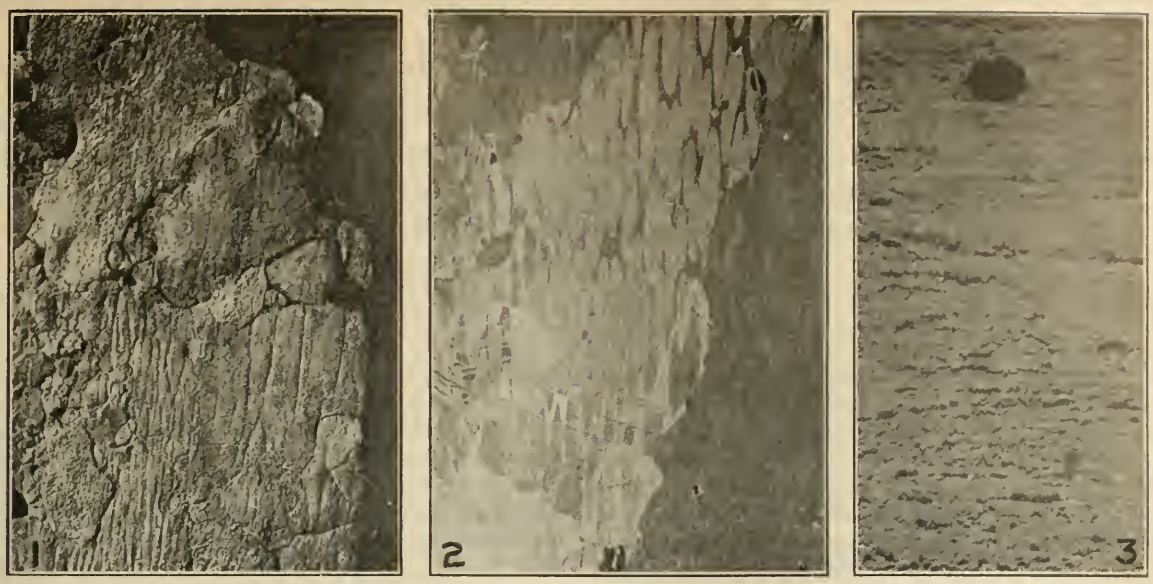
*Physicist, Associate Physicist and Laboratory Assistant, respectively, Bureau of Standards.

[1]The chemical analysis of the material indicated the following composition: lead, 0.007 per cent; copper, 0.003; iron, 0.002; a trace of each, arsenic and sulphur; antimony, not detected; tin (by difference), 99.998 per cent.

[2]The chemical analysis indicated the following composition: Lead, 0.04 per cent; Iron, 0.02; cadmium, trace; sulphur, not detected; zinc (by difference), 99.94 per cent.



FIGS. 1 TO 3

Fig. 1—Pure tin after 87 days' corrosion in N $SnCl_2$ + 2.2N HCl. × 5.
Fig. 2—Pure tin after 1 hour in N $SnCl_2$ + 0.6N HCl. × 5.
Fig. 3—Annealed zinc after 17 days' corrosion in N $ZnSO_4$ + 2N H_2SO_4; cleaned before photographing with 5 per cent acetic acid. × 2.

tests, were heated in an oil bath and maintained at a temperature of 350 deg. C. for a period of 3½ hours and allowed to cool in the oil, the entire period above 300 deg. C. being approximately 5 hours.

Normal aqueous solutions of zinc sulphate to which various amounts of sulphuric acid had been added in order to give a series of solutions of increasing acid concentration were used as the corroding liquids. The results obtained after a period of 17 days at room temperature are summarized in Table I.

TABLE I.—LOSS OF WEIGHT OF ZINC DURING CORROSION

Spec. No.	Dimensions, Cm.	Area, Sq.Cm.	Corroding Solution	Loss of Wt. After 17 Days,* G.	Loss per Sq.Cm. per Day, Mg.
1	4 x 2.1 x 0.12	17.26	N zinc sulphate	0.018†	0.06†
2	4 x 2.1 x 0.12	17.26	N zinc sulphate + N/4 sulphuric acid	0.157	0.53
3	4 x 2.1 x 0.12	17.26	N zinc sulphate + N/2 sulphuric acid	0.698	2.38
4	4.1 x 2.1 x 0.12	18.7	N zinc sulphate + N sulphuric acid	1.291	4.06
5	4 x 2.2 x 0.12	19.1	N zinc sulphate + 2N sulphuric acid	2.600	8.00

*The scale was removed from the corroded specimens by immersion in 4 per cent acetic acid solution before weighing.
†Slight gain caused by incomplete removal of the corrosion scale.

The attack of the metal appears to be, at least in part, intercrystalline in nature, as is best shown by examination of the edges of the corroded sheets and the margins of corrosion pits. However, upon sharply bending the sheets after corrosion no pronounced evidence was obtained which would indicate that the metal had been embrittled or otherwise seriously affected in its properties as is the case with lead after corrosion under similar conditions.

The character of the corroded surface appears to have been determined in a very large measure by the mechanical working which the material previously received. The pits resulting from the corrosive attack were arranged in rather definite lines which coincided with the direction of rolling of the sheet. This feature was noticeable even in the annealed sheet, but more so in the commercially annealed metal. Fig. 3 shows an annealed specimen after corrosion for 17 days in N $ZnSO_4$ plus 2N H_2SO_4. Results obtained by prolonged corrosion in solutions of zinc chloride and of zinc nitrate with additions of the corresponding acid were very similar to those described above.

Upon sharply bending the specimens after the prolonged corrosive attack no satisfactory evidence was obtained which would warrant the conclusion that the metal had been seriously affected in an intercrystalline manner.

The Metallurgical Situation in France

According to figures reproduced in the French press, the total production of iron in France in 1921 was 2,074,732 tons, as compared with 3,265,000 tons in 1920 and 5,207,197 tons in 1913. The steel production for 1921 is given as 2,602,800 tons, as compared with 2,914,800 tons in 1920 and 4,686,866 tons in 1913. Thus the reduced activity in France is not as considerable as in Belgium, where the 1921 production of iron was only 34.7 per cent of the 1913 figure. The only country where production has increased is Germany, where, according to the same estimates, the production of iron rose from 7,000,000 tons in 1920 to 8,000,000 tons in 1921 and that of steel from 8,400,000 in 1920 to 9,400,000 tons in 1921.

A steady improvement is noticeable in the metallurgical industries in the Lyons district. The orders given by railway companies for locomotives and rolling stock and for repair materials have recently been so numerous that certain works are short of skilled hands. An improvement is remarked in the construction of machines for the cardboard and paper industries, and one establishment, which specializes in the construction of installations for slaughter houses and refrigerating warehouses, is seeking skilled hands.

Metallurgical works are profiting by the resumed activity of the chemical industries, which are ordering new vats and reservoirs, but the situation in the boiler trade is regarded as serious. Cast iron and steel foundries are receiving a certain number of orders, and although fewer workers are employed than in a normal period, work is active. Copper foundries are also more active, the tap industry having improved considerably.

Breakage Factors in Silica Brick Manufacture

A Critical Discussion of Those Factors in the Manufacture of Silica Brick Which Determine the Breakage Records—Properties of Silica Rock—Grinding—Effect of Bats—Workmanship—Drying—Setting in the Kiln—Burning—Methods of Firing

By PHILIP H. JUNG
Consulting Chemical and Metallurgical Engineer

OF ALL refractories, silica brick are probably the most difficult to manufacture, or in other words, it is most difficult to obtain a low breakage record on silica brick. The reasons for this are, first, that the very nature of silica, considered from its physical aspects, makes it difficult to bond and shape as compared to an argillaceous substance, and second, that extreme care is required in burning and cooling, as silica will not stand rapid changes in temperature. Users of silica brick sometimes do not take this into consideration, and, in these cases, when brick are subjected to rapid heating and cooling, they soon fail and are condemned unjustly. At the present time manufacturers are interesting themselves in a silica brick machine and find that more intricate problems have to be faced than in the case of fireclay.

Breakage is a matter of uniformity, and the various factors that influence breakage are being more clearly recognized than heretofore. Investigations are continually being carried on to determine correct practice and then an effort is made to adhere to this.

Properties Desired in the Silica Rock

First of all, we have the character of the rock to consider. The physical appearance of silica rock or ganister varies considerably. Some of it is dark, some light, some streaked and the surface of some highly discolored. Of course, the purest rock is white. A colored rock is not necessarily one to be rejected. Very often a very high-grade rock is highly colored on the surface and gray throughout the mass. In the same quarry, the floe or surface rock will almost always vary from the solid measure rock. Some quarries will give an excellent floe rock and others a superior solid measure rock. Manufacturers differ in opinion as to which is the better. A clean-looking rock usually implies a pure rock, which forms a crude index of the chemical analysis. However, the physical features of the stone equal and perhaps exceed the chemical composition in importance. Sandstone which shows a very high percentage of silica is unsatisfactory for making brick, because it lacks physical strength. It invariably consists of rounded grains that are not tightly cemented to one another. On the other hand, there is a mountain of rock in the state of Washington which is pure quartz and translucent in appearance. It is entirely of a crystalline structure, and on fracture will break into small fragments with edges as sharp as a needle. Experiments have shown that a rock which is too pure, or in other words lacking some alumina and iron to aid in bonding, is difficult to bond even with a large percentage of lime, and this is especially true when the structure is all crystalline. Therefore the best rock for making silica brick is one not too pure (under 99 per cent silica) and one which consists of crystals, which break into sharp fragments and which are cemented together with a ground mass of granular quartz. In this case the amorphous quartz, alumina and iron will aid in the bonding and help to make a physically stronger brick, other things being equal. Furthermore, such a rock will be difficult to pulverize. It is evident, then, that the selection of rock is of prime importance and that an experienced quarryman is absolutely essential.

After the rock has been crushed to the desired size, it is conveyed into bins, from which it is fed into pans having double mullers, milk of lime being added, and this mixture is ground and mixed thoroughly and constitutes what is known as silica mud. Sometimes bats are ground with it. What bats are and how they affect the situation will be discussed later on. The lime, if kept within certain limits, does not affect the breakage as much as was once thought. To be sure, it is an important factor and needs constant watching, but it cannot prevent a high breakage if other important factors are not uniform.

Importance of Uniform Grinding

It has been mentioned above that the rock is ground to a desired fineness. How fine or how coarse this must be depends on circumstances. A coarse grind means more abrasive qualities, ability to stand greater wear and tear and greater porosity. A fine grind means better filling out of corners, denser brick and greater thermal conductivity. As a rule, brick for open-hearth furnaces are coarsely ground and brick for byproduct coke ovens and glass tanks are ground finer. It is quite difficult to get a uniform grind. Experiments have been made often, the utmost care being taken to have the same rock as near as possible, the pans being properly repaired and time identical, and yet divergent results have been obtained. My personal view is that the varying factor lies in the hardness of the rock. No doubt practical brick manufacturers will dispute this point and maintain that their rock does not vary enough in hardness to warrant this inconsistency in grind. However, although no series have been made conducted along this line to my knowledge—that is, to show the exact relation between variation in grind and hardness of rock—my belief is that a small variation in the hardness of the rock will cause a much greater variation in grind than is thought possible. At least personal observation and practical experience lead me to believe this. All told, grind is an important factor, and whereas it does not influence breakage as heavily as some other factors, it does have a tendency to affect workmanship, which will be discussed later.

The next thing to consider is the amount of water to add in the brick mud to make it plastic and workable. Moisture varies ordinarily from 7 to 13 per cent. Below and above these limits it is quite noticeable. Below 7 per cent the mud feels very dry to the touch and above 13 the excess can easily be squeezed out and is so apparent that brick with that amount of moisture that have just been molded and set aside to temper sag at the edges and the excess water appears in beads on the surface of the brick. When carefully watched, it is very easy for an experienced pan-runner to get between 10½ and 12 per cent day in and day out. It is remarkable how accurate the workmen become with practice, simply by feeling before dumping the mud on the table. When it is a trifle wet, say 12 per cent, it will help toward making a firmer bond than if it is a little drier. Strength tests have shown this. The moisture is not difficult to control and therefore does not cut much figure in the breakage item. Furthermore, molders refuse to work with mud that is too wet or too dry, especially if the brick are branded with the molder's individual brand, and therefore it is very seldom that brick enter the driers having this defect.

Along with the question of moisture and closely allied to it is that of introducing scrap. By this is meant the addition of dry mud obtained from rejected green brick in order to give the charge the right plasticity, or in other words, when too wet, to correct this fault. Inasmuch as so little is added to the ordinary charge, and then only at intervals, it has practically no bearing on the breakage.

Effect of Bats on Breakage

A statement has been made previously concerning bats and their effect on breakage. The term bats applies to rejected burned brick which are used over again in preparing the brick mud mixture. I doubt whether there is any subject concerning the manufacture of silica brick about which there is so much controversy and which arouses so much ire. Up to the present time it has not yet been shown just what amount of bats is correct, if any. The consensus seems to be around 15 per cent. At the present time I know of three silica brick yards that differ on this question. For example, yard 1 issues instructions to its pan-runners to add so many 9-in. brick (6 lb. apiece) to each charge and attempts to adhere to this religiously. In this case the amount happens to be about 8 per cent. Yard 2 never adds any unless the breakage is unusually high, and then only to get rid of the excess and in small quantities in each charge. Yard 3, after some technical investigation in the matter, came to the conclusion that the effect on the strength of the brick was not very great, that is, up to a certain point. For a time bats were added indiscriminately in spite of the fact that the mixture was hard to work with and was detrimental to small breakage records, because rigid inspection has shown that a high percentage of bats does not give the brick the clear ring when tapped with a hammer. But later on this practice was discontinued.

Just how does the addition of bats affect the structure of the brick? It is quite evident that if two brick receive an equal degree of burn, one containing no bats and the other about 20 per cent, the first will have expanded further than the other, because the latter contained 20 per cent of material that had already been burned and expanded. The natural inference would be if one part of the brick expands more than the other part, this might cause fissures and even a rupture of the brick. However, strength tests have not borne this out. In fact a small percentage of bats seems to make a little stronger brick, especially when added in a pulverized form. Moreover when being molded, it is unquestionably more difficult to bond a small piece of bat to a piece of raw rock than it is to bond a small piece with another. This, however, is self-corrective, inasmuch as in burning, when changing from free lime to tricalcium silicate, the chemical change is the same in either case, at least there would be the same knitting together, although, as noted above, it would seem physically as if fissures would appear. The question as a whole is as yet difficult of solution, but it is conceded at least that it affects breakage considerably, if only from a standpoint of rigid inspection.

Workmanship

We now consider the important item of workmanship. This and burning probably affect breakage more than any other two factors.

It is a curious fact that according to the popular mind, the only big requirement for a brick is to shape up well, or in other words to fill out the mold exactly, with edges sharp. This conception is due no doubt to the fact that the average person invariably thinks of a building brick, which of course must be straight, so that it can be laid right. When considering refactory brick, however, although workmanship is not everything, yet it is a great deal. In the first place, the molds are very carefully made, and the process of molding varies with the kind of brick being made. When ordinary 9-in. straight are being made, slop mud is used—that is, two handfuls are thrown in the mold simultaneously and with considerable force, the hands being about 6 in. above the mold. The impact is sufficient to fill the mold completely. It is then slicked off and the brick pressed out. In case of shapes, especially where the shape is large and intricate, the brick are more carefully made. The mud for this purpose is both finer and more dry, as noted before. The edges of the mold are filled in first and the mold partly filled with mud and then hammered. This is then stirred around to prevent cleavage and enough mud added to fill the entire mold, which is then slicked off as in the previous case. The molds are so made that they can be taken apart, thus freeing the brick easily. A brick that is not carefully filled out is usually spongy in appearance. Sometimes brick warp and are not exactly straight. This may be due to poor workmanship or else the use of mud that was too wet. However, brick sometimes warp in spite of every precaution. Workmanship is such an important factor in this department that rigid inspection is essential, and this, together with the fact that physical imperfections can be seen, ordinarily reduces to a minimum the breakage for which this department is directly responsible.

Drying an Important Factor

After the brick are made, they are put on a rack-car and left standing in the open air to temper properly. This process permits the brick to dry very slowly and harden, an action not unlike the setting of cement. Special shapes are put on a hot floor and permitted

to remain there sometimes several days. After they are tempered, they are put in the driers. Temperature uniformity is of prime importance in drying and is difficult to obtain, owing to the fact that the old-time method of employing waste heat from the kilns is still utilized in brick plants, both because of economical operation and for want of something better to meet the situation. The hot air is drawn in by huge fans and the temperature is controlled by opening and shutting blades on the fan. Even then unless the temperature recorders are closely watched, there will be considerable temperature fluctuation. The incoming end of the drier must be comparatively cold compared to the outgoing end.

As the brick are placed in the drier, they gradually work their way forward, being pushed by others behind them and in this way they reach the hottest zone, which should be just before reaching the outgoing end. This sometimes is as high as 325 deg. F. The reason for this is that if they are suddenly plunged into a temperature of 300 deg. F. or over from ordinary temperature, the sudden formation of steam will cause cracks in the structure and the bond will be somewhat broken. In other words, shattering on a small scale is the result, and, although the same thing occurs on a much larger scale in rapid burning, the damage is just as severe, and it leaves the brick while yet in the green state in a friable condition and with a cracked sound when tapped with an inspector's hammer. Time and time again, brick that were apparently O.K. in other respects were in this condition and were set and burned. This not only represented a waste of time and money, but was misleading in investigating the cause of high breakages. I recall a startling example of a case where a sudden depression in the industry proved to be a blessing in disguise, because the management, having more time to investigate such matters because of diminishing orders, finally found a clew to what had caused them grave concern for months. After investigating every possible source of trouble, they found that fully 10 per cent of their breakage was due to rapid heating and lack of temperature control in the driers.

Owing to practical condition, at times some time elapses after the brick are taken out of the drier and are set. A series of experiments run to establish a relation between absorption of moisture by green brick and the weather conditions proved that in no case was sufficient moisture absorbed to give concern, and furthermore, even on long standing, the amount of moisture absorbed was negligible. Whereas this is but a minor matter in the manufacture of silica brick it proved that if any appreciable moisture was present, it came from improper drying and thus an alibi long used by the drying foremen was no longer available.

Setting the Brick in the Kiln

Although the setting has a great deal to do with breakage, it should not occupy a prominent place in a technical dissertation of this kind. Proper setting is a matter of skill backed by years of experience in the brick industry. In the first place, it should be noted that the kiln has been properly repaired, that the fireboxes are in good condition, the riddle holes well cleaned out and the kiln-floor as nearly level as possible. All this helps both in setting and burning. In down-draft kilns, such as are being used in the silica brick industry, checkerworks of old brick are built in back of each firebox to divert the path of the flame upward toward the top and middle of the kiln, whence it is drawn down through the riddle holes and up the stack. Another reason for the erection of checkerwork is to prevent fire-flashing of ware nearest the firebox. The order or style of setting depends on the kind of shape being set. Ordinarily, difficult shapes are boxed in—that is, surrounded by benches of 9-in. or other small straight brick.

There usually is a preponderance of standard easy makes, such as 9-in., wedge, large 9-in., soaps, feather-edge, etc. These are usually nearest the fireboxes. The usual procedure of setting is to start with a course of tie-brick—that is, brick that have been burned over and over again and are used to support the courses of green brick that are being set. Several courses or rows of brick are set on top of this and then another row of the tie-brick. Sometimes brick are set on edge, either lengthwise or breadthwise, but in any case it is necessary to alternate this procedure with each row. This permits proper spacing between brick, which is important, as brick must have room to expand. After the setting is completed, a space is allowed for test brick and testing cones, the doors are sealed and coal in the fireboxes ignited with oil, pitch or other flammable material.

Burning a Major Factor in Breakage

We now come to the burning. This and the workmanship form the two major operations in silica brick making and ordinarily influence the breakage more than any other factor. Attention has been called to the fact that silica brick are difficult to make and that one of the principal reasons for this is found in the structure of silica. This becomes very evident when the subject of burning is considered. A silica brick must be heated slowly and cooled slowly. Rapid heating causes spalling or chipping off into slivers and even disintegration. Even when heating moderately fast the brick are apt to swell, causing excessive expansion, and sound brick do not result. Likewise rapid cooling causes fine cracks and slight disintegration. A fundamental fact is that a silica brick does not expand uniformly. Half of the expansion occurs below 600 deg. C. and the brick are burned to 1,500 deg. C. In speaking of expansion, it is well to remember that there are two kinds of expansion. The first or permanent expansion is that which occurs when a brick changes from the green state to a burned state, or technically speaking from quartz to crystobalite tridymite. In a well-burned brick this should be between $\frac{1}{4}$ and $\frac{3}{8}$ in. per linear foot. The other expansion is a temporary one which occurs when any substance is heated (except of course those substances that shrink on burning), and this expansion disappears on cooling. A well-burned brick does not mean one which has been burned to its extreme expansion limit, since it can be overburned as well as underburned. On the contrary, a very slight difference between the utmost expansion and actual expansion should remain, as this will help the brick fit tightly together when used in the open-hearth furnace or coke oven. This slight difference should be known and provided for. A well-burned brick will ordinarily have a clear ring, will measure up to standard if the amount of bats are not excessive, and will have a specific gravity under 2.36. The term specific gravity here refers to the true density of the

brick, irrespective of the porosity. The bulk density takes the brick as a mass and allows for the porosity. The figure varies according to physical structure of the rock used and its geographical location. Eastern rock burns to a lower density than Western rock.

In burning brick made for byproduct coke ovens, the shape and size of the brick are important considerations. The shapes are very often large and thick and sometimes intricate. It is therefore more difficult to burn these thoroughly than ordinary run of kiln. Such being the case, it quite frequently happens that a brick is burned so hard as to be called overburned. An overburned brick is just as apt to cause a high breakage as an underburned one. It is practically burned to its expansion limit in the first burn, or, in other words, a second heating and burning when used by the consumer in his ovens will bring about only a minute residual expansion, sometimes insufficient to knit the brick together. But the worst feature, from the manufacturer's standpoint, is that in overburning, minute fissures appear, which give the brick a cracked sound, causing a rejection. Furthermore, from an operating cost standpoint, it takes lots of coal to bring about an overburned condition. The consumer's specifications in this connection are now so rigid that the manufacturer in trying to give him a well-burned brick is apt to get a run of overburned brick. However, in most cases, he has met this admirably and the quality of coke-oven brick is constantly improving. An underburned brick, in the first place, has not the physical strength and from a consumer's standpoint is highly undesirable, as it will expand excessively when used causing tilting and failure of walls in the coke-oven.

Heavy Firing vs. Light Firing

Heavy or light firing is another point where manufacturers differ. In "heavy" firing, a lot of coal is put into the firebox at one time and at long intervals. During these intervals the coal is gradually burned to incandescence, causing a long flame which is necessary to burn silica brick. This argument is used by the advocates of this system. But the disadvantage is that when the next firing time is due, an addition of a lot of fresh coal causes a sudden decrease in temperature. The effects of this are self-evident. In light firing the coal is added in smaller quantities and at more frequent intervals, thus bringing about a greater uniformity of temperature. The disadvantage is of course that the fire is mostly in the coking stage and combustion takes place nearer the firebox because of a smaller flame and in this way it is more difficult to burn completely the brick that are farthest away from the firebox. The determining factor in the method adopted depends upon the character of the fuel available.

Control of the Burning Operation

In the question of burning control, several aids are used. The temperature is gaged by the pyrometric cones, but unfortunately they show only when the burn is completed—that is, fusing at the final temperature desired. It has been noted before that silica brick expand unevenly and the cones give no indication of what is happening during successive temperature changes. The use of pyrometers has been suggested to overcome this difficulty. They have not been successful in the silica brick industry and to my mind have been unjustly condemned in some cases, due to the fact that they indicate the temperature at only one spot in the kiln and to the inaccuracy in recording the higher temperatures. This is no reflection on the merits of the pyrometer, as numerous papers have been written showing their successful application to many industries. This paper attempts only to record the actual experience of the pyrometer in the silica brick industry. The writer sees no reason why the pyrometer could not be used here in the future, even if only during the critical period, when most of the expansion takes place.

The other aid to proper burning is the draft gage. A uniform draft, like a uniform temperature, is desirable. Some works prefer the draft gage as a means of controlling temperature, but its use is open to discussion. Experienced users state that 0.4-in. is ideal but difficult to attain. Of course, the actual draft varies with the kind of fuel employed and also with the location of the gage.

Only experienced firemen should be employed, the test brick watched, and the appearance of the flame noted through the peep-holes. Old hands become very accurate in telling temperatures by this means. The cooling is the reverse of burning. Less and less coal is used until finally the fireboxes are sealed and then the air is gradually let in. The door is then taken down. Fans are sometimes placed at the fireboxes to assist in cooling. The time of firing usually takes from 5 to 8 days depending upon the kiln and cooling takes the same amount of time.

This practically covers the whole subject of breakage factors. Sometimes careless handling in taking brick from the kiln to the stockshed or cars increases breakage, the percentage from this source usually being very small. This, of course, requires the vigilance of the foreman of this department.

Huntingdon, Pa.

Mineral Production of Spain

A report recently published by the Ministry of Fomento ranks Spain as the second country in the world in the production of copper, the United States being first, according to an article appearing in the Jan. 23, 1922, issue of *Commerce Reports*. Ninety per cent of the Spanish production of this mineral is controlled by British interests, and most of it comes from the Rio Tinto mines, which are developed by foreign capital. In 1919 there were exploited 622 hectares of mineral copper, which produced 864,414 tons, valued at 13,387,261 pesetas at the mine.

Spain is second in the production of lead, according to the same study, and in 1919 produced 136,180 tons of lead ore, valued at 46,129,647 pesetas, and 41,875 tons of silver-bearing lead, valued at 10,259,351 pesetas. French capital controls the Penarroya lead industry.

In production of mercury Spain leads all countries, having produced in 1919 24,966 tons, valued at 6,356,435 pesetas at the mine mouth. This represents an exploitation of 196,554 hectares. All of the quicksilver is exported under contract with the Rothschilds. Production of nickel, chromium and similar minerals is insignificant.

Although most of the Spanish industries converting raw metals into finished products are very small, there are eight enterprises employing over 1,000 men and thirteen others employ over 500 men.

The Determination of Nitrogen in Steel

An Extended Review of the Literature Covering Past Attempts to Determine Nitrogen in Steel Is Followed by a Detailed Description of the Reagents and Apparatus Recommended for the Determination of Nitride Nitrogen

By FREDRIK HURUM and HENRY FAY

ALTHOUGH the presence of nitrogen in iron and steel has been an established fact for almost a century, it is surprising to find what a small amount of definite and reliable information is available on this subject. The reason why so little is known about nitrogen in steel is undoubtedly due to the difficulty of analyzing for this element.

The value and outcome of any investigation on the effect of nitrogen on steel depend on a reliable and practicable method of analyzing for nitrogen, and the writers endeavored to work out such a method and try out its merits.

The method as worked out and which proved to be very successful is described herein, together with a discussion of the bibliography bearing upon the subject.

Historical Notes on Analysis of Nitrogen in Steel

The first mention of any compound between iron and nitrogen was made by Berthollet[1] and Thenard, who permitted ammonia gas to act on iron wire at red heat and found that the weight of the iron scarcely increased but that the metal became brittle. The discovery of nitrogen in commercial iron and steel appears to be due to Schafhäutl,[2] who during his stay in England in 1839 pointed out that both white cast iron and the English cast steel contained nitrogen besides carbon, and he claimed to have determined this amount quantitatively. To determine the nitrogen in large steel samples, he used the Dumas method, burning the iron in vacuum with copper oxide and measuring the liberated volume of nitrogen. For small samples he heated the sample with caustic alkali and caustic baryta. Ammonia was formed, and this was absorbed by hydrochloric acid and determined as ammonium platinum chloride. Schafhäutl found results running between 0.2 and 1.2 per cent nitrogen.

In 1850 Marchand[3] published the results of his experiments on heating steel with metallic potassium, endeavoring to obtain all the nitrogen in the steel together with some of the carbon as potassium cyanide. Marchand points out that it is very likely that ammonia and cyanogen are carrying nitrogen into the steel, both in the blast furnace and during case-hardening operations. In the blast furnace he attributes the result to ammonia in the fuel, and the formation of cyanides from alkali metals in the flux. When discussing the cementation process he says it is a well-known fact that animal charcoal is particularly effective in transferring iron into steel. He believes that iron and steel are likely to contain nitrogen as a nitrogen-carbon compound, and mentions cyanogen and paracyanogen as likely.

Marchand recommends analyzing for nitrogen in steel by the same method which Lassaigne has proposed to use for every carbonaceous substance which contains nitrogen—viz., heating with potassium or sodium and determining the potassium cyanide. He heated the powdered iron samples strongly with metallic potassium in a glass test-tube and excluded the nitrogen of the atmosphere by conducting a current of hydrogen into the test-tube through a two-hole stopper. He never succeeded in finding nitrogen in steel whenever precautions were taken to exclude the atmospheric nitrogen. Marchand was, however, able to detect nitrogen when using Schafhäutl's method. In cast iron he found 0.03 per cent nitrogen, which was one-twentieth of the amount found by Schafhäutl. The results, however, he admits are very doubtful and concludes that the nitrogen does not exceed the amount of 0.02 per cent.

Buchner[4] claimed that he was able to detect sulphocyanides in iron from Tyrol. This iron left when dissolved in hydrochloric acid a carbonaceous residue. He mixed 240 g. of this residue with potassium carbonate, this latter substance being entirely free from sulphates, cyanides and chlorides. The mixture was heated strongly in a small retort over a coal fire for 1½ hours.

The alkali in the fused mass was separated from the iron by extraction with water, and this colorless solution gave a blood red color with ferric chloride. This also happened with acid iron sulphate, but in neither case in alkaline solution. Buchner has excluded atmospheric nitrogen by submerging the neck of the retort in hydrochloric acid. He does not mention, however, the probability of exposing the retort to sulphurous and nitrous gases from the coal fire.

Buchner pointed out that a small amount of ammonia was absorbed by the hydrochloric acid, but the reaction with platinum chloride was not strong enough to warrant any quantitative determination.

In 1861 Fremy[5] tried to determine the nitrogen by heating samples in a current of hydrogen and measuring the decrease in weight, assuming that all the nitrogen would be given off as ammonia. He claimed to have found considerable amounts of nitrogen in all his iron samples. Bouis[6] refined the method of Fremy and found very much lower results, not over 0.18 per cent.

No positive results seem, however, to have been obtained until Boussignault[7] in 1861 developed a method which today is used as the basis for nitrogen analysis. He dissolved the steel sample in dilute hydrochloric

[1] Traite de Chemie, 1834, p. 434.
[2] *The London and Edinburgh Philosophical Magazine*, 1839-1840. *J. prak. Chem.*, 1840, vol. 19, p. 409.
[3] *J. prak. Chem.*, vol. 49, p. 451.
[4] *Liebig's Annalen*, vol. 73 (1850).
[5] *Compt. rend.*, 1861, vol. 52, p. 332.
[6] *Compt. rend.*, 1861, vol. 52, p. 1195.
[7] *Compt. rend.*, vol. 53, p. 77.

acid and obtained the nitrogen as ammonium chloride. He then distilled this solution over lime, and titrated the ammonia in the distillate with sulphuric acid. Boussignault found only very small amounts of nitrogen in steel.

F. C. Calvert[8] made experiments on the solution of cast iron in acids. He found that dies of cast iron about 1 cm. square would dissolve slowly in acids without appreciably changing volume, but left a well-defined structure of carbonaceous matter high in iron and richer in nitrogen than the original. His experiments extended over long periods of time. He found that acetic acid would attack cast iron slowly but steadily for years without necessitating a renewal of acid. Other acids, however, dissolved the iron more rapidly, but would have to be renewed from time to time.

Boussignault's method was reviewed and criticised by Ullgren,[9] who demonstrated that by dissolving 10 g. pig iron in concentrated hydrochloric acid, part of the evolved ammonia would pass over with the hydrocarbon gases, even when not applying heat, and this amount of ammonia could be determined by conducting the evolved gases through hydrochloric acid solution free from ammonia. By distilling this acid solution with excess of caustic lime, he could, when titrating the distillate with oxalic acid, find up to 0.2 mg. ammonia that otherwise would not have been accounted for when using, for instance, Boussignault's original method. He was further able to show that the amount of ammonia carried off with the evolved gases when dissolving steel samples in hydrochloric acid solution increased when a stronger concentration of hydrochloric acid was used. He then suggested using neutral cupric chloride solution for dissolving the steel sample and found in a sample of 2 g. gray pig iron 0.103 per cent nitrogen. Ullgren found that the steels would contain from 0.1 to 0.7 per cent nitrogen.

Rammelsberg,[10] who used a similar method, found only 0.002 per cent nitrogen. In 1865 Rinman[11] published in Stockholm the results of his work. He found only very small amounts of nitrogen in steel (0.005 to 0.016 per cent). After the proposal of Ullgren he also attempted to prevent the evolved hydrocarbon gases from carrying off any ammonia when dissolving the sample. He distilled the solution as usual and titrated the ammonia in the distillate with oxalic acid.

No Reaction Between Iron and Nitrogen

Stahlschmidt[12] in his paper "Beiträge zur Kenntnis des Stickstoffeisens" reported the formation of iron nitride containing 10.8 to 11.4 per cent nitrogen, when using Fremy's method of heating ferrous chloride with ammonia below red heat. This compound would correspond to the formula Fe_2N. He attributed the difference in the value of 0.6 per cent nitrogen to incomplete reaction or formation of ammonium iron chlorides not easily vaporized. Stahlschmidt was not able to find any reaction at all between free nitrogen and pure iron, even when using freshly reduced spongy iron. He was able to show that free nitrogen would not combine with iron even in the nascent state. In this latter experiment he heated iron oxide in a mixture of nitrogen and hydrogen. The water formed from this reaction was free from ammonia and the iron free from nitrogen.

Stahlschmidt further reported that iron nitride, when brought to a red heat in contact with steam, decomposed with formation of iron oxide and ammonia. He also showed that hydrochloric, sulphuric and nitric acids would dissolve nitride rapidly with formation of ammonia salts. He reported that iron nitride was not attacked at normal temperature by the halogens, but was attacked at an elevated temperature. The specific gravity of iron nitride he found to be 6.03.

At about the same time Stuart and Baker[13] attempted the analysis of nitrogen in steel, but in most cases could not detect any. They used Fremy's method and took every precaution of purifying and drying the hydrogen gas.

Allen's Researches

Allen[14] in 1880 tried to determine the nitrogen in steel by means of steam which he passed over the red-hot sample, making use of Stahlschmidt's previous observation. The iron nitride was decomposed, giving ammonia and iron oxide, and the ammonia was collected in the condensed vapor and determined. Allen did not get any reliable results with this method. Afterward he had better success with Boussignault's method, using Nessler's reagent to determine the ammonia in the distillate. He distilled the solution over lime. Allen's colorimetric method was adopted and used later to a great extent for the determination of nitrogen in steel.

Harbord and Twynam[15] used Allen's method without any modifications in their researches, and found that steels examined by them would contain from 0.000 to 0.024 per cent nitrogen. Langley[16] in his results used Allen's colorimetric method, with the modification that he substituted sodium hydroxide for calcium hydroxide, and he also attempted to purify this alkaline solution by destroying any nitrites and nitrates by means of a copper-zinc couple.

Tholander[17] dissolved the steel sample in dilute sulphuric acid and distilled over sodium hydroxide solution. He used the iodide-iodate method to determine the ammonia in the distillate. This method seemed to work out very nicely. Braune[18] published in 1906 the results of his extensive work on nitrogen in steel, a work which covered several years and aimed to render a complete account of the subject. Braune used the colorimetric method based on Nessler's reagent, and analyzed a great variety of steel samples.

Braune suggested using 1 g. sample for 0.03 to 0.005 per cent nitrogen in the steel sample and smaller samples for higher contents. For dissolving 1 g. of steel he used 20 c.c. hydrochloric acid of sp.gr. 1.124. He filtered this ferrous solution and distilled it over 20 c.c. potassium hydroxide (equivalent to 20 c.c. hydrochloric acid sp.gr. 1.124). Braune then determined the amount of ammonia in the distillate with Nessler's reagent. He recommends taking 2 c.c. standard Nessler's reagent and diluting to 10 c.c. He then adds the whole at once to the distillate and stirs. The

[8] *Compt. rend.*, vol. 52, p. 1315.
[9] *Liebig's Annalen*, 1862, vol. 124, p. 70.
[10] Monatsberichte d. kgl. preuss. Akad. d. Wissenschaften zu Berlin, 1862.
[11] Vetenskaps-akademiets forhandlinger, Stockholm, 1865, p. 143.
[12] *Pogg. Ann.* (1865), vol. 125, p. 32.
[13] *Chem. News*, vol. 10, p. 245.
[14] Iron and Steel Inst., 1880, No. 1, p. 181.
[15] Iron and Steel Inst., 1896, p. 2.
[16] Private report from Prof. J. W. Langley, Pittsburgh, to A. Blair, cit. Blair: "Chem. Analysis of Iron and Steel," seventh edition.
[17] *Jernkontorets Annaler*, 1888.
[18] *Jernkontorets Annaler*, 1906, p. 671.

solution is then diluted to 150 c.c. In a special sample tube the color of this solution is matched to the color of a standard solution. This standard solution is prepared by dissolving 0.038147 g. ammonium chloride in 1 liter (i.e., 1 c.c. to 0.01 mg. N_2). He now takes 3 c.c. of this standard solution, treats it with Nessler's reagent and dilutes it to the same color intensity as the distillate. From the volumes used the nitrogen content is then computed.

Braune made tests and confirmed Stahlschmidt's assertion that all the nitrogen in a soft steel (0.06 per cent C) would be present as ammonium salt after dissolving the sample in hydrochloric or sulphuric acid. Braune also extended his researches to determine whether or not nitrogen might be present in the insoluble matter (graphite and temper carbon) left when dissolving a steel sample in acid.

He was not able to find any nitrogen in this residue and came to the conclusion that contradictory results by previous experimenters were likely to be due either to inexactness of method or to the ease with which this residue would absorb nitrogen from the atmosphere. Braune, however, admits the possibility of secondary reactions resulting in precipitation of a black matter from the acid with the carbon in the steel, evidently an organic compound of ammonia. Braune points out that in the color carbon test it is not the nitrogen from the steel but the nitrogen from the nitric acid that takes part in the reaction and results in the organic compound rendering the brownish color.

Method of Grabe and Petren

Grabe and Petren[19] made a thorough investigation on the methods of analysis of nitrogen in iron and steel. They used the method involving the use of potassium iodide and potassium iodate in the presence of dilute acid and made comparisons of this method with the colorimetric method as used by Braune. Grabe and Petren followed the ordinary procedure of dissolving the steel sample in acid and distilling this solution with an excess of alkaline solution. They collected the distillate containing the ammonia in 5 c.c. N/20 sulphuric acid so as to insure complete absorption of the ammonia as ammonium sulphate. They then titrated the iodine set free by the excess acid with sodium thiosulphate after having added potassium iodide and potassium iodate. They came to the conclusion that the colorimetric method was by no means exact enough and found that results obtained by Braune would disagree widely with results obtained with the iodide-iodate method. They showed that traces of nitrites in the alkalis used for distilling would to a great extent effect the results, and in some cases the nitrogen from this source would exceed the amount of nitrogen in the steel sample. However, they believed that hydrocarbon compounds (18 to 20 per cent of which may remain in the ferrous solution) would interfere with the iodine titration. They held the belief that unsaturated hydrocarbon compounds of the olefin series might combine with the iodine.

Tschischewski[20] asserts that the iodate method will give higher results than the colorimetric method of Nessler. He attributes this to the formation of amines, which are formed when dissolving the steel and which have a much lower coloring effect than ammonium chloride toward Nessler's reagent. Tschischewski suggested using a 6-g. steel sample and dissolving in 35 c.c. hydrochloric acid of sp.gr. 1.19 and adding 50 c.c. pure water. He distilled his ferrous solution with 40 c.c. potassium hydroxide (1:1) to 50 c.c. water. The distillate was collected in 20 c.c. N/100 sulphuric acid.

W. Herwig[21] determined nitrogen in iron and steel and used for his analysis a 5-g. sample which he dissolved in 50 c.c. hydrochloric acid of sp.gr. 1.124 and to which he added 40 c.c. water. On distilling this solution he prescribed addition of potassium hydroxide until the solution became only slightly alkaline. The distillate was collected in 20 c.c. N/100 sulphuric acid.

Iodide-Iodate Method Recommended

The various methods suggested in the literature were subjected to critical examination and comparative tests, with the result that the iodide-iodate method seemed most worthy of further study. This method was subjected to detailed study and with certain minor modifications and attention to details it is herewith recommended as being the most satisfactory method for the accurate analysis for nitrogen in steels. The

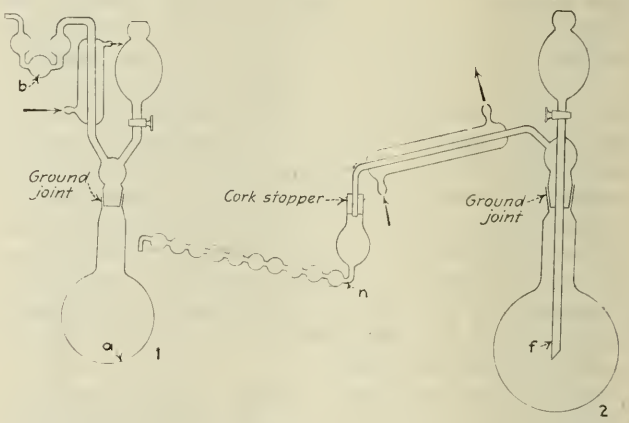


FIG. 1—DISSOLVING FLASK. FIG. 2—DISTILLING FLASK

method has not been tried on high-chromium or high-tungsten steels, but it gives satisfactory results on high-speed steels and all ordinary steels.

Method of Analysis

Apparatus

Dissolving flask should be such as shown in Fig. 1, having a dropping funnel, condenser and bubble tube connected with the flask by a ground glass joint. A convenient size is 200 to 250 c.c.

Distilling flask should be an apparatus such as shown in Fig. 2, consisting of flask, dropping funnel and condenser connected by a ground glass joint. The receiver is a convenient form to use, although a simpler form may be substituted.

Reagents

Pure, ammonia-free water is prepared by distilling distilled water with a solution of alkaline potassium permanganate made by dissolving 200 g. potassium hydroxide and 8 g. potassium permanganate in 1,100 c.c. distilled water, and then concentrating by boiling to 1,000 c.c. This solution is added to the water to be purified in the ratio of 1:10. Distillation is then carried on until a test of the distillate made with Nessler's reagent shows freedom from ammonia. Further dis-

[19] *Jernkontorets Annaler*, 1907.
[20] *Stahl u. Eisen*, 1908, p. 394.
[21] *Stahl u. Eisen*, 1913, p. 1721.

tillation produces water, which may be collected for use in the analysis. It is advisable to use a condenser tube of tin.

Four hundred grams sodium hydroxide is dissolved in 1 liter of water for this reagent. It is likely to contain nitrites, which might be reduced to ammonia by the ferrous hydroxide when distillation is made during the analysis. Zinc finely covered with deposited copper is used for destroying the nitrites and to some extent the nitrates. The zinc is kept submerged 10 minutes in dilute copper sulphate and washed with distilled water and a small amount of it is permitted to stand for 24 hours at 50 deg. C. in contact with the sodium hydroxide solution.[22] Nitrites are then reduced and the sodium hydroxide solution decanted off. The solution is then boiled in a distilling flask until the ammonia has been expelled. The solution is then brought to the same molal concentration as the hydrochloric acid solution of sp.gr. 1.12. Small amounts of nitrates present do not interfere with the analysis, as they are not easily decomposed by ferrous iron so long as the concentration is low (Braune).

Pure hydrochloric acid will always contain some traces of ammonia and should be purified before being used for dissolving the metal. Hydrochloric acid of 1.124 sp.gr. can be recommended for dissolving the steel sample. Prepare pure hydrochloric acid solution of sp.gr. 1.12 by distilling concentrated hydrochloric solution with addition of a little concentrated sulphuric acid and absorbing the hydrochloric acid gas in pure water, prepared by distilling over potassium permanganate solution.

Potassium iodide and potassium iodate may be obtained free from impurities which affect the analysis. A single recrystallization suffices to remove traces of free alkali. A solution of each salt is prepared by dissolving 5 g. of the respective salt in 100 c.c. of water.

Sodium thiosulphate solution, N/100, is made by dissolving 2.5 g. of crystallized sodium thiosulphate in pure water; dilute to 1 liter.

Sulphuric acid, N/100: Dilute 0.3 c.c. concentrated sulphuric acid with water to 1 liter. Standardize against pure sodium carbonate or by means of barium chloride.

Solution of the Steel

Approximately 5 g. of steel is placed on the bottom of the dissolving flask *a* (Fig. 1). About 7 to 9 c.c. hydrochloric acid (1.12 sp.gr.) is placed in the bulb neck *b*, so as to seal this gas passage. Through the dropping funnel is introduced 40 c.c. hydrochloric acid (1.12 sp.gr.) and the flask *a* is slightly heated. The steel sample will rapidly dissolve, the evolved gases passing through the water-cooled condenser and out through *b*.

Vapors are condensed in the water-cooled tube and returned to flask *a*. Neck *b* washes the evolved gases so that any ammonia which otherwise might be carried off with the escaping hydrogen and hydrocarbon gases will be retained in the hydrochloric acid. The water-cooled condenser should not be omitted, as it is an essential feature of the apparatus.

When the steel has been completely dissolved all the nitride nitrogen remains as ammonium chloride in the flask *a* with the exception of traces of ammonium chloride to be found in the bulbs *b*. The contents of the latter are washed into *a* and the contents of *a* are then washed into the dropping funnel of the distilling flask, Fig. 2.

Distillation of the Solution Containing Ammonium Chloride

In the distilling flask as shown in the sketch is placed at least 50 c.c. of the sodium hydroxide solution, 300 c.c. of water, 10 c.c. of a potassium permanganate solution (8 g. $KMnO_4$ and 200 g. NaOH dissolved in 1,000 c.c. water). On the bottom of the flask is placed small coils of nichrome wire to insure quiet boiling. The liquid is then boiled until part of it is distilled over.

The receiver *n*, containing 10 c.c. N/100 H_2SO_4 or a larger exactly measured amount, is then attached to the condenser and care is taken that the position of the receptacle is kept in such a way that the bend *n* is sealed with the acid. The acid ferrous solution, which up to that moment has been kept in the drop funnel, is then gradually run down into the distilling flask.

The boiling immediately accelerates, as the liquid in the distilling flask will give off ammonia and hydrocarbon gases, and the ammonia together with water vapor begins to collect in the water-cooled condenser and drops will soon run down into the receiver. After a few minutes of boiling all the ammonia has passed over into the receptacle *n* and has combined with the sulphuric acid.

Violent boiling and detrimental shocks are apt to occur when distillation has proceeded for a certain time. For this reason it is advisable to retain a small part of the ferrous solution in the dropping funnel instead of adding all the ferrous solution to the distilling flask at the beginning. When the few remaining drops of acid ferrous solution are finally added to the distilling flask at the end of distillation, additional volumes of hydrocarbon gases revive the boiling of the alkaline liquid and prevent accidents.

When properly handled the process of distillation lasts only a few minutes and sufficient alkaline solution can be kept in the distilling flask to make it possible to run a series of four or five analyses without interrupting the boiling.

Collecting the Distillate in Sulphuric Acid

Before beginning the distillation it is necessary to attach the receiver *n* to the end of the condenser tube as shown in Fig. 2. The connection is made airtight by a cork stopper.

In the bend *n* is the sulphuric acid, which has been carefully measured out from a burette. The sulphuric acid completely seals this bend. Under these circumstances no ammonia can escape, but all of it will be retained as ammonium sulphate in the receiver whether it escapes from the distilling flask as gas or is collected in water drops in the inclined condensing tube. Distillation is continued until about 50 c.c. has been collected in the receiver. The progress of distillation can be readily controlled as one bulb after the other is filled with the distillate and the gases pass through as bubbles. The distillate will always smell strongly of hydrocarbons.

When distillation is finished, the receiver is detached and the distillate, containing all the ammonia as ammonium sulphate, is poured into a small beaker and is titrated. The distillate should always contain an excess

[22] Cit. Braune (Swedish Dept. Testing Materials.)

of free sulphuric acid and this amount of free sulphuric acid must be determined.

The liquid in the receiver, originally consisting of 10 c.c. N/100 sulphuric acid or any other exactly determined volume, is now partly a mixture of ammonium sulphate and free sulphuric acid. After this solution has been transferred to a beaker, 4 c.c. potassium iodide solution and 2 c.c. of potassium iodate solution are added and the liberated iodine is immediately titrated with N/100 sodium thiosulphate.

Immediately after this titration it is necessary to make a second one. For this purpose 10 c.c. N/100 sulphuric acid or exactly the same amount as originally used in the receiver is measured from a burette and the same volume of iodide and iodate solution is added. The idodine set free is again titrated with sodium thiosulphate and the amount of sodium thiosulphate recorded. The difference in the two values represents the amount of sulphuric acid equivalent to the ammonia absorbed.

Notes on the Procedure

Nitrogen exists in steel as iron nitride, Fe_2N, which is readily decomposed by hydrochloric acid with formation of ammonium chloride. Ammonia is set free from ammonium chloride when heated with sodium hydroxide, and may be collected in sulphuric acid, which must be present in excess. Free sulphuric acid, in small amounts, may be determined with great accuracy by making use of the following reaction:

$$5KI + KIO_3 + 3H_2SO_4 = 3K_2SO_4 + 3H_2O + 3I_2$$

The amount of iodine liberated is a direct measure of the sulphuric acid, and consequently of the nitrogen, and may be determined by means of N/100 sodium thiosulphate. When the N/100 H_2SO_4 is measured for the receiver a similar amount should be measured and treated with iodide and iodate so as to get the value of the N/100 $Na_2S_2O_3$. The difference between the amount of iodine liberated in this blank determination and the amount set free in the actual analysis represents the amount of H_2SO_4 not neutralized by the ammonia, and hence gives a value for the amount neutralized. Inasmuch as $3I_2$ is equivalent to $3H_2SO_4$, from the above equation it follows that $3I_2$ is equivalent to 6N, or I_2 is equivalent to N_2. Knowing these values, the nitrogen content of the steel may be calculated.

Sulphuric acid is used as the standard basis for all calculations, as its value remains permanent. Sodium thiosulphate, on the other hand, changes from hour to hour and should always be checked for each series of analyses. It should be checked against the sulphuric acid using the iodide-iodate reactions, and occasionally against iodine, making use of a carefully standardized potassium permanganate and the reaction:

$$2KMnO_4 + 10KI + 8H_2SO_4 = 6K_2SO_4 + 2MnSO_4 + 8H_2O + 5I_2$$

Glass-stoppered apparatus is essential if accuracy is desired. Care should be taken to prevent caustic soda coming in contact with the ground joints, and the joints should always be wet with pure water before closing.

The dropping funnel extends below the liquid in the distilling flask, otherwise there is danger of ferrous chloride spattering on to the hot walls of the flask and liberating hydrochloric acid.

It would be advantageous to have the condenser tube made of tin or quartz, otherwise a blank of about 0.0003 g. nitrogen should be made for each 50 c.c. of distillate.

The presence of hydrocarbons has apparently no effect upon the iodine titration. This was established by adding ammonium chloride in known amount to a hydrochloric acid solution of an annealed high-carbon steel and putting it through the regular operations. In every case the total nitrogen was recovered, even though the distillate smelled strongly of hydrocarbons. In this respect this method has decided advantage over the Nessler method.

The following different steel samples were analyzed and the results are given as characteristic with regard to nitrogen in ordinary steel samples. The analysis shows that the amount of this element present is very small in the cases examined, particularly in the three high-speed steels. Several analyses are given below:

Steel	N as Nitride Per Cent
Swedish crucible steel	0.0006
High-speed steel No. 1	0.0011
American ingot iron	0.003
High-speed steel No. 2	0.0005
High-speed steel No. 3	0.0005
Tool steel No. 1	0.011
Crucible steel	0.011

From this table it seems that with the exception of the tool steel No. 1 the amount of nitrogen is apparently negligible. In this exceptional case, however, it may rank in influence probably with other impurities such as sulphur and phosphorus, and should not be omitted from a complete analysis statement.

In steels which have been case-hardened by almost any of the commercial methods, the nitrogen content may rise to as much as 0.50 to 0.75 per cent.[23]

The Tanning Industry in Russia

Commerce Reports for Jan. 23, 1922, reproduces a statement appearing in the bolshevik press to the effect that 1,775 tanneries, large and small, were in operation at the end of June, 1921, in the whole of Soviet Russia. During the first 6 months of 1921, the statement indicates, 3,451,000 hides were tanned, as compared with a total of 2,700,000 for the same period in 1920, an increase of about 28 per cent. The actual production during the first half of 1921 represents 88 per cent of the prearranged program of production of the tanneries, according to the bolshevist statement.

Since the decree was issued some time ago permitting private persons to engage once more in the operation of industrial establishments a considerable number of the tanneries, all of which had been "nationalized," have been leased for private operation.

The government has retained a number of the larger tanneries, however, and will continue to operate them as government properties.

Vapor Luster on Pottery

An investigation of lusters for pottery decoration has recently been made by the Bureau of Mines to determine the most suitable glaze compositions for taking vapor lusters. Luster decorations are applied to pottery by two methods: First, by applying in paste condition suitable metallic salts to the surface of the ware and firing at a dull heat; second, by vaporizing such salts in the flame of iridescent effects similar to that of favrile glass. Results indicated that glazes containing B_2O_3 and PbO produced the best luster effects, the intensity of the luster increasing with larger amounts of these two components in the glaze.

[23] Fay, Chem. & Met. Eng., vol. 24, No. 7, p. 289.

Industrial Uses of Phosphoric Acid and Phosphates

Phosphoric Acid Is Employed in Clarifying Sugar, Preparing Soft Drinks and Pharmaceuticals—Use of Calcium Acid Phosphate in the Production of Baking Powder and Self-Rising Flour—Formulas for Preparing Food Phosphates—Consumption of Sodium Phosphates

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THE phosphate industry, as distinguished from the fertilizer industry, may be divided into three groups—viz., (1) the use of phosphoric acid as such, (2) the use of phosphate of calcium, and (3) the use of phosphate of sodium.

The only phosphoric acid of commercial importance is the ortho acid, the chemical formula being H_3PO_4. This is sold in various densities and purities, depending upon the uses to which it is applied. The more important uses are covered in the following paragraphs.

Clarification of Sugar Solutions

Undoubtedly the greatest consumption of phosphoric acid as such is in the clarification of sugar juices in the sugar refineries, large quantities being manufactured for consumption in the cane refineries of this country, Cuba and South America. Various densities may be used and it must be free from arsenic and other deleterious substances. Iron and aluminum salts need not be removed to any great extent, and certain amounts of monocalcium phosphate are generally present.

Often a solution of commercial phosphoric acid, containing a certain amount of dissolved monocalcium phosphate, is concentrated to form a phosphoric acid paste, containing between 47 and 50 per cent of available P_2O_5. This is shipped in casks, and the present prevailing price is about 10c. per lb. of available P_2O_5. Some manufacturers produce a semi-dry mixture of commercial phosphoric acid, which has been properly purified to remove all deleterious substances, and a silicate base, such as fullers earth, Filter-cel, or kieselguhr. This semi-dry compound contains between 38 and 40 per cent of available P_2O_5, and has the advantage that it may be shipped in the regulation flour barrels or in wooden boxes without the difficulty of leakage. It is, therefore, especially desirable for the export trade.

The advantages of phosphoric acid claimed over other clarifying agents are better color of the finished sugar, more rapid crystallization and greater yields. Phosphoric acid in this industry is called a defecating, flocculating and clarifying agent, and the process is called defecation of sugar juices. The raw sugar solution is treated first with lime, the lime combining chemically, is in turn neutralized by the phosphoric acid, an insoluble lime phosphate being formed. The flocculent precipitate is left standing to settle out, or is removed by filtration. The resultant clear solution is evaporated to the required density, cooled, and a snow-white sugar crystallizes.

Jellies—Preserves—Soft Drinks

Considerable phosphoric acid is used in the jelly and preserving industry. Again various densities and purities are used. Acid is sometimes added to the jelly and preserve stock during the boiling period; sometimes only a portion is added at that time, and an additional portion added at the time the jelly is poured into the glasses. This process is chemically controlled, and very exact factory control must be exercised in order to produce a uniform product. The taste and mechanical properties of a jelly are influenced by the addition of too small or too large an amount of the acid.

During the scarcity of tartaric acid and citric acid, considerable phosphoric acid was used in the preparation of soda fountain beverages and bottled soft drinks, but the requirements as to purity for this purpose are very rigid and it is claimed by some of the phosphate manufacturers that the consumption of this acid by the beverage trade is declining. One pound of high-grade phosphoric acid, containing approximately 40 per cent of P_2O_5 or 55 per cent of H_3PO_4, is equivalent in acidity to 0.75 lb. of commercial tartaric acid, or 0.7 lb. of commercial citric acid. Some contend that the phosphoric acid, on account of its pharmacological properties, should not be used in place of the above organic acids, while others claim that on account of the small amount of acid thus consumed by each individual it is not harmful and that on account of its much lower cost it has a distinct advantage commercially.

Medical and Pharmaceutical Compounds

For the preparation of medical and pharmaceutical compounds, sirupy phosphoric acid (85 to 88 per cent H_3PO_4) is mainly in demand. This acid is fairly pure and is made entirely from phosphorus by the so-called electric furnace or distillation process. For some purposes, however, such as the manufacture of hydrogen peroxide, acids of lesser purity are suitable, some being iron free and others having certain impurities removed to suit particular requirements. In the manufacture of metal glycerophosphates, an acid of approximately 42 deg. Bé. (50 per cent H_3PO_4), sulphate free and of low mineral content is required.

A small amount of phosphoric acid, generally about 50 per cent in strength and of different purity, is used for pickling and for the manufacture of rustproofing compounds in the metal industry. An insoluble iron phosphate, it is claimed, is formed, which is not acted upon either by the oxygen of the air or affected by moisture.

Monocalcium Phosphate

By far the largest amount of phosphoric acid is used by the phosphate manufacturer in the production of phosphates of calcium and of sodium. Small amounts of phosphates other than calcium and sodium, such as phosphates of potassium, aluminum, ammonium and magnesium, are produced, but their use is limited.

Monocalcium phosphate, or calcium acid phosphate, $CaH_4(PO_4)_2$, finds its largest uses in the manufacture

of baking powder and self-rising flours. This industry is about 50 years old in America and today there are eleven different phosphate plants in the United States.

Phosphate Rock Present Raw Material

Up to 15 years ago practically all the phosphates of calcium and sodium were made from bone, but as the consumption increased, it became apparent that, if the industry was to have a permanent growth, a product of highest purity was necessary. As a result of research work, processes were developed and perfected for the utilization of the ordinary mineral phosphate, tricalcium phosphate, $Ca_3(PO_4)_2$, with an admixture of calcium fluoride, iron and aluminum phosphate, so extensively mined in Tennessee and Florida. Today probably 95 per cent of all the calcium phosphate going into food products is of mineral origin and is of vastly higher purity than that formerly produced. Owing to the very large capacity in this country, competition is keen and prices have practically receded to pre-war levels.

Baking Powder Indusiry

The monocalcium phosphate is considered the most economical and superior acid ingredient for baking powder manufacturing purposes. It is true that the price of sodium aluminum sulphate is lower, but a large percentage of this acid ingredient causes a better aftertaste in the baked goods.

When the acid phosphate is mixed with bicarbonate of soda and corn starch in proper proportions, and after the complete reaction in baking, no disagreeable and objectionable taste or residue is left in the baked goods. The acid phosphate of calcium is universally used. Monosodium phosphate is also employed in limited quantities, but is considered to be inferior to the calcium acid phosphate for this purpose. The acid phosphate of calcium is often used in combination with sodium aluminum sulphate, cream of tartar and tartaric acid in leavening compounds, also in the compounding of cream of tartar substitutes (C. T. S.).

The granulation or size of granules of the calcium phosphate plays an important part in the action and keeping quality of a baking powder. The finer the phosphate is ground the more readily it will dissolve. When used in combination with sodium aluminum sulphate, the phosphate, being the more soluble, acts first on the bicarbonate of soda and as the baking proceeds the sodium aluminum sulphate dissolves and acts with the remaining bicarbonate of soda. The granulation of the phosphate not only influences the rate of reaction, but also determines the keeping quality of the baking powder. The phosphate manufacturers produce both a powdered and a granular grade, each grade serving its particular use and purpose. In the so-called "straight phosphate powder" a granular phosphate and soda should be used. Not only will a powdered phosphate cause premature reaction, but will also react too fast during the baking process. A baking powder produced from both powdered phosphate and powdered soda will show considerable deterioration at the end of a few weeks, while a powder produced by the use of both granular phosphate and granular soda will show very little deterioration even at the end of 6 months.

The average composition of a phosphate baking powder for household use should be as follows:

25 to 28 per cent bicarbonate of soda (granular).
33 to 37 per cent calcium acid phosphate (granular).
42 to 35 per cent re-dried corn starch (5 to 8 per cent moisture).

For bakery and hotel uses the formula should be:

30 to 35 per cent of bicarbonate of soda (granular).
40 to 46 per cent of calcium acid phosphate (granular).
30 to 19 per cent of re-dried corn starch (5 to 8 per cent moisture).

In the formula it is seen that 0.75 lb. of bicarbonate of soda is neutralized by 1 lb. of calcium acid phosphate. In other words, calcium acid phosphate is used as a neutralizing agent at a neutralizing strength of 75 per cent in terms of bicarbonate of soda. The neutralizing strength is sometimes used at 80 per cent instead of 75 per cent. Some manufacturers reduce the high strength phosphate by the addition of a high-grade corn starch, either during the wet process of manufacture or during the final standardization by mixing in a dry state. In this manner the phosphate is made to any strength desired and the method has its advantages and disadvantages.

Self-Rising Flour

Thousands of tons of self-rising flour, examples of which are the prepared soft wheat flour (for hot biscuits), pancake flour and cake flour, are manufactured and consumed every year in this country. A standard formula cannot be given for preparing all the above flours. As a basis the following formula may act as a guide in the compounding of a self-rising flour. To every 92 lb. of flour and 2½ lb. of bicarbonate of soda, 3⅓ lb. of 75 per cent strength calcium acid phosphate and 2½ lb. of edible salt; or to every 92 lb. of flour add 2½ lb. of bicarbonate of soda, 3⅓ lb. of 80 per cent calcium acid phosphate and 2½ lb. of edible salt.

Usually the powdered soda and powdered phosphate are used, since the flour acts as the separatory agent and prevents a premature reaction and decomposition. The moisture in the flour, however, must not be too high, as it influences very materially the keeping quality of the prepared product. At no time should a self-rising flour be prepared in large quantities without first testing out the formula in a trial baking test, and the moisture and quality of all the ingredients should be carefully determined. The color and odor of the phosphate are very important, as no manufacturer of self-rising flour will permit addition of dark color or noticeable foreign odor to his product.

Sodium Phosphates

The uses of sodium phosphates in the industries is very extensive and, according to the U. S. Geological Survey, over 30,000 tons valued at about three and one-quarter million dollars were manufactured in 1920.

Monosodium phosphate has a limited use. As ordinarily manufactured, it is very hygroscopic and not suitable for either baking powder or self-rising flour. However, by a patented process it is now manufactured in a non-hygroscopic state and is used to some extent. It is considered inferior to calcium acid phosphate for these purposes.

Disodium phosphate is also a commodity used in a large way in the dyeing and textile industries, for water softening, medicinal and dental purposes and in the arts generally.

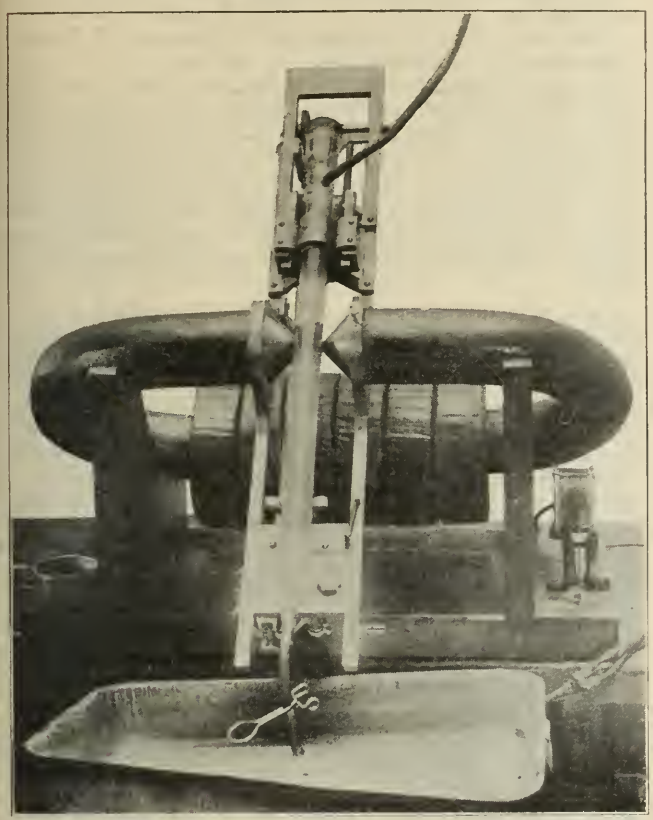
Trisodium phosphate is the most important of the sodium group. This finds extensive use in the preparation of boiler compounds in the laundry, paper industries, etc.

Acid sodium pyrophosphate is a product which finds some use in bake shops and restaurants as a substitute for cream of tartar.

Davis Tube Analyzer for Magnetic Assays

The Davis Tube Analyzer is a simple device for quickly reducing a sample of ore so that the magnetic iron percentage can be accurately computed. It was developed by E. W. Davis, head of the Experimental Mines Station of the University of Minnesota. The device is now being manufactured by the Dings Magnetic Separator Co., of Milwaukee.

Briefly, its operation is as follows: A sample of ore is placed in the glass tube, shown in the illustration,



DAVIS TUBE ANALYZER FOR MAGNETIC ASSAYS

which has previously been filled with water. The carriage bearings are placed at the poles of the magnet. A stream of water passes through the tube, washing away the tailing from the concentrate, which is held at the poles. When the washing is completed, the concentrate and tailings are dried, weighed and analyzed. A complete computation for magnetic iron may be made when the soluble iron assays of the feed, concentrate and tailing and the weight of the concentrate are known.

Summary of New Oil Companies

During December, 1921, fifty-eight new companies with individual capitalization of $50,000 or more were organized to engage in different branches of the oil industry. The aggregate indicated capital is $65,615,000. This compares with the November record of seventy-one such new companies with a total indicated capital of $60,129,000. The corresponding figures for December, 1920, show ninety-five new oil companies with aggregate capitalization of $108,680,000.

Comparing the two years, the 1921 records set forth a total of 936 companies of this character organized, with combined indicated capital of $1,255,657,000. The 1920 figures stand at 1,712 such new companies, with combined capitalization of $2,786,814,000.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Desulphurizing Gases.—Coal gas is first purified by treatment with a washing liquid such as moderately concentrated sulphuric acid or passed through charcoal to remove certain tarry constituents, and is then passed through a reaction vessel in which it is treated with active charcoal in the presence of oxygen or air. The sulphur in the gas as sulphuretted hydrogen is deposited on the active charcoal, and may be extracted by a solvent, the charcoal being re-used. A small amount of ammonia or ammonium carbonate may be added to the gas entering the reaction vessel or to the catalytic mass therein, after purification with an acid. The porous mass in the purification vessel is either replaced at intervals or revivified by solvents or steam. (Br. Pat. 170,152. Badische Anilin- & Soda-Fabrik, Ludwigshaven-on-Rhine. Nov. 30, 1921.)

Slow Setting Cement.—A slow setting cement free from calcium aluminates and ferrites is prepared by adding ferric oxide to the usual ingredients of portland cement, so that the ratio of ferric oxide to alumina is between 1 and 1.563 to 1. Siliceous sand is also added to restore the ratio of silica to sesquioxides to the normal value. The materials are treated in the usual manner. (Br. Pat 170,063. Bombrini Parodi-Delfino, Rome. Nov. 30, 1921.)

Viscose Filaments.—The salts carried by or found on the threads after leaving the acid precipitating bath are recovered and utilized by washing the threads with dilute sulphuric acid so as to form the very soluble bisulphate of soda or potash, and then returning the resulting acid salt solutions, after concentration, to the precipitating bath. For the washing a 10 to 12 per cent sulphuric acid solution is preferably employed. (Br. Pat. 170,316. E. Bronnert, Mulhouse. Dec. 7, 1921. Br. Pat. 170,322 and 170,313 by the same patentee, Dec. 7, 1921, refer respectively to the addition of lactic acid to the sulphuric acid precipitating bath employed in spinning viscose filaments and to a modification in the precipitating bath in which a solution of common salt or waste stassfurt salts and sulphuric acid is used.)

Pigments.—In producing pigments consisting of a true pigment and an "extender," such as barium sulphate, by precipitating the extender in the presence of the suspended pigment or precipitating the two simultaneously, the solutions employed are so dilute or the precipitating reagent is added so gradually as to cause the formation of barium sulphate in the colloidal state. The resulting pigment is separated by filtration, dried and ground. (Br. Pat. 170,431. J. C. Smith, London. Dec. 7, 1921.)

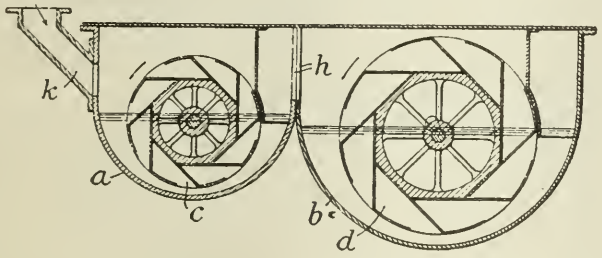
Flux for Welding Aluminum.—A flux for the autogenous welding of aluminum comprises one or more alkali halides and an activating agent which reacts with them only in the presence of aluminum oxide. An alkali pyrosulphate or pyrophosphate is employed as activating agent, a suitable mixture being potassium chloride 45 per cent, sodium chloride 30 per cent, potassium fluoride 7 per cent, lithium chloride 15 per cent, and the pyrosulphate or pyrophosphate 1 to 10 per cent. The materials are all melted together in a vessel free from metallic oxide soluble in the flux, and on solidifying a homogeneous mass remains, which is powdered. (Br. Pat. 170,343. H. V. A. Briscoe, D. Richardson and District Chemical Co., Ltd., all in London. Dec. 7, 1921.)

Urea; Fertilizers.—Urea is obtained by heating cyanamides with water and neutral or basic salts or alkali or alkaline earth metals. The water may be added wholly or in part as water of crystallization of the salt employed, or

steam may be led in; catalysts such as oxides of iron or manganese may be added, or the reaction effected under pressure. In an example, calcium cyanamide is heated with water and crystallized calcium nitrate; the calcium oxide present in commercial calcium cyanamide may be previously in part or wholly neutralized by acids such as carbonic or sulphurous acids. The products may be obtained in granular form for use as fertilizers, and there may be used in the process other salts which are themselves fertilizers—for example, potassium salts. (Br. Pat. 170,329. E. Lie and Aktieselskabet North Western Cyanamide Co., Odda, Norway. Dec. 7, 1921.)

Ammonium Sulphate.—In the production of ammonium sulphate by passing into a saturator gases which are likely to contain cyanogen compounds, the cyanogen compounds are prevented from reaching the saturator by adding to the ammoniacal liquor to be distilled a polysulphide, or forming a polysulphide in the liquor—for instance, by adding sulphur or blowing in air—so as to fix the cyanogen compounds in the liquor as sulphocyanides; or the vapor from the still may be passed over spent oxide on its way to the saturator. In the case of the direct process, the ammoniacal gas is passed through a washer containing a polysulphide solution. (Br. Pat. 170,613. South Metropolitan Gas Co. and P. Parish, London. Dec. 14, 1921.)

Recovering Gases and Vapors Absorbed in Solids.—For recovering gases or vapors absorbed in solids such as charcoal or alumina, the solid is caused to travel through a bath of liquid metal, for example of molten lead, heated to the requisite temperature, or through a series of such baths



maintained at gradually increasing temperatures so as fractionally to expel the gases; in the latter case the heated solid may be returned to the bath of lower temperature so as to carry into the latter, heat acquired in the bath or baths of higher temperature. When recovering ethylene, etc., which has been absorbed from coal or other gas, the saturated charcoal may first be passed through a bath of molten alloy maintaned at about 120 deg. C., and then through a bath of molten lead at about 350 deg. C.; the charcoal is afterward cooled by passage through the first bath, through a bath of cooled mercury, or by the stripped and cooled gases; and benzene may be recoverd from the charcoal of the preliminary absorbers in a similar manner, but generally these will be charged with charcoal already saturated with ethylene. A convenient apparatus comprises baths *a*, *b* arranged close together and each containing two pairs of rotating paddles *c*, c^1, *d*, d^1; the charcoal enters the bath *a* by a shoot *k*, is carried beneath the molten metal by the paddle *c*, falls through the adjacent openings *h* into the bath *b*, is carried there through by the paddle *d*, then passes to the other side of the bath, and is carried back in a similar manner by the paddles d^1, c^1, (not shown) which rotate in an opposite direction to the paddles *d*, *c;* the gases which escape are collected separately and are led away through outlets in the cover. (Br. Pat. 170,323. Thermal Industrial & Chemical Research Co. and J. S. Morgan, Westminster. Dec. 7, 1921. Br. Pat. 170,617 by the same patentee, Dec. 14, 1922, covers the application of the molten metal bath to the heating of liquids, such as tar.)

Viscose Silk.—The precipitating bath employed in the manufacture of artificial silk from raw viscose consists of sulphuric acid, which is at least partly bound to aromatic radicals. Examples are given of baths containing sodium benzene sulphonate and free sulphuric acid. The acid mixtures obtained in the direct sulphonation of benzene and its homologs, and of phenol, naphthol and their homologs may be employed. (Br. Pat. 170,029. E. Bronnert, Mulhouse. Nov. 30, 1921. Patents 166,931 and 170,024 refer to the process of spinning, using the above precipitating bath. The use of a bath of highly concentrated solution of bisulphites with or without formaldehyde or glucuse is covered by Br. Pat. 170,874, by the same patentee, Dec. 21, 1921.)

Concentration of Ores.—In a froth-flotation process, products obtained by treating viscous substances such as tars, fuel oil or tar oil with emulsifying agents such as caustic alkalis, carbonates, soaps, sodium resinate or mixtures thereof, are used as frothing agents or as a source of or in conjunction with frothing agents. For example, producer-gas tar may be heated with an aqueous solution of caustic soda. (Br. Pat. 170,944. W. G. Sellers and Minerals Separation, Ltd., London. Dec. 21, 1921.)

Sulphite Cellulose.—Wood is cleaned, split into small pieces, and treated with dilute sulphuric acid under pressure, drained and neutralized. The wood lignine is thus decomposed and is subsequently dissolved by boiling in known manner with calcium or magnesium-calcium bisulphate under pressure, yielding a nearly pure alpha-cellulose particularly suitable for making pure viscose and cellulose acetate. (Br. Pat. 170,964. E. Bronnert, Mulhouse. Dec. 21, 1921.)

Calcium Superphosphate.—Phosphatic minerals are pulverized, subjected to a froth-flotation process to separate undesirable constitutents, and finally treated with sulphuric acid. In examples in which crude phosphorite and waste phosphatic material rejected after hand-picking are used as the starting material, the mineral after grinding is agitated and aërated with water containing oelic acid as the frothing agent. Sodium silicate is also added to wet effectively the constituents which are not to be floated. The froth is drained or mechanically filtered, and the resulting damp powder treated with sulphuric acid. In place of oleic acid other frothing agents such as soap may be used, and when the water is hard a small amount of sodium resinate should be added. The frothing agent may be emulsified by adding sodium oleate or sodium resinate before mixing with the mineral pulp. When it is necessary to repeat the flotation process, the concentrate is agitated and aërated with water containing sodium silicate without the addition of oleic acid or other frothing-agent. (Br. Pat. 171,155. W. Broadbridge and E. Edser, both in London. Dec. 30, 1921.)

Artificial Silk.—Relates to modifications of the processes for spinning the finest threads of viscose silk, using the ordinary spinning apertures of 0.1 mm. diameter. According to the present invention, artificial resins prepared by the condensation of phenols with formaldehyde are added to the viscose before spinning and preferably before ripening. As spinning baths, concentrated solutions of bisulphite of soda, alone or with the addition of ammonium bisulphite, are employed and the concentration of the bath is maintained, higher according as the threads are finer. By this addition it is stated that the threads take darker shades in the dye bath, and that their resistance to water is increased. (Br. Pat. 171,125. E. Bronnert, Mulhouse, Dec. 30, 1921.)

Insulating Coatings for Metals.—In coating metal and other surfaces with phenol-formaldehyde condensation products or resins such as Bakelite and asbestos, blistering is prevented by coating the surface with the resin, applying asbestos paper or the like, hardening the resin by heat, and then impregnating the asbestos with liquid or dissolved resin which is finally hardened. (Br. Pat. 171,369. Not yet accepted. J. K. Wirth, Berlin. Dec. 31, 1921.)

Metal Carrier for Catalyzers.—The carrier or support for a catalyst for chemical reactions, particularly the production of acetone from acetic acid, is made of a metal or an alloy. Aluminum is specially suitable, for by vigorously stirring the molten metal as it cools, rough porous granules are produced, upon which the catalyst can be deposited by boiling the granules in a solution or suspension thereof. For acetone production, acetic acid vapor is conducted through a tube heated to 300 to 400 deg. C., and containing as catalyst an oxide, hydrate, carbonate or acetate of calcium or barium supported upon the metallic carrier. (Br. Pat. 171,391. Not yet accepted. Stockholms Superfosfat Fabriks Akiebolag, Stockholm. Dec. 31, 1921.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Managing Editor of Chem. & Met. to Go to Europe

In accordance with editorial plans for 1922, announced in CHEM. & MET. on Jan. 4, the Managing Editor of this magazine, J. S. Negru, will sail for Europe on Feb. 11. He will be gone for at least 6 months, and during that time will make a trip through Germany, France, Belgium and other European industrial countries. The purpose of the trip is to study industrial and economic conditions and observe the latest advances in science and engineering.

Mr. Negru is unusually well qualified to undertake this work, which should prove distinctly serviceable to the readers and advertisers of CHEM. & MET. He is a native

J. S. NEGRU, MANAGING EDITOR OF CHEMICAL & METALLURGICAL ENGINEERING

of Europe, a graduate engineer from the University of Liége, and consequently familiar with European conditions and widely acquainted among European engineers. For the past 16 years he has spent a large portion of his time in the United States, acquiring a broad experience in American industrial practice, which will enable him to co-ordinate his observations abroad with conditions in this country. Added to this engineering and industrial experience is the fact that he has for nearly 3 years been the Managing Editor of CHEMICAL & METALLURGICAL ENGINEERING, where he has acquired our viewpoint of service to the industry.

It is expected that through Mr. Negru the magazine can reflect industrial conditions in Europe and interpret them to the mutual benefit of American and European manufacturers and consumers.

Federated American Engineering Societies Appoints Committees

The Federated American Engineering Societies has appointed a new committee on registration of engineers. The personnel of the committee is as follows: A. S. Dwight (chairman), New York; Gardiner S. Williams, Ann Arbor, and Philip N. Moore, St. Louis.

A new federal water power committee also has been named. John H. Finney, Washington, is the chairman of the committee. Other members are Calvert Townley, New York; G. S. Williams, Ann Arbor; Gano Dunn, New York, and A. P. Davis, Washington.

Dye Investigation Sub-Committee Finally Complete —Hearings to Begin Promptly

With the acceptance by Senator Ernst of Kentucky of an assignment on the sub-committee which will conduct the dye investigation recently ordered by the Senate, the early opening of the hearing is assured. The sub-committee has held an executive session at which plans for the conduct of the hearing were discussed.

It is the intention of the sub-committee to hear first the witnesses who will be called in an effort to establish that there is a monopoly in the manufacture of dyes in this country and that the domestic industry is engaged in improper activities in an effort to influence legislation. Up to the present time no date has been fixed for an open hearing and no announcement has been made as to the witnesses that will be called first.

New Head of Paper Division of Bureau of Commerce

Grosvenor M. Jones of Cleveland has been appointed by the Secretary of Commerce to be chief of the Paper Division of the Bureau of Foreign and Domestic Commerce. Mr. Jones has had considerable experience in the paper industry and trade both officially and unofficially. In 1913, before entering the service of the Bureau of Foreign and Domestic Commerce, he was engaged in a special investigation in Washington in behalf of American Paper and Pulp Association.

He was assistant director of the Bureau of Foreign and Domestic Commerce from February, 1918, to August, 1919. He has traveled in Europe and in Latin America in behalf of the Department of Commerce, studying industries, ports and shipping. Mr. Jones visited Central America in 1919 in connection with the second Pan-American financial conference. He was then appointed assistant manager of the Mercantile Bank of the Americas, followed later by appointment as director of that bank's Peruvian branch.

Mr. Jones attended Harvard University and is a graduate of Georgetown University, where he received his LL.B.

Patent Office Relief Bill Reported Favorably to Senate by Committee on Patents

The Patent Office relief bill was advanced another step in its legislative course Jan. 24 when the Senate Committee on Patents reported the bill to the Senate with the recommendation that it be passed without amendment. Senator Johnson of California, the chairman of the committee, states that every effort will be made to obtain consideration of the bill at the earliest moment.

It is understood that Senator Norris of Nebraska, formerly chairman of the Senate Patent Committee, will offer as an amendment the proposal to allow the Federal Trade Commission to administer patents for employees of the

federal government. It was this rider which killed the Patent Office bill at the last session of Congress. The chances are that the Norris amendment can be brought to a vote promptly, and if defeated the final enactment of the legislation would be a matter of a very few days. Should the Senate feel obliged, for the sake of consistency, to support its former action and vote the Norris provision into the bill, the delays incident to a divided conference committee and a possible fight on the conference report would loom.

Varnish Company Establishes Industrial Museum in Connection with Technical Library

The Murphy Varnish Co., Newark, N. J., has established an industrial museum, the first of its kind in the city, in the rooms formerly used as offices by the Essex Varnish Co., now a part of the Murphy plant, totaling about 800 sq.ft. of floor space. The museum is designed primarily for visitors to the factory, and presents an interesting exhibit of raw materials, processes and finished products of the company. A fine photograph collection sets forth methods of operation from the gathering of raw materials to different features of plant production. The finished products are displayed in company with articles upon which they have been used, such as clocks, buttons, electrical apparatus, stampings, etc. A technical library for employees at the works has been established in connection with the museum, containing about 350 volumes, pertinent to paint and varnish manufacture, selling, advertising, business methods and the like. Technical magazines and other periodicals are also on file.

Industrial Optimism Justified by Many Increases of Operating Programs

Glass.—The Allegheny Window Glass Co., Port Allegheny, near Kane, Pa., has arranged for the immediate resumption of operations at its local plant, following a shutdown for the past 13 months. Employment will be given to about 1,300 workers.

The Whitall-Tatum Co., Millville, N. J., manufacturer of druggists' glassware products, resumed operations on Jan. 17 at four of its local plants recently closed down through lack of orders.

Practically all of the glass-manufacturing plants at Tarentum and Brackenridge, Pa., are now in operation on nearly normal production schedules.

The Millville Bottle Works, Millville, N. J., manufacturer of druggists' glassware specialties, has completed the construction of a new 12-pot plant, and will place the unit in operation at once.

Paper.—The International Paper Co., New York, N. Y., will commence operations at its plant at Three Rivers, near Montreal, early in Feb., with an initial production of about 100 tons of newsprint paper per day.

Leather.—The New Castle Leather Co., Wilmington, Del., specializing in the production of morocco leathers, has increased the working force at its tannery to the normal quota of 750 persons for the first time in the past 4 years.

Tin.—The N. & G. Taylor Co., Cumberland, Md., manufacturer of tinplate, has increased the force of operatives at its local plant. The present basis of production is better than 50 per cent.

The Follansbee Brothers Co., Pittsburgh, Pa., has commenced production at its new tin mills at Toronto, Ohio. Two sheet mills at the plant were opened recently and arrangements are being made for the early operation of all departments at the plant.

Effective Jan. 17, the McKeesport Tin Plate Co., Portvue, near McKeesport, Pa., resumed operations at twenty hot mills, fifty-nine tin stacks and cold mills at its local plant, giving employment to about 1,500 workers. Operations will be resumed at other hot mills at an early date.

The American Sheet & Tin Plate Co., Farrell, Pa., has placed two additional hot mills in service at its local works, giving employment to about 100 extra men. A gradual increase will be made in production until capacity is reached.

Cement.—The Bessemer Limestone & Cement Co., Youngstown, Ohio., is maintaining capacity operations at its mills, and has already booked orders for 200,000 bbl. for delivery in 1922, or about one-sixth of the plant capacity. It is expected that 80 per cent of the 1922 output will be sold for the year within a short time.

Zinc.—The New Jersey Zinc Co. is operating above normal production at its properties at Millport and Hazard, near Palmerton, Pa., giving employment to about 150 more men than in 1914.

Asbestos.—In connection with the maintaining of regular production at its different plants, the Johns-Manville Co., New York, has restored the 10 per cent wage cut of certain employees, placed in effect last October. The reinstatement will be operative from Jan. 1.

Iron and Steel.—The Trumbull Cliffs Furnace Co., Warren, Ohio, has blown in its new 600-ton blast furnace. The furnace and auxiliaries represent an investment of about $3,000,000. There are more furnaces in blast in this district now than at any time since February, 1921.

The Carnegie Steel Co. is now operating five of the six blast furnaces at its Ohio mills.

The Glasgow Iron Co., Pottstown, Pa., resumed production at seven of its local puddling furnaces on Jan. 17.

The Trumbull Steel Co., Trumbull, Ohio, has increased operations from ten to nineteen mills at its plant.

University of Illinois Offers Assistantships in Engineering Experiment Station

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen research graduate assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics or applied chemistry.

An appointment to the position of research graduate assistant is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Not more than half of the time of a research graduate assistant is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study.

Nominations to these positions, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than the first day of March. Additional information may be obtained by addressing the director at the University of Illinois, Urbana, Ill.

Foundrymen Change Convention Plans

It has been previously announced that the annual convention and exhibit of the American Foundrymen's Association would be held in Cleveland the week of April 24. Due to the incomplete condition of Public Hall, uncertainty as to when it would be open to the public and the manner in which it would be operated made it impossible for the city of Cleveland to give a lease for any specific date in 1922. Because of these conditions the present administration could not honor the agreements which the previous administration had entered into with the association. Rochester had previously extended a cordial invitation for this year's meeting, backed by assurances of 100 per cent support on the part of Rochester foundries and other civic bodies. All these were promptly reaffirmed by Rochester, with the result that this city has been chosen for a convention to be held during the week of June 5.

New Haven Section, A.C.S., Elects

At the annual meeting of the New Haven Section of the American Chemical Society the following officers were chosen for 1922: President, Milo C. Burt; vice-president, Treat B. Johnson; secretary, Blair Saxton; treasurer, John L. Christie; councilor, Harold Hibbert.

English and American Crucible Steels Compared at Society for Steel Treating Meeting

T. Holland Nelson, steel works manager, Henry Disston & Sons, Philadelphia, spoke before the Washington Chapter of the American Society for Steel Treating, Jan. 20, discussing American and English methods of producing high-grade crucible steels. He contrasted particularly the methods of manufacture as affecting the uniformity and real value of the product of the two countries. Emphasis was laid particularly upon the greater use of Swedish iron by the English manufacturers, not so much because of any advantage that can be revealed by analysis or microscopic examination as because practical experience indicates that a more uniform product can often be made from the Swedish iron.

Mr. Nelson also warned against acceptance of tool stock as hammered bars when really the material offered as such is only rolled bar stock given a finishing treatment under the hammer. The extra cost and extra price charged for such hammer-finished bars is not, in Mr. Nelson's judgment, at all worth while to the purchaser for tool manufacture. However, he does point out a definite advantage under some circumstances for genuine hammer stock in contrast with rolled bar stock.

Italian Chemistry Subject at Chicago Section, A.C.S.

Dr. William McPherson, chairman of the department of chemistry at the Ohio State University, spoke before the Chicago Section of the American Chemical Society, Jan. 20, on his experiences in visiting the Italian universities. Although not so well known as they deserve to be, Italian universities have behind them a history in the advancement of science that is highly commendable. Dr. McPherson spoke of the charm of the old universities where such noted men of science as Galvani, Volta and Avogadro carried on their work, many of which have the laboratories located in the courts of old monasteries, most adaptable places for such work because of their quiet atmosphere and the fireproof construction of the buildings. Dr. McPherson showed many slides of the various buildings and interiors of laboratories and spoke at length on the more noted men in Italy.

Louisiana Leads in Training Sugar Chemists

John M. Parker, Governor of Louisiana, made the following statement to the Senate Committee on Finance on Jan. 23, during the course of an argument for the tariff on sugar:

"Louisiana has done more for the sugar industry of the world than any other single community. At this time we have sixty-seven men from different nations studying sugar chemistry at Louisiana State University. There, sugar chemistry has been worked out in a very advanced way and that knowledge is being utilized all over the world."

Joint Meeting of Four Societies in New York Feb. 10

"Research in Chemistry as Related to Medicine" will be the subject of an address to be delivered by Dr. Russell H. Chittenden of the Sheffield Scientific School, Yale University, before a joint meeting of the New York sections of the American Chemical Society, the American Electrochemical Society, the American sections of the Société de Chimie Industrielle and the Society of Chemical Industry on Feb. 10, at Rumson Hall, New York. The address will be followed by a discussion by C. H. Herty, H. T. Bogert and F. P. Garvan.

Water-Gas Production Costs

In a hearing before the Board of Public Utility Commissioners of New Jersey, Jan. 11, Henry D. Whitcomb, vice-president and general manager of the Public Service Gas Corporation, Newark, stated that a close estimate of the cost of production showed $0.5304 per 1,000 cu.ft. of gas in the Essex, Hudson and Bergen divisions of the system, and for all parts of the state in which the company operates, a figure of $0.5670 per 1,000 cu.ft. The company estimates unaccounted-for gas at 11 per cent.

U. S. Chamber of Commerce to Consider Metric System

Among the questions to be discussed at the meeting of the National Council of the Chamber of Commerce of the United States in Washington, Feb. 8 and 9, is a consideration of the advisability of legislation for the compulsory adoption of the metric system. At this time the special committee on metric system will make its report to the board of directors and the advantages and disadvantages of the adoption of the system will be presented.

The committee on railroads will also report to the directors and the railroad situation will be discussed.

Institute of Mining and Metallurgical Engineers Announces Program of 125th Meeting

The 125th meeting of the American Institute of Mining and Metallurgical Engineers will be held in New York, Feb. 20, 21, 22, 23, 1922. The first three days will be devoted to meetings of the various sections at the headquarters of the Institute, 29 West 39th Street.

Special entertainment has been arranged for evenings. On Monday evening, Feb. 20, a smoker will be held in the Engineering Societies Building. On Tuesday evening, two moving pictures, "Mexico and Its Oil" and "Through India With the Duke of Connaught, Including a Visit to the Tata Iron and Steel Works," will be shown. On Wednesday afternoon, Senator William A. Clark will open his art galleries to members and guests of the Institute. Admission tickets must be obtained at the registration desk. Wednesday evening will be devoted to the banquet.

The program of the meetings of the Institute of Metals Feb. 20 and 21 was given on page 86 of our issue for Jan. 11, 1922. Other papers of interest to our readers will be presented Wednesday, Feb. 22, in the Iron and Steel sessions.

Iron and Steel Session

10 a. m.—Room 1.

This session is in memory of Prof. J. W. Richards

Application in Rolling of Effects of Carbon, Phosphorus and Manganese on Mechanical Properties of Steel. By W. R. Webster.

Acid Open-Hearth Process for Manufacture of Gun Steels and Fine Steels. By W. P. Barba and Henry M. Howe.

Effect of Sulphur and Oxides in Ordnance Steels. By W. J. Priestley.

Electrolytic Deposition of Iron as Applied to Building Up Worn or Undersized Parts. By D. R. Kellogg.

2 p. m.—Room 2.

Effect of Time in Reheating Quenched Medium-Carbon Steel Below the Critical Range. By C. R. Hayward, D. M. MacNeil, and R. L. Presbrey.

Effect of Quality of Steel on Case-Carburizing Results. By H. W. McQuaid and E. W. Ehn.

Malleableizing White Cast Iron. By Arthur Phillips and E. S. Davenport.

Thursday will be devoted to excursions to several plants in New Jersey. The party will be divided into groups—those interested in steel, in oil and in copper. The members will ferry to Jersey City, where a special train will take the steel group to the plant of the Crucible Steel Co. of America, Harrison, N. J.; the oil group to the Bayway plant of the Standard Oil Co. (N. J.) and the copper group to the Chrome plant of the U. S. Metals Refining Co. About 2 hours will be allowed for seeing these plants. The special train will collect the different groups and take them to Perth Amboy, where they will be entertained at luncheon by the industries of Perth Amboy.

After luncheon the steel group will be given an opportunity to visit the Pardee Steel & Pardee Tile Works; the oil group the Chesebrough Mfg. Co. or the Barber Asphalt Co. and the copper group the Standard Underground Cable Co. or the Raritan Copper Works. The ladies of the party will be entertained at cards and tea during the afternoon. The groups will re-assemble at the Perth Amboy station about 4:30 p. m., for return by special train which will bring them back to New York about 5:30 p. m.

Present Status of Muscle Shoals Development —Investigation of Opposition Proposed

The report that Henry Ford has returned to the Secretary of War the contract for the lease of the Muscle Shoals water-power and nitrate plants with his signature attached presages the early consideration of the offer by Congress. Secretary Weeks has remained noncommittal as to the nature of the comment he will make in referring the proposal to Congress, but it is believed that his recommendations will carry considerable weight with the legislators. Senator Underwood has consistently maintained that the only way in which the public can obtain maximum benefit from the operation of the Muscle Shoals plants is by government operation. On the other hand, it is believed that the majority in the Senate favors a reasonable contract with responsible private interests, since government operation was blocked by the opposition of the ultra-conservationists to the formation of the proposed U. S. Fixed Nitrogen Corporation. It is expected that the proposal as it stands will be condemned by the fertilizer interests on the basis that Mr. Ford is obtaining property, in which the government has invested over eighty million dollars, at a ridiculously low figure—namely, five million dollars. Also, that in offering to pay 4 per cent on the construction cost of dam No. 2 the $15,278,828 already expended by the government has been disregarded. The point has also been raised that the granting of a 100-year lease with renewal option during that period is directly contrary to the Roosevelt water-power policy, adopted in 1920, providing for the recapture of water-power projects by the government at the end of 50 years. The Roosevelt policy also provides for the regulation of the price of power to the consumer and that public power taken for profit shall make a return to the public. Neither of these provisions is covered by the Ford contract as it stands.

On the other hand, there is undoubtedly a strong sentiment for immediate resumption of construction work on the dam among the agricultural interests and the advocates of industrial expansion in the South. There is little doubt that if Mr. Ford's plans materialize considerable industrial activity would be fostered by the abundance of water power available, although it is probable that only a relatively small part of the power developed by dams 2 and 3 would be used for the operation of the nitrate plants in the production of fertilizer.

Briefly stated, the Ford contract as far as made public at present provides for the completion of Wilson dam and the installation of hydro-electric equipment for the generation of 600,000 hp., the construction being undertaken by the Ford organization at cost. When completed, the company would pay to the government as annual rental of the property an amount equal to 4 per cent of the total cost of construction. The company would lease the dam, power house and all equipment for a period of 100 years. At the beginning of the seventh year and annually thereafter the company would pay to the government a sum not exceeding $39,537 to write off the cost of the dam, power house and appliances taken at $40,000,000—the sinking fund investments to bear the highest rate of interest obtainable but not less than 4 per cent per annum. The company would pay $35,000 annually for repairs and maintenance.

Upon the completion of dam No. 2 the government would construct dam No. 3 and its 250,000-hp. plant, the company to lease this property for 100 years, paying the government 6 per cent annually on the cost—taken at $8,000,000—except during the first 3 years after the plant is generating 80,000 hp., when the annual payments are $16,000, it being presumed that at the end of that period the plant will be complete and operating at full capacity. At the beginning of the fourth year of the lease period and annually thereafter the company would make amortization payments not greater than $7,010 to write off the cost of dam No. 3, taken at $8,000,000.

The actual purchase price of Nitrate Plants No. 1 and 2, including all equipment, patents and processes, the Waco quarry and equipment, the steam plant at Gorgas and transmission lines, is $5,000,000. The company would have the option of renewal of water-power lease and would guarantee to operate Nitrate Plant No. 2 to approximate capacity in the production of "nitrogen and other fertilizer compounds," the maximum net profit to the company not to exceed 8 per cent. Plant No. 2 would be maintained ready for the production of war materials and turned over to the government when required in the event of war.

Active opposition to the Ford proposal is led by the National Fertilizer Association, which has recently issued a chart as one of its Truth-About-Muscle-Shoals series, which shows that only 4c. of the "fertilizer" dollar goes for sulphate of ammonia. The intention is to emphasize the association's contention that no matter how cheap sulphate of ammonia is made at the Muscle Shoals plant, it could

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WILSON DAM (NO. 2) AND CONSTRUCTION CAMP LOOKING UPSTREAM ON TENNESSEE RIVER

Photo copyright by Akers Airphoto Corp., Chicago.

ABOVE—U. S. NITRATE PLANT NO. 2, MUSCLE SHOALS

1—Electric bus tunnel. 2—Water reservoir. 3—Water-treating plant. 4—Electric switch house. 5—Limekilns, coke and coal driers. 6—Raw material mixing. 7—Carbide furnaces. 8—Carbide cooling. 9—Carbide mill. 10—Cyanamide cooling. 11—Liquid air plant. 12—Cyanamide cooling. 13—Cyanamide mill. 14—Storage and hydrating. 15—Process steam plant. 16—Ammonia plant. 17—Nitric acid plant. 18—Ammonium nitrate houses. 19—Laboratories. 20—Storehouse. 21—Shops and foundry.

BELOW—NORTH END OF U. S. NITRATE PLANT NO. 2, SHOWING WILSON DAM ON TENNESSEE RIVER

22—60,000-kw. steam power plant. 23—Electric bus tunnel from steam plant to switch house. 24—Wilson dam.

not reduce the cost of fertilizer greatly. It is also pointed out graphically that it would cost $68 a ton to make sulphate of ammonia at Muscle Shoals, whereas the average wholesale price during 1921 was $48 per ton.

An investigation of the activities in opposition to the lease or other disposition of the government's plant at Muscle Shoals is provided in a resolution introduced in the Senate by Senator Harris of Georgia. A portion of the resolution reads as follows:

> Whereas it has been charged publicly that various persons, associations, corporations and combinations interested in the production of fertilizers, commonly known as the fertilizer trust, and various persons, associations, corporations and combinations interested in the production and transmission of power, commonly known as the water-power trust, have been and are engaged in extensive propaganda and in the maintenance of a lobby to defeat any plans for and to prevent the lease or other disposition by the government of the Muscle Shoals plant and projects; therefore, be it
>
> *Resolved*, That a committee composed of five Senators, to be appointed by the President of the Senate, is hereby authorized and directed to investigate such charges and activities of any such persons, associations, corporations or combinations, and to report its findings to the Senate with such recommendations as it deems proper.

Research on Motor Fuels Subject of Delaware Section, A.C.S., Meeting

"The Detonation of Gaseous Mixtures" was the subject of an address delivered by Thomas Midgley, Jr., chief engineer, Fuel Section of the General Motors Research Corporation, before the Delaware Section of the American Chemical Society in Wilmington on Jan. 16. "More miles per gallon" is a topic of almost universal interest, and the speaker explained that, as a result of his extended researches on the combustion of motor fuels, he could prescribe a never-failing method for producing the desired effect—namely, to decrease the clearance in the cylinder head and thus increase the pressure. This change always increases the power produced, but unfortunately it also causes severe "knocking."

During the study of various types of motor fuel, the speaker found that the ethers "knocked" at low pressures, then came the paraffines, olefines, aromatics and finally the alcohols, which would stand very high pressures without "knocking." Some blended motor fuels, such as benzene-gasoline-alcohol mixtures, appear to have some advantages over any one of their components used separately.

Mr. Midgley has studied a wide range of "anti-knock" compounds. Such materials as ethyl and phenyl chloride and iodide are effective, but are obviously impracticable on account of corrosion. The aromatic amines, such as aniline, toluidine, xylidine, etc., also prevent "knocking" if present to the amount of 2 to 3 per cent. The mileage of automobiles could be increased considerably by redesigning the motor to take care of motor fuels containing up to 10 per cent of aniline. The most effective "anti-knock" compound known was said to be tellurium-tetra-ethyl, but the available supply of tellurium is far from sufficient to treat the total amount of gasoline consumed.

"Chemical Education" Topic at South Jersey Section, A.C.S.

A symposium on "Chemical Education" was held by the South Jersey Section of the American Chemical Society on Jan. 19, at Carneys Point, N. J. Short papers were presented by P. W. Carleton, A. E. Houlehan, G. B. Bradshaw and W. S. Calcott, all of whom are members of the Jackson Laboratory or dyeworks staff of the du Pont company. The opinions expressed may be crystallized in the statement that the college and university training of a chemist should be merely a foundation and therefore should be as broad as possible. The general sentiment of the meeting was in favor of less industrial and applied chemistry and more thorough training in the proper use of the English language and mathematics in the modern college curriculum.

Personal

Charles A. Blaney has been elected president of the Eddy Paper Co, Kalamazoo, Mich., succeeding Oscar Gumbinsky, who recently tendered his resignation on account of other pressing business interests.

Robert M. Gates has resigned his position as engineer with the Lakewood Engineering Co., the resignation to be effective Feb. 1. Mr. Gates has made no definite plans for the future.

Chester H. Jones, Industrial Editor of Chemical & Metallurgical Engineering, stationed in Chicago, is in New York for a stay of a few days.

Charles W. Leavitt, consulting engineer for the Continental Asphalt & Petroleum Co., New York, is on an inspection trip to the company's properties in Oklahoma.

Dr. Lester A. Pratt, who has been in charge of the research laboratory of the Merrimac Chemical Co. for the past 6 years, has been made director of research for the same company.

Arthur W. Sewall, president of the General Asphalt Co., Philadelphia, Pa., has been elected a member of the board of directors of the Alliance Insurance Co. of that city.

Edgar C. Shimer, Allentown, Pa., has been re-elected president of the Brick Manufacturers' Association of Eastern Pennsylvania, Southern New Jersey and Delaware.

Dr. Ludwik Silberstein gave a lecture on "An Optical Experiment in Connection With the Rotation of the Earth," Jan. 26, 1922, at the Franklin Institute.

Harold B. Thorne, vice-president of the Metropolitan Trust Co., New York, has been elected vice-president and director of the Pierce Oil Co., New York. He will relinquish his position with the trust company at an early date, but will continue as a director and member of the executive committee.

Obituary

Dr. Charles Baskerville, director of the chemical laboratories of the College of the City of New York, died Saturday, Jan. 28, at his home, following an attack of pneumonia.

William H. Bradley, chief engineer of the Consolidated Gas Co., of New York, died recently of heart disease in his office. He had been chief engineer of the company 36 years. Although eighty-four years of age, he was a daily visitor to his office. He was born in New Haven, Conn., where he received a common school education, and for several years was employed in the mechanical department of a large manufacturing establishment. Shortly after his marriage at the age of twenty-one he entered the services of the Continental Iron Works in Brooklyn as a construction engineer. That company was then actively engaged in the execution of large government contracts, and among them, in 1862, was the building of Ericsson's *Monitor*, and Mr. Bradley took an active part in the building of that new war craft, which subsequently met and defeated the *Merrimac*. At the close of the war he went to Pennsylvania, where he established a plant to manufacture oil well drilling tools, returning to the Continental Iron Works as head of the gas department in 1870. Mr. Bradley became chief engineer of the Consolidated Gas Co. 2 years after its formation in 1884, and since then had made many valuable engineering contributions to the industry. The Astoria plant, the largest in the world, was constructed under plans and specifications drawn by him. Mr. Bradley leaves a widow, a daughter, Miss Bessie Bradley; two sons, George Bradley, assistant engineer of the Nevins street plant of the Brooklyn Union Gas Co., and Charles W. Bradley, gas engineer of the People's Gas, Light & Coke Co., in Chicago, Ill.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Business Conditions in January

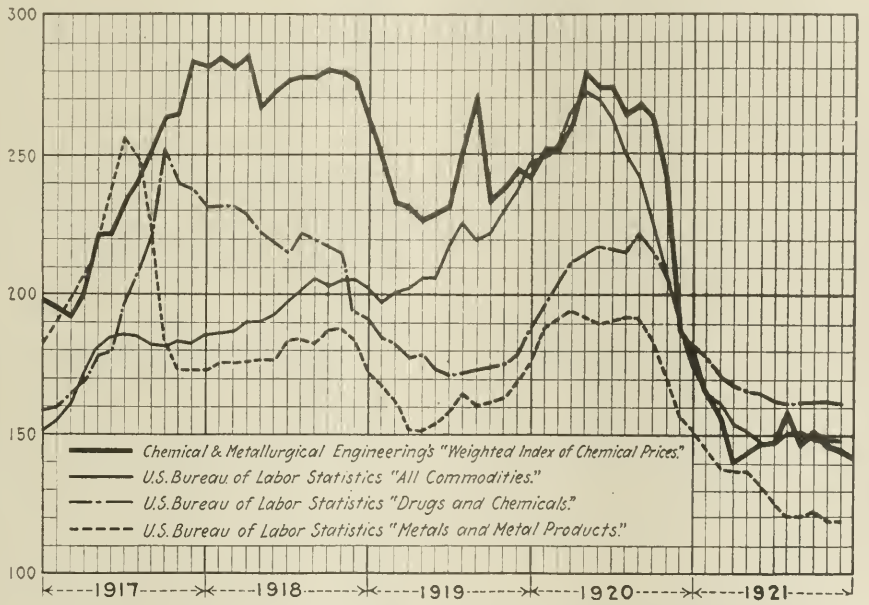
January contributed but little toward the improvement of fundamental conditions in business. Readjustment continued without interruption and without any particularly significant developments.

The full forces of depression were felt by practically every branch of business. Unemployment in the chemical, iron and steel and a number of other industries has been on the increase. Business failures, always most frequent during December and January, have occurred on an unprecedented scale. The greatest number of failures in 6 years was reported in 1921. Bradstreet's number reached 2,380 in December, which was the largest monthly total ever recorded. It is customary for January to show about one-fifth more business failures than December, so that another record-breaking month is to be expected. A significant factor in the general business situation has been the availability of credit at steadily declining rates of interest. In the first week of January time money dropped to 4¾ per cent and has since reached 4½ per cent. This is reported to be the lowest rate for this kind of a loan since August, 1917. Call money dropped to 3½ per cent on Jan. 6 and to 3 per cent on Jan. 9. On Jan. 16, however, the rate for call money jumped to 6 per cent and at the end of business on Jan. 26 stood at 4½ per cent. This is to be compared with 7 per cent of a year ago. A plentiful supply of credit means that working capital can be obtained with less difficulty and expense and should therefore react favorably on business.

Stocks and bonds have shown some improvement of late. The *Wall Street Journal* average for twenty industrials stood at 81.54 on Jan. 25, 1922, in comparison with a high of 81.50 and a low 63.90 for 1921.

The chemical market during January has been characterized by a continuation of the careful buying policies pursued by the consumers during the latter part of 1921. In spite of sharp price reductions there has been practically no real buying. What little demand exists has been for staples and other large-scale products rather than for specialties. Some long-time contracts have been recorded, but the number has doubtlessly been considerably less than is usual for the opening month of the year. Imports have continued to affect the market and have largely governed the prices of several important chemicals.

Price changes for particular commodities are reviewed in this week's letter on the New York market, and the general trend in chemical prices is reflected in the CHEM. & MET. index number. For the week ended Jan. 4 this index stood at 143.30, or 3.30 more than the 5-year minimum reported in April, 1921. On Jan. 11, it was 144.49; on Jan. 18, 143.75; on Jan. 25, 143.50, and on Feb. 1, 144.60. The average for the month of January was 144.09. The uncertainty regarding the tariff situation has had a very depressing effect on the chemical industry. The failure of the Senate to agree on a basis of valuation and Senator Smoot's prediction that the embargo on dyes would not be included in the new tariff law have discouraged trading and held production at a virtual standstill.



A COMPARISON OF WHOLESALE PRICES, 1917-1922

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	144.60
Last week	143.50
February, 1921	166
February, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

There was a noticeable increase in the index number during the past week due principally to the higher prices for vegetable oils. Linseed oil advanced 4 cents on the gallon and cottonseed oil was up ¼ cent per pound. The lower prices for caustic soda, methanol and formaldehyde failed to offset the upward movement of the index.

Wholesale Prices, 1917-1922

A graphic comparison of the prices for chemical and metallurgical products with the general average for all commodities is afforded by the accompaning chart. It is of interest to note the close relation which has existed since 1919 between the CHEM. & MET. index of chemical prices and the Department of Labor's average for over 300 commodities. These curves exhibit the same general tendencies, although there is an apparent lag of 1 to 3 months in the case of the chemical prices. Both reached the 1920 maximum in the month of April.

The indexes for metal products and drugs and chemicals also show a certain noticeable similarity. During 1919 and 1920 both were considerably under the average for all commodities. Since December, 1920, the Labor Department's index for drugs and chemicals has been 10 to 15 per cent above the general level, while on the other hand, metals and metal products have been 20 to 30 per cent under this average.

Decreased Output of Cottonseed Oil

Figures recently issued by the Bureau of the Census show that the production of crude cottonseed oil during the last 5 months of 1921 was about 5 per cent less than during the same period in 1920 The principal cottonseed products manufactured, shipped and in stock are shown in the following table:

	Year	On Hand Aug. 1	Produced Aug. 1 to Dec. 31	Shipped Out Aug. 1 to Dec. 31	On Hand Dec. 31
Crude oil, lb....	1921	*18,762,794	611,412,655	545,846,505	*100,167,166
	1920	22,620,357	643,566,331	543,037,678	156,088,844
Refined oil, lb...	1921	†228,263,633	‡461,488,151	.....	†257,577,703
	1920	297,741,580	445,926,305	.....	274,388,802
Cake and meal, tons.....	1921	36,303	900,545	679,410	257,437
	1920	133,475	897,787	787,080	244,182

* Includes 4,346,848 and 9,315,790 lb. held by refining and manufacturing establishments and 5,507,880 and 16,377,160 lb. in transit to refiners and consumers Aug. 1 and Dec. 31, respectively.

† Includes 5,884,495 and 9,638,605 lb. held by refiners, brokers, agents and warehousemen at places other than refineries and manufacturing establishments and 7,969,713 and 6,202,928 lb. in transit to manufacturers of lard substitute, oleomargarine, soap, etc., Aug. 1 and Dec. 31, respectively.

‡ Produced from 501,376,842 lb. crude oil.

Savings Resulting From Standardization

An intelligent program of standardization has been urged by the Department of Commerce because of the many ways in which it will benefit the manufacturer, distributor and consumer. Some of the direct gains to the manufacturer have been listed by the Fabricated Production Department of the Chamber of Commerce. Among those which apply to chemical manufacturers and dealers are included the following:

Gains to Manufacturers

1. Less capital tied up in
   - *a* Raw materials.
   - *b* Semi-finished stock.
   - *c* Finished stock.
   - *d* Manufacturing equipment.
2. More economical manufacturing through
   - *a* Larger production units.
   - *b* Longer runs.
   - *c* Simplified inspection.
   - *d* Cheaper handling of materials and stock.
   - *e* Simplified cost methods.
3. Increased efficiency of labor by
   - *a* Making personnel training more simple.
   - *b* More permanent employment.
4. Better service to trade in
   - *a* Controlling quality of product.
   - *b* Prompt delivery.
   - *c* Standardized packing.
5. More efficient sales force.
6. Fewer factory shutdowns.

Gains to Dealers

Those who handle chemical products in the wholesale markets might profit in the following ways:

1. Increased rate of turnover due to
   - *a* Elimination of slow-moving stock.
   - *b* Concentration of sales on fewer items.
2. Decreased capital invested in
   - *a* Stocks.
   - *b* Storage space.
3. Less stock depreciation and obsolescence.
4. Decreased overhead.
5. Better service to consumers.

General Asphalt Co. Shows Large Deficit

The forthcoming annual report of the General Asphalt Co. is expected to show a loss of about $1,000,000 for 1921. Although about half of this deficit is accounted for by arbitrary charges to depreciation and reserve accounts, the company has been severely affected by adverse business conditions and the fire at the Maurer, N. J., plant.

Since such unusual conditions cannot be expected to occur again, the directors of the company have seen no reason to discontinue payment of the preferred dividends and last week declared the regular quarterly dividend, payable March 1. The loss incurred in 1921 can easily be absorbed, since the profit and loss surplus at the close of 1920 amounted to over $5,000,000.

The officials of the company are more optimistic regarding business for the current year. New contracts, the resumption of road-building by states and municipalities and the promising increase in building activity are all regarded as favorable factors.

The new plant erected at Maurer, N. J., at a cost of about $3,000,000 was completed late in 1921 and has not yet had time to demonstrate the savings which will result from its greater efficiency and more modern equipment.

Industrial Reconstruction in France

The French Office for Industrial Reconstruction of the Liberated Regions has prepared a table showing the relation between productive capacity in the devastated regions at the present time and that which existed prior to the war. The percentages given for some of the principal industries are as follows:

	Production Compared With 1914 Per Cent	Labor Compared With 1914 Per Cent
Iron and steel	50	55
Other metallurgy	66	63
Chemical industries	58.5	62
Hides and leather	45	67
Textiles	53	55
Cothing	58.5	73
Mlining	31	36

The average for all industries would appear to be about one-half of the pre-war production, but it is stated that not all of the productive capacity is effective because of the present economic crisis.

Extra Dividend by Dow Company

The Dow Chemical Co. of Midland, Mich., has declared an extra dividend of 1¾ per cent on the common stock in addition to the regular quarterly dividend of the same amount. The regular quarterly dividend on the preferred stock was also declared. All dividends are payable Feb. 15 to stock of record Feb. 4.

The New York Market During January

NEW YORK, Jan. 30, 1922.

The chemical market during the past month has been something of a disappointment to those who had expected a radical improvement to follow the opening of the new year. There are a few indications, however, that the industry has been moving along the line of a gradual but rather general development. Among the outstanding features of the commodity market during January has been the steady decline in the prices of caustic soda, soda ash and the alkalis in general. However, the belief is quite commonly expressed that the bottom has been reached. The consumers have shown more attention to contracts during the past month and considerable business has been booked with the glass-making, soap and textile industries. It has been estimated that as much as 75 per cent of the regular consuming trade for alkali products is now covered by 1922 contracts.

The pronounced activity and steady demand for the prussiates has continued all during January. Yellow prussiate of potash opened at 24c. per lb. and is practically nominal on spot at about 25c. per lb. The red variety has made greater strides with a quoted advance of 3c. per lb. at the close of the month.

Another item that has been of market interest is arsenic. Leading importers who have received regular shipments from abroad have found it practically impossible to book any forward shipments for round quantities. Domestic producers are not anxious to quote at present prices, claiming the profits are too small. Opinion among large smelters is that arsenic will reach 10c. per lb. before the spring season. The opening quotation for 1922 was 6c. per lb., with a closing figure for the month of January around 7½@8c.

Linseed oil has been another commodity to show a sharp increase during the month. Opening the year at 67c. per gal. for carlots, prices reached 74c. during the past week and the market continues to be firm.

Developments of the Week

Among the developments of the week has been a decline in the spot price of caustic soda. The lower prices were due to the falling off in export orders and the producers' desires to attract additional buyers. Considerable business was recently booked to Japan, Italy and South America. Business to the Orient was seriously restricted recently by increased freight rates. Sales for export were recorded at $3.60 per 100 lb. Dealers reported a quiet movement in resale caustic at $3.50@$3.60 per 100 lb. Goods ex-store in small lots have sold up to 3¾c. per lb. Producers still maintain prices at $2.60 per 100 lb., basis 60 per cent, f.o.b. works. Exports of soda ash have been small since the beginning of the year due to English and German competition. Light ash, single bags, is moving at $1.75@$1.85 per 100 lb., depending upon the seller and quantity. Dealers are quoting barrels at $2@$2.15 per 100 lb. and report a fair movement. Producers' quotations remain at $1.35 per 100 lb. in bags and $1.55 in barrels, f.o.b. works, basis 48 per cent. Dense ash is being bought by the glass industry at 10c. per 100 lb. higher. Bichromate of soda has shown more activity of late and the market appeared steadier since the recent decline. Tanneries are inclined to buy only for immediate consumption. Prominent sellers quote 7¾c.@ 8c. per lb. on spot and the same figures were named for forward shipments. Some large contract sales have gone through for delivery over the year. Producers have reduced prices on chlorate of potash to 8c. per lb. for immediate or forward deliveries, f.o.b. works. Second hands are asking 5¾@6c. per lb. for spot imported chlorate and state that business is very quiet. Makers of formaldehyde have lowered their quotations to 10c. per lb. in barrels. This is a new low price for this chemical. Dealers generally quote the market around 10½c. per lb. for odd lots. Nickel salts are down to 11c. per lb. for both the double and single varieties. Manufacturers of cream of tartar have announced another sharp reduction and now quote 21½c. per lb. for the crystals and powdered U. S. P. Imported material is somewhat weaker on spot and sellers are openly quoting 23c. per lb. Owing to competition from the imported material, domestic makers of tartaric acid have again reduced prices and now quote 30c. per lb. Imported U. S. P. is still held at 25@26c. per lb. The prussiate of potash market is very strong and spot stocks of the red or yellow are difficult to locate. The red variety is nominally quoted at 33@34c. per lb. The yellow is held at 25@26c. Arsenic prices are very firm and makers quote 7½c. per lb. for limited amounts. The consuming demand is holding steady. Manufacturers of barium chloride sold several carlots early in the week at $50 per ton, but have retracted their figure and now quote $52 as the minimum. Importers are experiencing great difficulty in competing with American producers and ask $53 per ton for limited amounts. Prices range all the way up to $70 per ton, according to quantity and seller.

The Metal Markets

The New York metal markets have been exceedingly dull during January, and no immediate improvement is being anticipated by leading interests. Metal products will probably not experience any marked price recessions in the next few months, but all indications are that the gradual improvement which took place around the closing months of 1921 is practically at an end. Most of the large producers of copper are quoting 14c. delivered but there are few buyers at this price. Resale merchants are doing a fair business at 13¾c. on spot and second quarter delivery. The copper market on the whole was noticeably weaker owing to the fact that producers have announced the reopening of some mines and the expected early resumption of others. This has caused consumers to wait in the hope that competition would drive prices down to a lower level. The official lead price remains at 4.70c. Leading producers reported an unusually quiet week with an occasional sale noted here and there. The London price has recently declined owing to increased shipments from Australia and the possibility of imports from United States. The market on zinc continued its decline, with sales fewer and smaller in volume. The price earlier in the week was held at 4.70c. but has dropped since to 4.60c.

The Chicago Market

Chicago, Jan. 27, 1922.

Developments were lacking in the industrial chemical market during the past two weeks. A few items are showing an indication of strength, but for the greater part the list is dull and neglected. The tendency to shade prices on the part of weak holders is again in evidence, but this is having little if any disturbing effect on the market. Price reductions have proceeded to a point where it cannot be expected that further sharp reductions will be named in the near future. There are many items on the list which are now priced either at or below the pre-war levels and on the whole the prices existing at the moment are not so far from those prevailing in 1914.

General Chemicals

The alkalis are weak on spot and very little material is moving in consuming channels. Holders have announced no reductions in their schedules and are offering solid caustic soda 76 per cent at $3.75 per 100 lb. The ground 76 per cent is quoted at $4.50. It is very possible that with a firm order in view these prices would be shaded. Caustic potash is quiet and firm at 6½c. per lb. for the 88-92 per cent material. Soda ash is quoted lower by some holders and $2.30 per 100 lb. for 58 per cent material in cooperage could readily be obtained.

Potash alum is quiet, with imported lumps available at 5½@6c. per lb. and the powdered at 6@6½c. White arsenic is one of the firmest items on the list and 8c. was apparently rock bottom for spot goods. Barium chloride is in but little demand and imported white crystals are quoted at $60 per ton. Blue vitriol is moving in a fair way and is unchanged at 6c. per lb. Carbon bisulphide is quiet, with supplies available at 7@7½c. per lb. Glycerine is among the strong items and is very firm at 16½@17c. per lb. for the c.p. grade in drums.

The bichromates are moving in a routine way and apparently ample supplies are available. Potash bichromate was offered at 11¾c., which is a somewhat lower figure than has been named lately. Sodium bichromate is very firm at 9@9½c. per lb. for material of standard brand. Red prussiate of potash is very scarce and material under 34c. per lb. could not be located. Potassium permanganate was in limited request and could be had at 17c. per lb. for U.S.P. crystals. Sodium fluoride is quiet and unchanged as to price at 11@12c. per lb., according to quantity and holder. Sodium hyposulphite is quoted lower by makers, the new level for pea crystals being $3.95 per 100 lb. for single barrels.

Vegetable Oils

Linseed oil is reported to be moving very slowly to the consuming trade but fairly well to speculators. The boiled oil was offered today in 10-bbl. lots at 81c. per gal. and corresponding quantities of the raw at 79c.

Naval Stores

Turpentine is in but a very limited demand and no sales of consequence were reported today. Ten-drum lots were quoted at 92c. per gal., delivered. Rosins were reported to be moving well in carlots, but very slow in 1- or 2-bbl. quantities. The WW grade was quoted today at $9.30 per 280 lb. in less than carlots.

The Iron and Steel Market

Pittsburgh, Jan. 27, 1922.

It may be that the current demand for steel products is no lighter than the demand of a month ago, and it may even be that on the whole the demand is a trifle heavier, but it is quite certain that the situation is decidedly unsatisfactory and disappointing. There was universal expectation that January would show a very decided improvement in demand, not necessarily a new high rate on this movement, which began after the extreme depression of early July, but an improvement over the December showing, as December witnessed a distinct lull as compared with conditions in the 2 months preceding. Such expectation has been

disappointed. January is little if any better than December and it is not nearly as good as November or October.

Expressed in tonnage rate of production, which may be estimated roughly for the present time and is known fairly well for previous months, production of steel ingots now is at a rate of about 18,000,000 or 19,000,000 tons a year. This is to be compared with a rate of 23,000,000 tons in October and November and a rate of 20,000,000 tons in December, the rate at the close of December being lower, perhaps 18,000,000 tons.

No precise and satisfactory explanation of the condition of demand is obtainable. Reference to buyers being disposed to buy "from hand to mouth" is not explanatory, since there has been no time recently when buyers were in any other mood. There is no disclosed change in fundamental conditions that would make for lighter consumption of steel. Possibly the explanation is simply that actual ultimate consumption of steel always decreases in midwinter and that ordinarily the decline is covered up by mills and their customers being supplied with orders for extended delivery, so that they have momentum to carry them over the lull.

Prices Unsteady

The unsatisfactory condition of the steel market is not due alone to the volume of demand being light by comparison with conditions of 2 or 3 months ago. There is a weakness in prices that is decidedly menacing. The regular or asking prices are unchanged on the leading mill products, but concessions from these prices are much more common. Recently it required a good-sized tonnage to be offered to draw a price concession, whereas now concessions in the case of several products are made on relatively small orders. In some lines the regular prices scarcely obtain on orders for anything beyond carloads, and in the case of bars orders for less than carload lots go at what is considered the regular market, 1.50c.

Perhaps the clearest analysis of the situation is that the mills have got themselves into a tangle in their keenness to meet the situation and encourage distributors and consumers to go ahead. There is one cost per ton when a mill is running at one rate and another cost when it is running at another rate. In the effort to get a larger operation and thus reduce costs mills have given price concessions in keeping with the larger operation expected and have failed to get the higher operating rate, so in the effort to avoid losing money they may lose more money.

The market cannot proceed indefinitely on its present basis. Unless demand broadens it is quite probable that some mills will drop out of the competition. Demand, however, is certain to improve with the approach of spring.

Regular prices, which in some cases obtain only on relatively small lots, remain as follows: Bars, shapes and plates, 1.50c.; standard steel pipe, 71 per cent basing discount; plain wire, 2.25c.; wire nails, $2.50; blue annealed sheets, 2.25c.; black sheets, 3c.; galvanized sheets, 4c.; tin plate, $4.75. The sheet prices are maintained absolutely, so far as can be observed. The tin plate price is maintained as well as is usually the case. In wire products the chief weakness is that some districts have local markets of their own, having departed from Pittsburgh basing. Hoops are easier, 1.90c. being done sometimes instead of 2c. while hot-rolled strip has gone as low as 1.75c.

Pig Iron and Coke

A lot of 1,000 tons of basic pig iron has been bought by a Pittsburgh consumer at a delivered price equivalent to $17.75 valley, but this was resale iron, sold by a middleman, and does not make the market. On the inquiry valley furnaces quoted $18 valley, against the former nominal market of $18.25. Foundry iron is off 50c., the Standard Sanitary Manufacturing Co. having bought 500 tons from each of two valley producers at $19. Bessemer is unchanged. The market is now quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

Connellsville coke for spot shipment continues soft, with furnace coke obtainable in small lots at $2.75 and foundry ranging from $3.75@$4.25.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 40 – $0 42
Acetone	lb.	$0 12½ – $0 12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	.12½ – .12¾	.13 – .13½
Boric, powder	lb.	.12¾ – .13	.13¾ – .14
Citric	lb.	..... –	.43 – .44
Hydrochloric	100 lb.	1 50 – 1 60	1 65 – 2 00
Hydrofluoric, 52 per cent	lb.	.12½ – .12¾	.13 – .13½
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06¼ – .06½	.06¾ – .07
Nitric, 42 deg	lb.	.06¾ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.14 – .14½	.14¾ – .15½
Phosphoric, 50 per cent solution	lb.	.10 – .10½	.10¾ – .11½
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	..... –	11 00 – 12 00
Sulphuric, 60 deg., drums	ton	..... –	13 00 – 15 00
Sulphuric, 66 deg., tank cars	ton	16 50 – 17 00	..... – .....
Sulphuric, 66 deg., drums	ton	21 00 – 22 00	22 50 – 23 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21 00 – 22 00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23 00 – 23 50	24 00 – 24 50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	..... –	.65 – .75
Tannic (tech.)	lb.	.45 – .50	.51 – .55
Tartaric, imported crystals	lb.	..... –	.24 – .25
Tartaric acid, imported, powdered	lb.	..... –	.25 – .26
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1 00 – 1 10
Alcohol, ethyl	gal.	..... –	4 75 – 5 50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.41 – .42
Alcohol, denatured, 190 proof	gal.	..... –	.43 – .44
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¾ – .04	.04¼ – .04½
Alum, chrome lump	lb.	.07½ – .08	.08¼ – .08½
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02¼ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.07 – .07¼	.07½ – .08
Amylacetate tech.	gal.	..... –	2 00 – 2 40
Arsenic, white, powdered	lb.	.07½ – .07¾	.07¾ – .08¼
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	52 00 – 53 00	55 00 – 70 00
Barium dioxide (peroxide)	lb.	.21 – .21½	.22 – .23
Barium nitrate	lb.	.06½ – .07	.07¼ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55 00	..... – .....
Bleaching powder	100 lb.	2 25 – 2 35	2 40 – 3.25
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .06	.06¼ – .07
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.20 – .21	.21½ – .26
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	23 00 – 24 00	24 50 – 28 00
Calcium chloride, granulated	lb.	.01¼ – .02	.02¼ – .02½
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.92 – .95
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07¼
Carbon tetrachloride, drums	lb.	.10½ – .10¾	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.03¾ – .04	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03¼ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04 – .04½	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.38 – .40
Cobalt oxide	lb.	..... –	2 00 – 2.10
Copperas	ton	15 00 – 16 00	16 50 – 20 00
Copper carbonate, green precipitate	lb.	.20 – .20½	.21 – .21½
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5 60 – 5 65	5 70 – 6 25
Cream of tartar	lb.	..... –	.23 – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.58 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – .....
Formaldehyde, 40 per cent	lb.	.10 – .10½	.10¾ – .11¼
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32 00	..... – .....
Fusel oil, ref.	gal.	..... –	2 50 – 3 00
Fusel oil, crude	gal.	..... –	1 50 – 1 75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16½ – .17
Iodine, resublimed	lb.	..... –	3 80 – 3 90
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.10¾ – .12½
Lead arsenate, powd.	lb.	.15 – .15½	.15¾ – .16¾
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2 65 – 2 70	2 75 – 3 00
Magnesium sulphate, technical	100 lb.	..... –	1 05 – 1 80
Methanol, 95%	gal.	..... –	.60 – .62
Methanol, 97%	gal.	..... –	.63 – .64
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½

		Carlots	Less Carlots
Phosgene (see carbony. chloride)		—	—
Phosphorus, red	lb.	.45 — .46	.47 — .50
Phosphorus, yellow	lb.	— —	.30 — .35
Potassium bichromate	lb.	.10 — .10¼	.10½ — .11
Potassium bromide, granular	lb.	— —	.14 — .18
Potassium carbonate, U. S. P.	lb.	.11¾ — .12	.12½ — .15
Potassium carbonate, 80–85%	lb.	.04½ — .04¾	.05 — .06
Potassium chlorate, crystals	lb.	.05½ — .06	.06¼ — .08
Potassium cyanide	lb	— —	.43 — .45
Potassium hydroxide (caustic potash)	lb.	.06 — .06¼	.06½ — .06¾
Potassium iodide	lb.	— —	2.90 — 3.00
Potassium nitrate	lb.	.07¼ — .07½	.08 — .09
Potassium permanganate	lb.	.14 — .15	.16 — .22
Potassium prussiate, red	lb.	.33 — .33½	.33½ — .34½
Potassium prussiate, yellow	lb.	.25 — .25½	.25¼ — .26½
Rochelle salts (see sodium potas tartrate)		— —	— —
Salammoniac, white, granular	lb.	.06¼ — .06¼	.07 — .07½
Salammoniac, gray, granular	lb.	.06½ — .06½	.07 — .07½
Sal soda	100 lb.	1.65 — 1.75	1.80 — 2.00
Salt cake (bulk)	ton	17.00 — 20.00	— —
Soda ash, light	100 lb.	1.75 — 2.00	2.05 — 2.40
Soda ash, dense	100 lb.	1.85 — 1.90	1.95 — 2.40
Sodium acetate	lb.	.04 — .04¼	.04½ — .05
Sodium bicarbonate	100 lb.	2.20 — 2.25	2.30 — 2.75
Sodium bichromate	lb.	.07¼ — .08	.08¼ — .08½
Sodium bisulphate (nitre cake)	ton	4.50 — 4.60	4.65 — 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ — .04¾	.05 — .05½
Sodium chlorate	lb.	.06¼ — .06¼	.07 — .07½
Sodium chloride	long ton	12.00 — 13.00	— —
Sodium cyanide	lb.	.26 — .26½	.26½ — .27
Sodium fluoride	lb.	.10½ — .11	.11½ — .12
Sodium hydroxide (caustic soda)	100 lb.	3.60 — 3.70	3.75 — 4.20
Sodium hyposulphite	lb	— —	.03½ — .03¾
Sodium nitrite	lb.	.06½ — .06¾	.07 — .07½
Sodium peroxide, powdered	lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic	lb.	.04½ — .04½	.04¾ — .05½
Sodium potassium tartrate (Rochelle salts)	lb.	— —	.19 — .21
Sodium prussiate, yellow	lb.	.17 — .17½	.17¾ — .17¾
Sodium silicate, solution (40 deg.)	100 lb.	1.00 — 1.05	1.10 — 1.30
Sodium silicate, solution (60 deg.)	100 lb.	2.25 — 2.40	2.45 — 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.25 — 1.30	1.35 — 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ — .04½	.04¾ — .05
Sodium sulphite, crystals	lb.	.03½ — .03⅝	.03¾ — .04¼
Strontium nitrate, powdered	lb.	.10 — .11	.11½ — .15
Sulphur chloride, red	lb.	.05½ — .05½	.05¾ — .06
Sulphur, crude	ton	18.00 — 20.00	— —
Sulphur dioxide, liquid, cylinders extra	lb.	.08 — .08½	.09 — .10
Sulphur (sublimed), flour	100 lb.	— —	2.25 — 3.10
Sulphur, roll (brimstone)	100 lb.	— —	2.00 — 2.75
Talc—imported	ton	30.00 — 40.00	— —
Talc—domestic powdered	ton	18.00 — 25.00	— —
Tin bichloride	lb.	.09 — .09½	.09½ — .10
Tin oxide	lb.	— —	.39 — .40
Zinc carbonate	lb.	.15 — .15½	.15½ — .16
Zinc chloride, gran	lb.	.08 — .08½	.08¾ — .09
Zinc cyanide	lb.	.42 — .44	.45 — .47
Zinc dust	lb.	.11½ — .11½	.11¾ — .12½
Zinc oxide, XX	lb.	.08 — .08¼	.08¾ — .09
Zinc sulphate	100 lb.	3.00 — 3.25	3.30 — 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.15 — 1.20
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.25 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.35 — 1.45
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.27 — .29
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.30 — .32
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.24 — .26
Cresylic acid, 97–99%, straw color, in drums	gal.	.65 — .70
Cresylic acid, 95-97%, dark, in drums	gal.	.60 — .65
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.90 — 1.05
Dimethylaniline	lb.	.40 — .45
Dinitrobenzene	lb.	.21 — 25
Dinitroclorbenzene	lb.	.25 — 27
Dinitronaphthalene	lb.	.32 — 35
Dinitrophenol	lb.	.38 — .40
Dinitrotoluene	lb.	.25 — 30
Dip oil, 25%, car lots, in drums	gal.	.31 — 35
Dipnenylamine	lb.	.60 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	1.05 — 1.10
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.25 — 1.30
Naphthalene crushed, in bbls	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — .08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.30 — 1.35
Para-amidophenol, HCl	lb.	1.50 — 1.55
Para-dichlorbenzene	lb.	.17 — 18
Paranitroaniline	lb	.77 — .80
Para-nitrotoluene	lb.	70 — 75
Para-phenylenediamine	lb.	1.60 — 1.65
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb	.37 — .40
Phenol, U. S. P., drums	lb.	.12 — 16
Pyridine	gal.	1.75 — 2.75
Resorcinol, technical	lb.	1.40 — 1.50
Resorcinol, pure	lb.	2.00 — 2.25
Salicylic acid, tech., in bbls	lb.	.20 — 21
Salicylic acid, U. S. P.	lb.	.23 — .24
Salol	lb.	.75 — .77
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — 28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — 16
Sulphanilic acid, crude	lb.	.26 — 28
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.32 — 38
Toluene, in tank cars	gal.	.25 — 28
Toluene, in drums	gal.	.30 — 35
Xylidines, drums, 100 gal.	lb.	.40 — 45
Xylene, pure, in drums	gal.	.40 — 45
Xylene, pure, in tank cars	gal.	.45 —
Xylene, commercial, in drums, 100 gal.	gal.	.33 — 35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.24 — .25
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.34 — .38
Candellila wax	lb.	.24 — .25
Carnauba, No. 1	lb.	.45 — .46
Carnauba, No. 2, North Country	lb.	.23 — .23½
Carnauba, No. 3, North Country	lb.	.14½ — .15
Japan	lb.	.19 — .20
Montan, crude	lb.	.04½ — .05
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ — 04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — 03¼
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04¾
Paraffine waxes, refined, 133-135 m.p.	lb.	.04¾ — .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05¼ — 05½
Stearic acid, single pressed	lb.	.09½ —
Stearic acid, double pressed	lb.	.09½ —
Stearic acid, triple pressed	lb.	.10½ — .10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.40 —	5.45
Rosin E-I	280 lb.	5.50 —	5.55
Rosin K-N	280 lb.	6.15 —	6.90
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.93 —	....
Wood turpentine, steam dist	gal.	.91 —	....
Wood turpentine, dest. dist	gal.	.90 —	....
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	$2.30 —	2.60
Blood, dried, f.o.b., N. Y	unit	3.75	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.37 —	2.40
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	33.00 —	34.00
Potassium sulphate	unit	1.00 —	

Crude Rubber

Para—Upriver fine	lb.	$0.21½ —	21½
Upriver coarse	lb.	.13 —	13½
Upriver caucho ball	lb.	.12¼ —	12½
Plantation—First latex crepe	lb.	.17½ —	17¾
Ribbed smoked sheets	lb.	.17½ —	17¾
Brown crepe, thin, clean	lb.	.14 —	....
Amber crepe No. 1	lb.	.16⅔ —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13¼ —	.13½
Coconut oil, Ceylon grade, in bbls	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls.	lb.	.09⅜ —	.10
Corn oil, crude, in bbls.	lb.	.08¾ —	.08½
Cottonseed oil, crude (f. o. b. mill)	lb.	.07¼ —	.07½
Cottonseed oil, summer yellow	lb.	.09 —	.09¼
Cottonseed oil, winter yellow	lb.	.09½ —	.10
Linseed oil, raw, car lots (domestic)	gal.	.74 —	.74½
Linseed oil, raw, tank cars (domestic)	gal.	.69 —	.70
Linseed oil, in 5-bbl lots (domestic)	gal.	.77 —	78
Olive oil, denatured	gal.	$1.15 —	$1.20
Palm, Lagos	lb.	.08¼ —	.08¼
Palm, Niger	lb.	.06¼ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07½ —	.07¾
Peanut oil, refined, in bbls.	lb.	.10½ —	.11
Rapeseed oil, refined in bbls.	gal.	.83 —	.84
Rapeseed oil, blown, in bbls.	gal.	.87 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 —	....

FISH

Light pressed menhaden	gal.	$0.45 —	....
Yellow bleached menhaden	gal.	48 —	....
White bleached menhaden	gal.	.47 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise States

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$23.00 —	23.50
Barytes, ground, off color, f.o.b. Kings Creek	net ton	15.00 —	17.00
Barytes, crude, 88% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude, first grade, Missouri	net ton	6.00 —	7.00
Casein	lb.	.15 —	.16
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50 —	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	12.00 —	20.00
China clay (kaolin), imported, powdered	net ton	25.00 —	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00 —	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00 —	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00 —	....
Graphite, Ceylon lump, first quality	lb.	.05½ —	.06½
Graphite, Ceylon chip.	lb.	.04 —	.05
Graphite, high grade amorphous crude	lb.	.00½ —	.02¼
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00 —	....
Kieselguhr, f.o.b. N. Y.	per ton	55.00 —	60.00
Magnesite, calcined	per ton	50.00 —	65.00
Pumice stone, imported	lb.	.03 —	.40
Pumice stone, domestic, lump	lb.	.05 —	.05½
Pumice stone, domestic, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.68 —	.70
Shellac, orange superfine	lb.	.71 —	.72
Shellac, A. C. garnet	lb.	.58 —	.60
Shellac, T. N.	lb.	.65 —	.66
Soapstone	ton	12.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50 —	11.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton		$50.00
Carborundum refractory brick, 9-in.	less than carlot	1,000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton		41–44
Chrome cement, 40-50% Cr_2O_3	net ton		30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton		33–35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		35–40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000		30–35
Magnesite brick, 9-in. straight	net ton		65–70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000		38–40
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000		40–42
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000		30–33

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6–8% carbon, carlots	lb.	.11½—	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 76-80% Mn, Foreign, c. i. f. Atlantic seaport	gross ton	54.00 —	58.35
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00 —	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	21.00 —	22.00
Coke, foundry, f.o.b. ovens	net ton	3.50 —	3.75
Coke, furnace, f.o.b. ovens	net ton	2.75 —	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24 —	....
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.48 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport.	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size. c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½—	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.45
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	33.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	30.875
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375–4.40
Zinc, spot, New York	5.05
Zinc, spot, E. St. Louis	4.60

OTHER METALS

Silver (commercial)	oz.	$0.65⅜
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.85@1.95
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	105.00
Iridium	oz.	170.00@200.00
Palladium	oz.	60.00–65.00
Mercury	75 lb.	48.00–49.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.25
Copper bottoms	28.75
Copper rods	19.75
High brass wire	17.45
High brass rods	14.75
Low brass wire	18.75
Low brass rods	19.25
Brazed brass tubing	25.50
Brazed bronze tubing	30.50
Seamless copper tubing	21.25
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.75
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. aref or structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.63	$2.78	$2.78
Soft steel bars	2.53	2.68	2.68
Soft steel bar shapes	2.53	2.68	2.68
Soft steel bands	3.13	3.28	3.28
Plates, ¼ to 1 in. thick	2.63	2.78	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

PYRITON—John Boyd, R.F.D. No. 2, and associates are planning for the establishment of a new local plant for the production of commercial mica. Grinding and other machinery will be installed.

TUSCALOOSA—Officials of the local Chamber of Commerce are considering the establishment of a brick-manufacturing and clay-working plant. A company will be organized to operate the works.

California

LONG BEACH—The Long Beach Milling Co., 1058 Appleton St., has disposed of its plant site and plans for the erection of a new flour mill on property recently acquired on Willowville Ave., near American Ave., 300 x 300 ft. The new plant will include a number of work buildings in addition to the main mill. E. I. Harnett is president.

Connecticut

MIDDLETOWN—The Mohawk Mfg. Co., Waterbury, manufacturer of brass products, has purchased the factory of W. E. Stroud on College St., 50 x 100 ft., and will equip the structure for a new plant. Later an addition will be constructed.

Florida

MIAMI—The Dixie Rubber Co., Memphis, Tenn., is considering the erection of a new branch plant at Miami, estimated to cost about $250,000, including machinery. L. C. Cadenhead is president.

CANAL POINT—The Florida Sugar & Food Products Co. is planning for the early occupancy and operation of its new local plant building, designed to increase the sugar mill output by about 400 tons a day.

Georgia

SAVANNAH—The Gulf Refining Co., Port Arthur, Tex., is planning for the construction of a new oil storage and distributing plant on Hutchinson Island, near Savannah, with capacity of about 55,000 bbl., doubling the present facilities. The work is estimated to cost about $100,000.

Illinois

CHICAGO—The Garden City Paint & Varnish Co., Troy and 25th Sts., has awarded a contract to Frederick Marz, 1515 South Austin Ave., for the erection of a 2-story top addition to its plant, 52 x 75 ft. Work will be commenced at an early date.

CHICAGO—The Niagara Radiator & Boiler Co., Tonawanda, N. Y., has construction well under way on a new foundry at 1101-13 East 83rd St., Chicago, and will occupy the structure at an early date. It will be 1-story, 130 x 400 ft., with other departments devoted to machine shop operations.

Indiana

MUNCIE—The Ball Brothers Mfg. Co., manufacturer of glass jars, etc., has broken ground for the erection of a new 2-story plant addition, 90 x 300 ft., to cost about $100,000. A portion of the structure will be used for general manufacturing and the remainder for storage purposes. A. Kibele, Johnson Bldg., is architect.

JONESBORO—The Indiana Rubber Co., First and Pearl Sts., will take bids early in the spring for the erection of its proposed 3-story plant addition, 60 x 125 ft. Plans have been drawn.

HUNTINGTON—The Huntington Chemical Co. is planning for the installation of new extraction and other equipment at its plant. A bond issue will be arranged to provide funds for the improvement. Fred H. Bowers is president, and J. L. Brenn, secretary.

Louisiana

ALEXANDRIA—The Adam Brick Co., recently organized with a capital of $50,000, has acquired the local plant of C. N. Adams, and in the future will operate the property. J. H. Johnson is president and W. D. Hill, secretary and treasurer.

Maryland

BALTIMORE — The Spanish-American Cork Products Co., Westport, near Baltimore, is planning to call for bids early in the spring for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about $40,000. Plans will be prepared at once. O. J. Harms is president.

Massachusetts

WALPOLE—Bird & Son, Inc., manufacturer of prepared paper roofing, has awarded a contract to the M. W. Allen Construction Co., Walpole, for the erection of a 1-story addition, to be used as a paper machine department.

Missouri

JOPLIN—The Joplin Zinc Products Co., will take bids during February for the construction of a new rolling mill. It is planned also to construct a plant for the manufacture of zinc roofing shingles. R. E. Love, 1531 East 7th St., Joplin, is architect.

KANSAS CITY—The Barnsdall Refining Co. has plans under way for extensions to the blending plant at its local oil refinery, formerly operated by the Plains Oil Co.

New Hampshire

NEWINGTON—Fire, Jan. 16, caused by an explosion, destroyed a portion of the plant of the Atlantic Dyestuffs Co., including equipment, chemicals, etc. The greatest damage was done to Bldg. No. 2. An official estimate of loss has not been made.

New Jersey

BOGOTA—The Bogota Paper & Board Co. will commence the immediate erection of a new 1-story mill addition. A power house will also be constructed. The work is estimated to cost about $42,000. Contract for the buildings has been let to the Austin Co., 217 Broadway, New York, N. Y.

NEWARK—The Orbis Products Trading Co., Wyckoff Ave., Brooklyn, N. Y., manufacturer of chemicals, oils, etc., has acquired property on Frelinghuysen Ave., extending to Virginia St., Newark, totaling about 4 acres, for the erection of a new plant. The works will consist of a series of buildings, and will be used for the distillation of essential oils and chemicals, the installation to comprise a number of mills for the grinding of gums and drugs, and auxiliary machinery. The entire plot will be utilized for the plant, plans for which will be placed under way at once.

WOODSTOWN—The South Jersey Farmers' Exchange is planning for the rebuilding of its fertilizer works, recently destroyed by fire with loss estimated at close to $150,000. Asa Moore, Mullica Hill, N. J., is president.

NEW BRUNSWICK—The Atriken Chemical Works, New Brunswick, N. J., have leased three 1-story buildings, forming part of the plant of the Hewes & Phillips Iron Works, recently dissolved, at 12-22 Orange St., Newark, and will remove its present plant to this location. Possession will be taken at once and necessary remodeling placed under way.

JERSEY CITY—The Baker Castor Oil Co., Bay St., has filed plans for the erection of a new 2-story plant at 80 Morgan St., estimated to cost about $25,000. Work will be commenced at once.

BRIDGETON—The Cumberland Glass Mfg. Co., manufacturer of glass bottles, jars, etc., has awarded a contract to Keeley Bros., Bridgeton, for the construction of a new plant on Laurel St., consisting of a number of 1-story buildings, estimated to cost in excess of $1,000,000, including machinery.

KEARNY—The plant of the Stern Rendering Co., River Rd., was destroyed by fire Jan. 19, with loss estimated at about $300,000, including buildings equipment, etc. Louis Stern is head.

New York

LONG ISLAND CITY—The Egan & Hausman Co., Inc., 476 Clinton Ave., Brooklyn, manufacturer of colors, etc., has awarded a contract to Levering & Garrigues Co., 552 West 23rd St., for the erection of a new 2-story plant, 50 x 100 ft., at Bodine and Hamilton Sts., Long Island City, estimated to cost about $25,000. Work will be commenced at once.

NEW YORK—The Hydro-Bar Waterproofing Co. has acquired the 3-story building at 356 First Ave., now occupied, and the adjoining 4-story building at 404 East 21st St., for expansion.

NEW YORK—The Chile Copper Co., 120 Broadway, has preliminary plans under consideration for extensions in its plant to increase the output from 15,000 to 35,000 tons a day. The work will be commenced as soon as conditions warrant.

North Carolina

GREENSBORO—The Pomona Terra Cotta Co., has commenced the erection of a new factory, to be known as Plant No. 4. It will consist of a number of buildings, with main structure, 70 x 225 ft. Other structures will approximate 30 x 50 ft. A total of 8 new kilns will be installed at the plant, each about 36 ft. in diameter. W. C. Boren, Jr. is secretary and treasurer.

ALBEMARLE—The City Council is having plans prepared for enlargements in the filtration plant at the municipal waterworks. Gilbert C. White, Durham, N. C., is consulting engineer.

WINSTON-SALEM—George D. Hodgin, Winston-Salem, is planning for the construction of a new brick- and tile-manufacturing plant on site now owned at Daisy, near Winston-Salem.

Ohio

WARREN—The K. W. Brick Co., 607 Home Savings & Loan Bldg., Youngstown, O., will soon commence the erection of a new brick manufacturing plant at Warren, to be 1- and 2-story, 70 x 150 ft., and estimated to cost about $30,000. J. Whittaker is president.

Oklahoma

OKLAHOMA CITY—The Process Refining Co., recently organized with headquarters at Oklahoma City, has acquired the plant of the Pirtle-Pittman Refining Co., at Newkirk, Okla. A number of improvements will be made to the refinery, including the installation of a new refinery process. A. C. Heiden is vice-president; and C. H. Hyde, secretary and treasurer.

HENRYETTA—The Harper Oil & Refining Co., recently incorporated with a capital of $200,000, has commenced excavations for a new oil refinery, on property purchased in the southwestern section of the city. A 10-acre tract of land has been secured for the plant, which will have an initial capacity of about 1,000 bbl. per day. J. P. Harper is president, and E. D. Ham, secretary.

ARDMORE—The Choctaw Oil & Milling Co. is said to be planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at about $40,000.

Pennsylvania

OIL CITY—The Oil Well Supply Co. will install a large electric steel furnace in one of the new buildings now being erected at the plant.

PHILADELPHIA—The Glenwood Industrial Distilling Co. has taken title to the 1-story and basement building on Cedar St., near Tioga St., and will use the property for a local works. It was obtained for a consideration said to be $38,000.

PITTSBURGH—Bethlehem Laboratories, Inc., a $5,000,000 corporation, has been organized here to manufacture a new antiseptic known as Hyclorite, possessing 175 times germicidal strength of hydrogen peroxide. Among incorporators are Homer D. Williams, president of Carnegie Steel; Taylor Allerdice, vice-president of National Tube; and Dr. J. J. Reilly, surgeon, United States Shipping Board. Plans include construction of modern chemical plant here.

Rhode Island

CRANSTON—Fire recently destroyed a portion of the local plant of the Graphite Mines Corp., with loss estimated at about $100,000, including buildings, equipment and stock.

Tennessee

DAYTON—The Dixie Coal, Lime & Clay Products Co., recently organized with a capital of $750,000, O. E. Thomas, Dayton,

president, has plans under way for the erection of a large brick- and tile-manufacturing plant at Graysville, eastern Tennessee district, where extensive propery has been secured. The initial works will have a capacity of 50,000 bricks per day, with departments for tile and stoneware manufacture. The company is planning also for the construction of a hydrated lime-producing plant, with initial capacity of about 50 tons daily.

Texas

THREE RIVERS—J. E. Jarrett and C. H. Kearney, Three Rivers, are organizing a company for the construction and operation of a local plant for the manufacture of glass products. Plans will be prepared at an early date.

LAREDO—The Kirk Refinery Co., San Antonio, has construction under way on a new plant at Laredo, for the manufacture of lubricating oils. The company has secured a site near the shops of the Texas-Mexican Railway Co. The refinery will have an initial output of about 1,200 bbl. per day, and will handle crude oil from the Mirando oilfield. E. W. Kirkland, San Antonio, is president; and R. B. Thomas, Tulsa, Okla., secretary and treasurer.

DALLAS—The Davis Mfg. Co., Knoxville, Tenn., manufacturer of chemical products, has completed plans for the erection of a new branch plant at Dallas, to be 3-story, and estimated to cost about $50,000. Contract will be let and the work commenced at an early date. Grover C. Davis is president and general manager.

YOAKUM—The Texas Hide & Leather Co., is planning for the erection of an addition to its plant for sole leather and other leather manufacture. The company is arranging for an increase in capitalization to $200,000. J. B. Harris is manager.

Washington

SPOKANE—The Bentley Paste Co., Minneapolis, Minn., has commenced work on a new branch plant at Spokane, for the manufacture of paste and kindred products. It will be ready for service at an early date.

West Virginia

NITRO—The Rubber Service Laboratories Co., Akron, O., has acquired a site at Nitro, for the construction of a new plant for the manufacture of chemical and affiliated products, to be used in connection with rubber vulcanizing work. Carl N. Hand, Nitro, is local representative for the company.

New Companies

THE K. S. T. NOVELTY CO., New York, N. Y., has been incorporated with a capital of $400,000, to manufacture celluloid and composition products. The incorporators are M. Grehman and I. Siper. The company is represented by J. G. Kremer, 233 Broadway, New York.

KNELLER, VAUGHN & CO., INC., New Haven, Conn., has been incorporated with a capital of $50,000, to manufacture liquid metal cleaners and other chemical products. The incorporators are Charles S. Vaughn, Henry S. Kneller and Frank H. Kasperson, 332 Norton St., New Haven.

THE HARBOR PRODUCTS CO., Carlstadt, N. J., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are J. F. C. Grow, H. G. Boardman and Frederick L. Locke, Carlstadt.

THE M. S. CHEMICAL CO., 1131 Stevens Bldg., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture carbon removers, cleansers and other chemical products. The incorporators are Milton L Smith, Norman H. Pritchard and William P. McCracken, Jr.

THE GULF & REFINERS' CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $1,000,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York

THE SAN-NOX CHEMICAL CO., Birmingham, Ala., has been organized under state laws to manufacture chemicals and chemical byproducts. James Johnson is president; J. G. Dickinson, vice-president; and H. H. Smithcon, secretary and treasurer, all of Birmingham.

THE BRUCE MARVIN CHEMICAL CO., Boston, Mass., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. Joseph A. Conway is president, and Joseph J Crotty, 185 Columbus Ave., Boston, treasurer.

THE F. E. M. MFG. CO., New York, N. Y. has been incorporated with a capital of $10,000, to manufacture chemicals and affiliated products. The incorporators are J. Baker, J. Levy and I. Kaplan. The company is represented by A. E. Schwartz, 140 West 42nd St., New York.

THE ILLINDA OIL CO., Breckenridge, Tex., has been incorporated with a capital of $350,000, to manufacture petroleum products. The incorporators are G. E. Stocking, W. E. Bowler and Fred Phipps, all of Breckenridge.

THE UNIVERSAL CHEMICAL CO., Wilmington, Del., has been incorporated under state laws with capital of $1,000,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE BAYONNE STEEL PRODUCTS CO., Bayonne, N. J., has been incorporated with a capital of $250,000, to manufacture steel and other metal products. The incorporators are Harry B. and Charles H. Dembe, 216 Jelliff Ave., Newark, N. J.

THE JAMES H. COOPER CO., INC., Westborough, Mass., has been incorporated with a capital of $50,000, to manufacture leather products. James R. Cooper, 11 Beach St., Westborough, is treasurer.

THE CONTINENTAL CERAMICS CORP., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture pottery and other ceramic products. The incorporators are W. S. McKay, L. E. Hellman and V. I. Weldon. The same incorporators have also formed the ROSENTHAL CHINA CORP., with capital of $10,000, to manufacture and deal in chinaware. Both companies are represented by S. F. Hartman, 120 Broadway, New York.

THE SAVANNAH CHEMICAL CO., Savannah, Ga., has been incorporated under state laws to manufacture chemicals and chemical byproducts. The incorporators are George L. Groover and W. B. Stratford, both of Savannah.

THE SEA LEATHER & OIL CORP., Caldwell, N. J., has been incorporated under Delaware laws with capital of $6,300,000, to manufacture leather products, oils and affiliated specialties. The incorporators are Frank C. Myers, Caldwell; Charles W. Owen, Hackensack, N. J.; and Robert Strange, Orange, N. J. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE NEWTON CHEMICAL CO., Newton, Mass., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. Charles G. Pickett is president; and William Hahn, Newton Centre, Mass., treasurer.

THE CARBON DIOXIDE PLANT FOOD CO., St. Augustine, Fla., has been organized under state laws to manufacture fertilizer products. W. B. Guy is president; Robert Ranson, vice-president; and R. D. Crawley, secretary and treasurer, all of St. Augustine.

IRELAND & HOLMES, INC., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture pulp and paper products. The incorporators are W. H. Holmes, C. H. Ireland and K. C. Newman, 38 Park Row, New York.

THE AMERICAN OIL CO., fourteenth floor, American Bldg., Baltimore, Md., has been incorporated with a capital of $2,250,000, to manufacture petroleum products. The incorporators are Louis and Jacob Blaustein, and Alvin Thalheimer.

THE CALCO CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are R. C. Jeffcott, G. A. Berry and W. G. Heath. The company is represented by S. C. Morehouse, attorney, New Haven, Conn.

THE EVANSVILLE PAINT & VARNISH CO., Evansville, Ind., has been incorporated with a capital of $50,000, to manufacture paints, varnish, etc. The incorporators are H. D. Bourland, Arthur C. Heberer and E. L. Fowler, all of Evansville.

THE PLYMOUTH RUBBER CO., Canton, Mass., has been incorporated with a capital of $150,000, to manufacture rubber products. Maurice J. Hamilburg is president; and Reuben B. Gryzmish, 70 Marshall St., Boston, treasurer.

THE NO RUB AUTO POLISH CO., Newark, N. J., has filed notice of organization to manufacture polishes and other chemical products. Joseph Lardiere, 132 Summer Ave., heads the company.

THE FRIENDS OIL CO., Wilmington, Del., has been incorporated under state laws with capital of $100,000, to manufacture petroleum products. The company is represented by the Corporation Service Co., Wilmington.

Capital Increases, etc.

THE TIDAL OSAGE OIL CO., Tulsa, Okla., has filed notice of increase in capital from $52,000,000 to $102,000,000.

THE MATTHIESSEN & HEGELER ZINC CO., La Salle, Ill., has filed notice of a reduction in capitalization from $426,000 to $310,000.

THE EASTERN MFG. CO., Lincoln, Me., manufacturer of bleached sulphite pulp and paper products, has disposed of a bond issue of $2,500,000, for financing, general operations, etc. Stuart W. Webb is chairman of the board.

THE TODD SALT CO., 409 East 8th St., New York, N. Y., has filed notice of increase in capital to $40,000.

THE HAWK OIL CO., Tulsa, Okla., has filed notice of change of name to the Wrightsman Petroleum Co. The company is organized under Delaware laws.

THE UNION SOAP CO., 214 North Pearl St., Baltimore, Md., has filed notice of reduction in capital from $50,000 to $12,000.

Frederick J. Telovitz has been appointed receiver for the GOODWEAR LEATHER MFG. CO., INC., Raritan, N. J.

THE ALBIAN OIL CO., Tulsa, Okla., has filed notice of increase in capital from $12,000 to $250,000.

THE DERBY DOME-WYOMING OIL CO., St. Louis, Mo., has filed notice of increase in capital from $50,000 to $1,500,000.

THE GUANTANAMO SUGAR CO., 129 Front St., New York, N. Y., has arranged for a new preferred stock issue to total $1,500,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN SOCIETY FOR STEEL TREATING, sectional meeting, Friday, March 3, Engineering Societies' Building, New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

NORTHWEST MINING ASSOCIATION will hold a convention in the Chamber of Commerce Bldg., Spokane, Wash., Feb. 14 to 18.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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Industrial Editor

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

R. S. McBRIDE
A. E. BUCHANAN JR.
CHARLES N. HULBURT
Assistant Editors
J. S. NEGRU
Managing Editor

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Bootlegging in Chemical Apparatus

THERE are a few fly-by-night concerns that claim to be "just starting out in business" that have, of late, been diligent visitors at laboratories of schools and colleges to offer chemical apparatus. They rarely have catalogs of their own, but refer to those of established dealers under specific numbers to indicate their wares. Their prices are low; enough below current quotations to get a hearing.

Now we sympathize with institutions of learning in their desire to get scientific apparatus as cheaply as they can, although we are not in favor of duty-free materials for them. We have the glass and porcelain industries well established in this country and we want to keep them. It has been suggested that universities, colleges and schools should get their laboratory equipment at approximately cost prices, but we are told that the educational demand represents about 80 per cent of the total. To sell 80 per cent of their goods at cost and then to make their living out of the remaining 20 per cent would be asking too much from the manufacturers and dealers. They are not fashionable physicians.

The Just Starters in the business of selling chemical apparatus, to whom we refer, are likely to be sympathetically received because of their low prices. Then when they make a sale, being so young and all, and having such a "slight margin of profit," they often ask for a considerable cash payment in advance. When the shipment comes in it turns out to be job lots of German and Japanese goods that are below the standards of quality maintained by reputable concerns. In the meantime the Just Starters lose interest as soon as they have disposed of their bargains and then are difficult to find. We are told that one large state university was seriously embarrassed by this very kind of a trick.

The late CHARLES BASKERVILLE, most of whose students were far from affluent, and who had to purchase with great care to keep within his appropriations, insisted on American-made goods and would deal only with established concerns. His point was that the need of these industries in America was greater and of more importance than his own personal convenience.

But whatever apparatus be purchased, whether American-made or imported, the only safe rule for colleges and universities is to buy from well-established and responsible houses. Just now when most things are at sixes and sevens and the prices of all sorts of merchandise seem to have no top and no bottom, the irregular dealer is abroad in the land. The wise buyer deals with a seller who has both experience and character and a responsible house behind him. Job lots of laboratory wares from unknown sources may cost less to buy, but they are likely to drag a trail of increased expense behind them, not only in work but occasionally a human eye into the bargain.

Ford's Offer Up to Congress

NEARLY seven months has elapsed since Mr. FORD made his first offer to purchase the power and nitrate plants at Muscle Shoals. This was formally presented to Secretary WEEKS on July 8, 1921, and was the basis of subsequent negotiations that resulted in a modified offer signed by Mr. FORD on January 25, 1922. The latter has now been transmitted to Congress by the Secretary of War with his recommendations and a careful business analysis of the entire proposal. The matter is now up to Congress.

Mr. WEEKS' analysis of the Ford proposal presents such a clear picture of the subject that we have reproduced it in whole in this issue, believing that our readers will be interested in getting more detail than was published in the daily press. For the final disposition of Muscle Shoals will have a tremendous bearing on the future of the fertilizer industry in this country, as well as on the whole industrial development of the South. In our last issue we pointed out some of the things that Mr. FORD is likely to do if he gets the plants.

A careful reading of Mr. WEEKS' analysis will impress the reader with the fact that Mr. FORD'S primary interest in Muscle Shoals is cheap power, and that he asks to have the nitrate plants thrown in at a knock-down price. His whole approach to the subject is based on his desire to obtain cheap power for his industrial projects, and on his estimate of what he can afford to pay for it. If the reader will keep this in mind, he will understand why Mr. FORD goes into considerable detail in his proposal to buy the dams and power plants, and then casually imposes as one of the conditions of his offer that the United States sell to him Nitrate Plants Nos. 1 and 2, the Waco lime quarry and the Gorgas-Warrior steam plant, with all appurtenances, for $5,000,000. These plants cost the government $85,000,000, and have a scrap or salvage value estimated at from $9,000,000 to $16,000,000.

Mr. FORD'S modified offer is more advantageous to the government than was his original proposal. His suggested rentals for the dams and power plants are more nearly adequate. Likewise his proffered compensation for maintenance is increased, and his plan for amortization has been improved. The clause relating to renewal of leases at the end of 100 years is more favorable to the government. All of these points are discussed in detail by Secretary WEEKS.

But there are points yet to be modified if, in the opinion of the Secretary of War, the proposal is to meet the approval of Congress. The present offer apparently is deficient in assurance that the contracts once entered upon by Mr. FORD will be carried out, or that some penalty will be imposed for failure to perform. The cost of acquiring certain lands and flowage rights in connection with Dam No. 3 should be included in the

sum upon which Mr. FORD is to pay interest at the rate of 4 per cent. Instead of paying the United States a fixed sum for maintenance of dams and locks, Mr. WEEKS suggests that Mr. FORD assume the cost and responsibility for maintenance just as the latter proposes in the case of the power plants. Finally, Congress shou'd see to it that the regular federal regulations are applied to the sale of power to custom buyers, and that the lease period be 50 and not 100 years. So much for the power project.

As for the nitrate plants, Mr. FORD binds himself to operate Plant No. 2 at its approximate present annual capacity for the production of nitrogen and other fertilizers, and to maintain the plant in readiness for the manufacture of explosives and to turn it over to the United States for that purpose when needed for the national defense. But for the rest of the outfit—Nitrate Plant No. 1, Waco quarry and Gorgas-Warrior steam plant—he is under no obligation to maintain or operate them, nor is there legal obstacle to his disposing of them Should he pursue the latter course and obtain their estimated salvage value, he would have left the $67,000,000 Nitrate Plant No. 2 for about $400,000.

Congress may well ponder the propriety and wisdom of throwing away these properties for a song. True, nitrogen preparedness is worth much, but perhaps not that much. Mr. FORD is still the only bidder. We must remember that the Air Nitrates Corporation that built the plant has, under the terms of its construction contract, an option to buy Nitrate Plant No. 2 on as favorable terms as those offered by a successful bidder, and the Alabama Power Co. has the same option in relation to the Gorgas-Warrior steam plant. Nobody knows what these companies think the properties are worth, but if Mr. FORD is a successful bidder their actions will be a measure of their valuation of the plants. The inevitable delay that will ensue in Congress in consideration of Mr. FORD'S offer may not be an unmixed evil, for it may bring other bidders into the market. Furthermore if Congress acts on Mr. WEEKS' recommendations, particularly in regard to the shortened lease period which we have consistently advocated, Mr. FORD may withdraw his proposal and the whole matter can be deferred to a more propitious time.

With Hoover At the Helm

BUSINESS is gradually coming to realize that it has friend at court in the person of the Secretary of Commerce. He has come to be regarded as the business man of the present Administration, for he stands out as one among the few who can share the viewpoint of industry and understand its problems.

If for no reason other than the record of his accomplishments in the Department of Commerce, Mr HOOVER is deserving of the confidence and gratitude of American business men. Under the past 8 months of his direction this branch of the government has been developed into an effective agency of industrial service. The three Bureaus of Foreign and Domestic Commerce, Standards and the Census have become points of active and intimate contact with trade and commerce. The records show that 127 trade associations are now working in close co-operation with the department. The Bureau of Foreign and Domestic Commerce alone has forty co-operating committees representing 60,000 men who are interested in the promotion of our foreign trade. In all, ninety committees form contact with the department, and through these committees 350,000 engineers, merchants and manufacturers are constantly receiving market information of actual dollars-and-cents value.

American firms concerned with the development of our export trade have learned to profit by the government's studies of foreign markets, as well as the definite inquiries and business advice published each week in the new *Commerce Reports*. Furthermore, the work of expert industrial representatives in many foreign countries and their official assistance in negotiations with foreign governments have been of genuine service in selling American goods. Nor has the domestic trade been neglected, although in the past the charge was often made that foreign trade had always received the predominant share of the bureau's attention. The program for elimination of waste and the work which has been done along the lines of standardization and simplification have been outstanding features in our national reconstruction. *The Survey of Current Business*, with its useful statistics on production, consumption, prices and trade, has proved a reliable guide to industry. Last but in no way the least of the new activities has been the work of the special commodity divisions. With more than a dozen industries actually represented in the bureau's organization it has been possible to interpret and make effective a great mass of information.

The questions naturally arise, What is left to be done? What are Mr. HOOVER'S future plans for the department? Briefly they are these: (1) To improve personnel conditions, for if these bureaus are to serve business effectively they must be competently manned; and (2) to broaden and enlarge the activities of the department until it can adequately represent industry in the government. That that hard-headed business man, the Director of the Federal Budget, was convinced of the soundness of these plans is evidenced by the proposed budget, which provides for an increase of about $750,000 in the department's appropriations. Much of this is to be spent for increasing the meager salaries now paid to technical and scientific employees.

If the appropriation is passed by Congress, approximately $270,000 will be used to increase the number and service of the expert commodity divisions. It will be remembered that in Mr. HOOVER'S original plans one of the commodity divisions was to represent the chemical industry. That this part of his plans should miscarry was not the fault of the department but rather because the industry or the trade association representing it at that time failed to accept the government's offer of co-operation. Fortunately, however, the chemical industry is beginning to recognize its mistake, and there is reason to believe that if the increased appropriation is obtained a chemical division will be of the first to be organized.

In the meantime Congress must be convinced that industry really wants this work continued. If Mr. HOOVER'S plans are to materialize, the budget must be approved and the increased appropriations granted. The chemical industry can and should do its share. Its trade associatons, firms and individuals can make known their desires at the hearings of the congressional committees which are now in session. If we are in earnest, if we are willing to back up the work of the Commerce Department, let's say so—and in no small voice.

The Passing Of a Friend

ON ANOTHER PAGE we print a biographical sketch of the late CHARLES BASKERVILLE. In addition to being a persistent investigator and voluminous author he was also a great teacher. "If you can't make your students believe in you and trust you, how can you teach?" he often asked. He was always accessible to his students; there was none too humble to find a ready response in him so far as his multifarious duties gave him the opportunity. Outside the college he was more reserved and held rather closely to his friends. He was the best of companions, a delightful raconteur, a very prince of good fellows—but he hated vulgarity. He was unashamed of his convictions; and his convictions were always honorable. They never wavered toward his advantage. A proud man withal; but "pride is no sin except when one will not live up to it." He lived up to his pride. He believed in the bigness and in the dignity of his profession. This very attitude sometimes caused others to misjudge him. He was an aristocrat in breeding and in sentiment. And yet whoever of good will would give himself the pains to get closer to him invariably found him at once both fair in mind and genial in disposition.

He had indeed a genius for friendship. It was singularly pleasant to tell him good news and it was helpful to go to him in the days of trouble. That is why, to those who were near to him, his passing takes some of the tang out of life and the mellowness from oncoming age. But *sursum corda!* Who would not rejoice and be glad in the benediction of such friendship?

Alcohol From Water Gas

IN A RECENT issue of *Chemical Age*, London, C. G. CALVERT states that in his small-scale model plants at work in England he is making ethyl alcohol from water-gas mixtures at the rate of one gallon of ethyl alcohol per 1,000 cu.ft. of gas, and that there is every indication that the efficiency will be greatly increased in large-scale plants. He says the process is extremely simple, and that it works constantly under all conditions likely to be met in practice.

Lately we printed the cost of water gas as presented at a hearing before the Board of Public Utility Commissioners of New Jersey by the general manager of the Public Service Corporation. He placed it between 53 and 57 cents per 1,000 cu.ft. for all parts of the state, with an estimate of 11 per cent for gas unaccounted for. But in making gas at the source for alcohol production, without enrichment or loss in pipes, the figure should be much lower. With this cost brought down and the efficiency, as predicted by Mr. CALVERT, brought up, the process begins to look interesting.

That is, it looks interesting anywhere except in the United States. Here the persistent incapacity of our law-making and law-enforcing authorities to distinguish between alcohol in industry and alcohol in drink makes the production of this great solvent, antiseptic and needed chemical almost impossible, irrespective of the fact that without it many industries must close down.

It may be that in time the virulence of the present drive against the industrial alcohol industry by the Anti-Saloon League and its supporters will give way to enlightenment, but as yet it is exceedingly difficult to get a hearing before ears that will hear. As an example of the prevailing means used in debate there was lately put to a number of physicians the question whether they held it to be necessary to administer ethyl alcohol in any form. One cheerful and successful practitioner declared that he never prescribed alcohol for internal use. Where whiskey or brandy was prescribed by other physicians he obtained just as good results with aromatic spirits of ammonia. This has been largely quoted. But the fact that while whiskey contains about 45 per cent of alcohol, aromatic spirits of ammonia contains 63 per cent of it, has been suppressed. That is the kind of "oral argument" that is popular. Wide-mouthed argument, we call it.

The Long Reach Of Romance

THIS is a story of Buffalo Bill. We do not vouch for the correctness of the details; we give it as we heard it and as such it will answer our purpose. While he was an army scout he was attached to a battalion under General CROOK. The Sioux were troublesome, and once when the battalion in question was encamped in the Bad Lands it was surprised by YELLOW HAND with his braves. They came in the night and established themselves on high ground, where they had considerable advantage. YELLOW HAND was a true savage; he neither gave nor asked for quarter; he was a fighting man. He sent a boastful challenge to the officer in command. "Let any one of your men," said he, "come out in the open and fight me singlehanded, and I will call it a battle!" The Colonel was about to scorn the message, when CODY said, "Colonel, I know their ways. If we don't agree to this we shall be sure to lose a considerable number of men, even if we defeat them, for they are stronger and have the advantage of position. But if we accept the challenge they will abide by the result and leave when the fight is over. Let me accept!"

Never mind the argument; in the end Buffalo Bill accepted. The two men were to face each other a quarter of a mile apart, before the assembled hordes, each on horseback and armed with a rifle and a knife. It was to be a duel to the death. No rules and no quarter.

It began and both fired. YELLOW HAND missed and Buffalo Bill hit his opponent's horse, which stumbled and fell. In the fall YELLOW HAND'S rifle slipped out of his grasp. Quickly he drew his knife and stood, awaiting his antagonist. *Buffalo Bill alighted from his horse and threw away his rifle.* Then he too drew his knife and approached YELLOW HAND on foot, to meet him on even terms. The fight proceeded to a finish; to the death of YELLOW HAND. Then the braves retreated and the battalion marched on.

That is an epic of the West, isn't it? It has the real, thirteenth century tang to it. Think of what CARL SANDBURG could do with the story!

Well, where is an epic of chemistry? We can't find one in chemical warfare. That is modern and wholesale and impersonal. It involves suffering and agony and death, but we can see only the victims; we miss the hero. What is wanted is the romance. The romance is there, but who has the wit to find it?

Before us is the whole field of literature to be spoken or read or acted. The moving picture people are straining every nerve for scenarios. Far too many chemists are now in idleness. Some of them have imagination. Some can write. And in the romance of science is the chance. It would instruct the public and be a good thing for science if they were to get busy.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, Jan. 6, 1922.

DECEMBER was a month of little accomplishment for the Italian chemical industries, although the workpeople had returned to their work and were willing to produce. This was due to the great fluctuations in the value of the Italian lira, which caused many to believe for a time that a strong recovery had begun. This idea was soon dissipated, however, by a further fall. In December the Leghorn chemical workmen, who had not reached an agreement in November, accepted the conditions proposed by their employers and returned to work. Many foresee that their example will be followed in other parts of Italy.

FERTILIZERS

The fertilizer market was weak, owing to the persistence of the dry weather, which discouraged many farmers in their cultivation operations, so that they would not draw the superphosphates from the works in many quarters. Despite this, the outlook for the present year is promising and a number of opportunities have been created through the special conditions prevailing. Thus the stocks of sulphate of ammonia fell to a very low point, Germany having prohibited all exportation and England having the absolute monopoly of the market. In the case of nitrate of ammonia, which gave very promising results when tested for fertilizing purposes, the demand was light in December, but will probably increase later. For these reasons offers of such products should be well received. In the case of Chilean nitrate of soda, especially low offers were made for immediate delivery, whereas for delivery during the next months an increase of 20 lire per ton and per month was asked. The imports of mineral phosphates reached 19,585 tons during September, 1921, against 39,530 tons during the same month of 1920, and during October 42,537 tons, against 23,865 tons during the same month of 1920.

GLUCOSE

In view of the progress made in the manufacture of glucose, the production of which reached 8,400 tons in 1918, the Italian Government arranged toward the end of the year a manufacturing tax of 1,200 lire per ton in the case of the crystalline or solid product, and of 600 lire per ton in the case of the liquid product. Besides this tax a yearly working license, ranging from 50 to 121 lire, is also necessary. The imports of solid glucose reached 42 tons during the first 6 months of this year, against nothing during preceding years, whereas the imports of liquid glucose were of 727 tons, against 3,660 tons in 1920 and 705 tons in 1919 during the corresponding period. Of the second importations of this year, 681 tons came from the United States of America, 29 tons from Holland and the remainder from other countries. The total exports reached only 5 tons.

SUGAR

The continual change in the policies of the Italian Government in regard to regulating the importation of sugar and the lack of shipping facilities from Cuba have rendered impossible a large importation of sugar from this source and the importers could satisfy the needs of the industries using this product only by passing comparatively small orders to the United States, England, Belgium, South America, Holland, Java and other countries. Such a state of affairs caused the German Government to propose the refining of 1,000,000 tons of sugar to be purchased in Cuba for Italy and France, on account of war reparation. However, Italy was not willing to accept the arrangement.

A new law increased the taxes on the importation of sugar, with the idea of protecting the national industry against the effect of the continental reductions in the foreign offers, while other laws limit the importations for each plant to 6 months' requirements and provide for permits for deliveries to be made simultaneously to several firms in the same town.

PEPPERMINT OIL

Owing to the excessively dry weather, the essential oil yield of the Piedmontese peppermint plant was above normal, and the production for the year would have been correspondingly large if the growers had not insisted on a price so high that it could be accepted only by those distillers that had previous contracts. The essential oil of the new mint harvest contains 50 per cent of menthol and is stronger than the product of the last year. The yield of mint oil was calculated to reach 300 g. per 100 kg. of herb treated. The plant, through the excessive dryness, remained low during the first period of its growth, and many ascribe to this fact its superior concentration in essential oil. In the first half of 1921 the imports of peppermint oil reached 4,518 kilos, against 9,462 kilos in 1920 and 3,226 kilos in 1919 for the same period. The exports reached only 796 kilos, against 2,894 kilos in 1920 and 7,742 kilos in 1919.

SULPHUR INDUSTRY

To bring to a speedy conclusion the negotiations that have been pending for some time regarding the troubles of the Sicilian sulphur miners special concessions were arranged for the miners, with the hope that they will contribute toward increasing the yield of the mines, permitting a reduction in the cost of extraction. In the meanwhile the prices of all sulphur products have fallen considerably, owing to American competition and the reduced demand on the home and foreign market, caused by the unfavorable season.

HYDRO-ELECTRIC PLANTS SHUT DOWN BECAUSE OF LOW WATER

In order to permit the slow refilling of the mountain reservoirs whose supplies had been depleted by the extreme dryness of the past months, the Italian Government stopped the supply of all electric current to the industries from midnight of Dec. 24 to midnight of Jan. 1 in all the provinces of Lombardy and in the provinces of Reggio, Modena, Parma and Piacenza. In the provinces of Genoa, Bologna, Novara and Alessandria this suspension was only partial. On their part the state railways reduced the number of trains hauled by electric engines and in some cases increased the use of steam locomotives. In the meanwhile studies are being made for the purpose of interconnecting the different Italian lakes, thus making part of their water available for producing electric power. Some Italian industrials insisted on special facilities being arranged for encouraging the importation of machinery for the working of heavy combustible oils. No great development is, however, foreseen in this direction, as motive power thus produced costs more than that obtained through coal, which in turn is six times as dear as that produced through water power.

The German and American Synthetic-Ammonia Plants*—I

Construction and Operation of U. S. Government Plant at Sheffield, Ala., Compared With That at Oppau, Germany—Water and Fuel Requirements Are Given and General Facilities Such as Housing of Equipment and Process Are Described

By R. S. TOUR

GREAT interest has arisen within the last few years in the chemical industry, looking toward the commercial development of synthetic-ammonia plants. Outside the chemical industry the agricultural interests are vitally concerned in the successful development of nitrogen-fixation processes. And in addition, it is of great importance to the United States Government, from a military standpoint, that there be a thriving nitrogen-fixation industry in this country. Although the War Department of the United States built, and attempted to operate as a war emergency, the first synthetic-ammonia plant of commercial size outside of Germany, still it feels that during normal times the development of such processes should be carried on by private interests. The experience and information that has been gained by the War Department will be of value under these conditions in so far as it is made available to the industry. As a step in this direction, the War Department has, therefore, acceded to the request of the American Institute of Chemical Engineers that a paper be submitted describing the German and United States synthetic-ammonia plants.

The direct synthetic-ammonia process has been described in a previous paper[1] by the author, which shows the steps and incidental processes involved in the industrial manufacture of ammonia by direct synthesis from its elements. The purpose of the present paper will be to indicate the methods of operation and types of apparatus and equipment that have been developed in the German and in the American plants. The plants in Germany and the United States are as yet the only industrial synthetic-ammonia plants producing the hydrogen and nitrogen gases by the water-gas and producer-gas methods. Some other smaller plants have been developed on the Continent for synthesizing ammonia from hydrogen produced electrolytically, but such processes are not generally applicable and have not been considered here.

German Plants

Two plants were built in Germany, one at Oppau with an annual capacity of 100,000 metric tons of ammonia and one at Merseburg with 200,000 tons rated capacity (respectively 110,000 and 220,000 short tons). Preliminary work on the Oppau plant was started in 1912, and by 1914 a pilot plant of about 10,000 tons annual capacity was in operation. The main plant construction was started in 1914 and the rated capacity of the entire plant was reached in 1917. The Merseburg plant was built mainly during the war and three-fourths of its rated capacity was in operation before the armistice was signed. The Merseburg plant has since been completed and can now develop its entire rated capacity. Both plants were designed and built by the Badische Anilin und Soda Fabrik after several years of experimental and development work. The same company also operated the plants, although the German Government furnished aid to the company in many ways during the war.

American Plants

One synthetic-ammonia plant was built at Sheffield, Ala., by the United States Government as a war emergency measure in 1917. This plant had a rated annual capacity of 10,000 short tons of ammonia. In the main it followed the principles and processes tried in Germany, but construction was based directly upon experimentation and designs developed by the General Chemical Co. over a preceding period of several years' duration.

After negotiation between the United States Government and General Chemical Co., arrangements were made for the construction and operation of the plant at governmental expense, but according to the company's plans and under its supervision. Experimental operation was started in June, 1918, but continuous operation was not realized up to the time the plant was closed in January, 1919. Another synthetic-ammonia plant is now being built at Syracuse, N. Y., by the Atmospheric Nitrogen Corporation, a company formed by the Solvay Process Co. and the General Chemical Co. It is expected that this plant will start operations within the year. Several other corporations have been formed in this country within the last few years for the purpose of investigating or developing nitrogen fixation, but as yet none has proceeded with its plans far enough to start construction.

After the Sheffield plant was closed, the Nitrate Division of the Ordnance Department very much desired that the development of the process be continued, but no satisfactory arrangements could be concluded with the General Chemical Co. for the latter to continue experimentation and plant development at Sheffield. The government then felt that it must proceed independently and the United States Fixed Nitrogen Commission was sent to Europe in June, 1919, to investigate the status of nitrogen-fixation there, particularly the Haber plants of Germany. During the summer of 1920, plans and redesigns of the Sheffield plant were undertaken, looking toward the substantial modification of the plant, to be followed by another operating period for further development. The general plans and programs are now nearly complete, but are being held in abeyance, awaiting commercial development of the process by private industry. In the meanwhile, the government

*Contribution from the Nitrate Division, Ordnance Department, U. S. Army. Published by permission of the Chief of Ordnance and presented at the thirteenth semi-annual meeting of the American Institute of Chemical Engineers, held at Detroit, Mich., June 20-25, 1921.

[1]R. S. Tour, *J. Ind. Eng. Chem.*, vol. 12, page 844 (1920).

desires to aid the industry in any way possible, by making available some of its general information concerning the art.

Products of German and American Plants

The Oppau plant in Germany is the one to be described in this paper, since the writer, as a member of the United States Fixed Nitrogen Commission, during the summer of 1919 was fortunate enough to spend a week at that plant and inspect it thoroughly, submitting a report, dated Nov. 1, 1919, covering this inspection. This report has served as the basis for much of the material and all the sketches relating to the German plant. Previous to the visit to the Oppau plant, the writer had been in direct touch with all the development and initial operation of United States Nitrate Plant No. 1 at Sheffield, Ala., and the descriptions and statements given here concerning that plant are from his report on the work there.

The point of view taken in this comparison of the Oppau and Sheffield plants will naturally be somewhat different for each of the two plants, in view of the fact that the former was in its final stages of development and was an operating success at the time of inspection, whereas the Sheffield plant was never out of its initial development period.

Only the synthetic-ammonia portions of the respective plants will be considered here, although the German plant included several processes for the utilization of the ammonia, such as (1) the oxidation of part of the ammonia to nitric acid with the final production of ammonium nitrate; (2) the interaction of ammonia and carbon dioxide gas with gypsum to give ammonium sulphate; (3) the reaction of the ammonia-soda process between ammonia and carbon dioxide gas with brine to give ammonium chloride and soda. Auxiliary processes involving the use of carbon dioxide are very attractive in view of the fact that the gas is a byproduct in large quantity from the process. At the Sheffield plant there were installed ammonia oxidation, absorption, concentration, neutralization and crystallization plants for the manufacture of the necessary war product, ammonium nitrate.

The Process

Before taking up the description of the plants, it might be well to mention the steps involved in the synthetic-ammonia process.[2]

Manufacture of Hydrogen and Nitrogen—Hydrogen is obtained by the "water-gas oxidation" method, wherein water-gas produced in standard machines is caused to react further with an admixture of steam in the presence of a catalyst according to the reaction $CO + H_2O \leftrightarrows CO_2 + H_2$, converting (oxidizing) most of the carbon monoxide to dioxide and generating additional hydrogen in so doing. The nitrogen in the mixture may be obtained by supplying air into the gas generator during the manufacture of the water-gas, or by the injection of air into the oxidation stage of the process, or by the admixture of straight producer-gas to the water-gas before oxidation.

Purification of the Gases—The purification of the gas mixture is accomplished by high-pressure water-scrubbing to remove carbon dioxide, followed by ammoniacal cuprous solution scrubbing to remove carbon monoxide and incidental impurities. Auxiliary or special purification may further involve scrubbing with hot or cold caustic solutions, drying with soda lime or similar treatment.

Manufacture of the Ammonia—The synthesis of the ammonia is finally accomplished in one portion of a continuous circulating system by passing the nitrogen-hydrogen mixture at high pressure and high temperature over a suitable catalyst. The ammonia synthesized

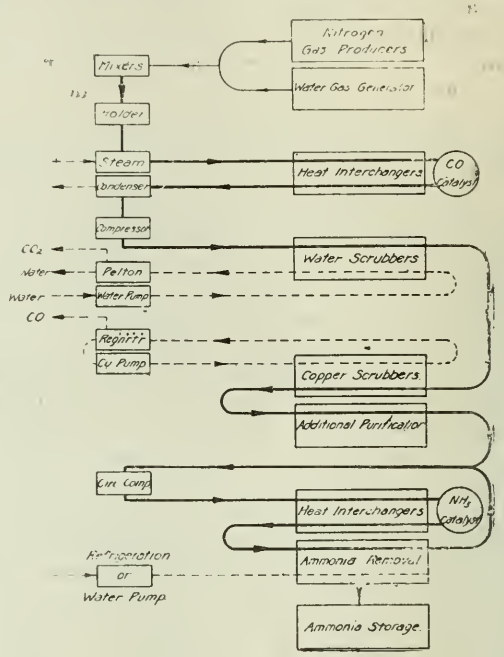

FIG. 1—DIAGRAMMATIC FLOW IN THE DIRECT SYNTHETIC-AMMONIA PROCESS

is removed continuously by liquefaction or absorption in another portion of the circulating system, while the uncombined gases repeat the cycle together with additional gas mixture introduced to replace that synthesized.

General Facilities of the Oppau Plant

The German plant is situated at Oppau, on the Rhine, about two miles below Ludwigshafen and about a mile from the main chemical plant of the Badische Anilin und Soda Fabrik, which controlled the plant and process.[3] The Oppau plant covers 175 acres of ground and much more is available if necessary. There are about 250 buildings or structures of various sizes and shapes. All the main buildings are substantially built of brick and steel and are logically arranged with carefully laid out streets. Necessary trackage, transportation facilities, cranes, etc., are provided throughout.

Primary central power for the plant is furnished by a producer-gas-engine installation of 10,000-kw. capacity and a steam turbine station of 18,000 kw. capacity. Electric power is generated and distributed at 5,000 volts, three phase, fifty cycles. In addition there are steam and gas engines for local power production at various points throughout the plant. Comparatively little of the central station power is consumed for the synthetic-ammonia manufacture, since, where compressors or pumps of large capacity operate continuously, they are directly driven by gas or steam engines.

High-pressure steam (175 lb.) is furnished by water-tube boilers equipped with superheaters, mechanical

[2]Editor's Note: Further consideration of these steps is given in succeeding installments of this article.

[3]Reference should be made to the articles on the "Manufacture of Synthetic Ammonia at Oppau, Germany," published in Chem. & Met. Eng., vol. 24, pp. 305-8, 347-50 and 391-4 (1921).

grates and forced draft. The total heating surface is about 60,000 sq.ft., divided among thirty-two boilers of several sizes. The fuel is normally lignite, although some of the boilers are equipped for burning tar and oil and others for producer-gas. Low-pressure steam (50 to 60 lb.), necessary in different parts of the process, is supplied by tubular boilers heated by gas-engine exhaust.

The main fuel for the plant is lignite in the form of briquets available near by in the valley of the Rhine. These are used for steam generation and for the producer or power gas manufacture. Considerable hard coal, or anthracite, is also used. The coke needed was purchased during the war, awaiting the completion of the byproduct coke-oven installation on the grounds. The total fuel consumption of the plant at capacity, including ammonia utilization processes, is about 2,500 short tons per day, most of which is delivered from barges on the Rhine and taken care of by elaborate coal-handling equipment.

Water is supplied by a pumping plant on the Rhine, operated with electric power and also by gas engines. All the water is filtered through sand and finally supplied to the plant at a pressure of 60 to 70 lb. The total water plant capacity is about 100,000 gal. per minute.

Shops and Laboratory at Oppau

The plant has large machine, pipe and repair shops. The equipment of these shops is complete in every respect and large enough to take care of the largest piece of apparatus in use at the plant. The administration offices and main research laboratory are housed in a beautiful building, fully and completely equipped, costing in all about 3,000,000 marks. This building is in addition to the different routine testing laboratories and superintendents' offices located in the individual buildings where operating control is necessary.

Each step of the process is housed in a separate building and in many cases the high-pressure apparatus is adjacent to, but outside of, the building assigned to it. The building itself contains the pumps, engines and other auxiliary apparatus together with the control valves and lines, which are carried through the walls from the apparatus outside and thus afford safety and shelter to the operators. Each step of the process involves several identical items of apparatus, operating in parallel; thus allowing the failure or repair of any single item without jeopardizing the balance of the process. The number of items installed is different for the respective steps of the process. No series of apparatus for all the steps is connected to form complete independent units for the entire process, but the entire plant works as one single unit with a productive capacity of 300 tons of ammonia per day.

General Facilities of the Sheffield Plant

The American plant is situated on the outskirts of Sheffield, Ala., about a mile from the Tennessee River. The plant proper occupies about 100 acres, although the plant has title to much more surrounding property. There are perhaps forty buildings, some of which are of a temporary nature, although the main process buildings are of substantial and modern construction.

Primary power for the entire plant is furnished by turbo-generators totaling 5,000 kw., generating at 2,200 volts, three phase and sixty cycles. There is no power generation about the plant other than the above. The power that is used for the synthetic-ammonia process is transmitted through rotary converters and used at 250 volts d.c. The main purpose of the d.c. power was to allow a more flexible speed control in the operation of the synthetic process plant.

High-pressure steam (190 lb.) is obtained from eight Stirling boilers of 500 b.hp. each, equipped with superheaters, stokers and forced draft. There is no installation for low-pressure steam, but this is obtained through a reducing valve from the high-pressure main or is "bled" from the turbines. The fuel is bituminous coal except in the gas generators, where coke is necessary. The coal and coke are brought into the plant grounds by rail and are normally obtained from nearby localities.

The use of direct-current power at Sheffield, Ala., is a definite inefficiency which is chargeable to the development of the process at that plant. In view of the fact that low-pressure or exhaust steam is necessary, it would have been much more advantageous to operate the experimental equipment in place with reciprocating steam engines properly equipped with throttle or cut-off adjustments, these engines exhausting into the exhaust manifold for supplying the steam requirements of the plant. High-pressure steam used for low-pressure purposes is expensive and the bleeding of steam turbines puts them at a disadvantage in comparison with reciprocating engines.

Water is supplied by a pumping station situated about two miles distant near a large spring and creek having the necessary capacity all year round. There is a filter plant on the plant grounds where all the water used may be filtered through sand and finally supplied to the plant at a pressure of 40 to 50 lb.

Shops and Laboratory at Sheffield

The plant has but one small machine shop and general repair shop and the equipment there installed is not sufficiently large to take care of the larger pieces of apparatus connected with the synthetic-ammonia process. If such work should become necessary, the apparatus would have to be shipped to a properly equipped machine shop in some other locality. The administration and control laboratory buildings are of temporary nature and have been held over from the construction period. The plan was to erect permanent buildings in accordance with their necessity at some later date.

The lack of large enough and properly equipped machine and repair shops was found to be a serious handicap immediately after starting operation. The omission of a crane for moving the heavy apparatus in the main ammonia process building was another serious oversight. The lack of an administration building was not seriously felt, but the need of a properly equipped research laboratory with the necessary personnel immediately became evident. The latter is a very necessary adjunct to the process in such a stage of development as it was at Sheffield.

Practically all the steps of the process are housed in one large building. All the high-pressure apparatus, together with pumps, motors and controls, are also within the building. Only the water-gas machines and their auxiliaries are separately housed. It is evident that this general scheme is undesirable in a commercial plant, especially one in a developing stage, since the rupture or explosion of one piece of apparatus endangers the entire equipment of the process. The crowding neces-

sary to place so much equipment under one roof caused many inefficiencies in proper development or operation.

The gas purification and ammonia-synthesis portion of the plant consists of three separate and independent units not interconnected although in the same building. The different steps of the process in each unit involve but single items of apparatus with spares where considered necessary. The operation of independent units with but single items of apparatus in some of the steps requires the shut-down of the complete unit in case of a failure to function of any single item. In view of all these handicaps it speaks well for all concerned that operation resulted in no serious mishaps and that success seemed finally within grasp.

Unit No. 1, the only unit upon which complete operation was attempted, and Unit No. 2 were rated at 15,000 lb. of anhydrous ammonia each per day. Unit No. 3, which was never completely installed, carried larger apparatus than the other units and was rated at 30,000 lb. of ammonia per day.

This article is to be continued. Part II will describe the manufacture of hydrogen and nitrogen, Part III the purification of these gases, Part IV will discuss the manufacture of ammonia and Part V will present some consideration of costs.

Permanence of Steel Gages

AT A recent meeting of interested manufacturers, called by the Ordnance Department, U. S. Army, for the purpose of considering ways and means for more satisfactory gages, it was pointed out that the most difficult problem to be solved is that of finding a steel that will "stay put"—i.e., one in which the dimensional changes after hardening are negligibly small. It is well known that at present the dimensional changes occurring in hardened steels during "aging" are very irregular in magnitude, direction and rate of change. Claims reported to have been made for a certain steel which is absolutely uniform in behavior on hardening were discounted.

No single composition or heat-treatment should be expected to be satisfactory for all types of gages; ease of machining, hardness of surface, resistance to abrasion, resistance to corrosion, freedom from distortion on hardening, and other characteristics being of different relative importance under different conditions of manufacture and use. Brinell hardness or file hardness is not necessarily a measure of abrasive resistance, and it is well known that alloy steel gages will outwear carbonized plain steel gages of much greater apparent hardness.

For plugs and rings a tool steel of 1.15 to 1.20 per cent carbon had been found satisfactory. For this purpose a steel with good wearing qualities and free from hard or soft spots is of prime importance. Freedom from slight dimensional changes after hardening is not so important for this class of work. From the information now available it would seem that ball race steel is best suited to the purpose. Manufacturers of ball race steel have specifications as to quality, but these may be found inadequate.

Dr. Mathews stated that in a series of experiments conducted by him in 1920 it was found that by differing the heat-treatment the dimensional changes could be very largely controlled. Extreme hardness and high resistance to abrasion are not compatible with freedom from dimensional changes after hardening, and it may be necessary to sacrifice hardness to some extent in order to secure stability of dimensions.

Heat-treatments that are supposedly the same often differ widely, and the heat-treatment as actually carried out in the plant may differ markedly from the instructions given and the program laid out. It may, therefore, be possible that observed differences in behavior of steels are due to differences in heat-treatment even when the treatment is supposedly uniform. Many factors affect the heat-treatment, rate of heating and time at the maximum temperature being perhaps the most important. The presence of chromium has a decided effect on the softening under heat; chromium steel softening at a lower temperature than straight carbon steel. It had been found to be good practice to draw at as high a temperature as possible without reducing the hardness too much. The beneficial effect of chromium in reducing corrosion and discoloration of polished surfares was also mentioned.

In work on gage blocks it was found that the steel giving the smallest dimensional change on hardening did not always show the smallest subsequent change; nor did the rate of change after hardening always decrease with time. Certain blocks showed very irregular changes of length, some remaining practically constant for one or two months or more, and then suddenly undergoing very considerable changes.

Standard Code of Lighting for Mills

The code of lighting for factory mills and other work places, based upon earlier codes issued by the Illuminating Engineering Society and recently revised by a sectional committee under the sponsorship of this society, has been officially approved as American standard by the American Engineering Standards Committee.

The code was first issued by the I.E.S. in 1915 and was revised slightly in 1918. Since June, 1920, the revision of the code has been carried out under the rules of procedure of the American Engineering Standards Committee. Pursuant to these rules, there was organized for the purpose of revising the code a sectional committee consisting of representatives of the following societies and organizations: American Gas Association, American Institute of Electrical Engineers, American Society of Mechanical Engineers, Association of Edison Illuminating Companies, Illuminating Engineering Society, International Association of Industrial Accident Boards and Commissions, National Association of Cotton Manufacturers, National Electric Light Association, National Safety Council, National Workmen's Compensation Service Bureau (now the National Bureau of Casualty and Surety Underwriters), U. S. Bureau of Standards, U. S. Department of Labor, U. S. Public Health Service.

The code is very brief, consisting of a few rules covering the minimum requirements, from the point of view of safety, for the illumination of traverse spaces during the time of use, methods for the avoidance of glare, and for exit and emergency lighting.

State lighting laws based upon the I.E.S. code have already been put into effect in Pennsylvania, New Jersey, New York, Wisconsin, Oregon, California and Ohio. The adoption of the code is now under consideration in several other states.

Copies of this code may be secured from the American Engineering Standards Committee, 29 West 39th St., New York City. Price 25 cents each.

The Slip Interference Theory of the Hardening of Metals

A General Reply to Many Questions Raised by Various Commentators—Since Martensite Is Undoubtedly Alpha Iron, the Widely Accepted Allotropic Theories Must Be Discarded—Carbon Is Held in Martensite as Dispersed Atoms

By ZAY JEFFRIES and R. S. ARCHER

SINCE the presentation of "The Slip Interference Theory of the Hardening of Metals" in the June 15, 1921, issue of this journal, several discussions have appeared.[1] It is interesting to note that the fundamental propositions of the theory were heartily indorsed by most of these scientists.

Rôle of Amorphous Metal

Heyn has received the impression that the authors attribute the hardness of cold-worked metals chiefly to amorphous metal, and dissents from such an explanation inasmuch as he does not accept the amorphous metal hypothesis. As a matter of fact, the authors attribute the hardness of cold-worked metals chiefly to the disregistry of slip planes produced by the fragmentation of the original grains. Any amorphous metal present at the slip planes and grain boundaries would of course contribute to the hardness, but is held to be at most a minor factor. Westgren also questions the importance of amorphous metal as a cause of hardness. The views of the authors on this subject have been set forth more fully in a later paper "The Amorphous Metal Hypothesis," which appeared in Chemical & Metallurgical Engineering, Oct. 12, 1921. The conclusion was there reached that the effect of amorphous metal on hardness has been greatly exaggerated by exponents of the amorphous metal hypothesis.

In the original article the authors considered that "strain" hardening is due in part to change in orientation of the crystalline fragments on deformation. At that time definite proof was lacking that change in orientation actually occurs during cold-working. This has since been supplied in an article by Bain and Jeffries (Chem. & Met. Eng., Oct. 26, 1921), in which it was shown that severe cold deformation of coarse-grained metal produces mixed orientation.

Honda thinks it improbable that a few per cent of a hard constituent in the form of highly dispersed particles can be responsible for much hardening. He compares the hardening of metal crystals by small hard particles to the hardening of gelatin by similar particles. The two cases are entirely dissimilar, as pointed out in the original paper. The case for the "critical dispersion" proposition rests largely on studies of the hardening by heat-treatment and aging of certain aluminum base alloys, as first developed by Merica, Waltenberg and Scott. Honda does not accept this explanation of the hardening of duralumin and offers an explanation of his own based on an assumed allotropy of aluminum. The experimental facts which he presents are entirely in harmony with the critical dispersion theory. We feel that the alternative hypothesis which he offers is practically untenable in view of the failure by many investigators, using all available methods of research, to find any evidence of allotropy in aluminum. It is significant that the metallurgists of the National Physical Laboratory of Teddington, England, who have been engaged for years in intensive research upon aluminum and its alloys, appear to have adopted the "dispersion" view, at least as a working hypothesis.

Hardening of Solid Solutions

The authors have attributed the hardness of solid solutions largely to increased interatomic forces, saying that in general the attraction between unlike atoms is greater than that between like atoms. Professor Sauveur has asked for evidence, or for references to evidence, that this is the case. To be more specific, the statement should be that when two elements form solid solutions or chemical compounds, the attractive forces between the unlike atoms exceed those between like atoms, since otherwise neither solution nor combination would take place. Consider a bronze containing about 7 per cent tin, for example. As cast the structure is made up of dendritic crystals rich in copper in the interior, but with the tin concentrated near the boundaries. This effect, called "coring," is found in all solid solution alloys. Now if the bronze is heated for a sufficient time at a suitable temperature, diffusion takes place and there is obtained a homogeneous solid solution of tin in copper. This shows that the attraction of copper atoms for tin atoms is greater than the attraction of copper atoms for each other, or of tin atoms for each other. If this were not the case, annealing would cause further segregation rather than an approach to homogeneity.

Constitution of Austenite

Most of the discussion relates to the authors' application of their general propositions to the specific question of the hardening of steel. Some of the points raised in this connection are vital to the explanation advanced for the hardness of martensite, while others are merely incidental.

Among the latter is the question of the condition of the carbon in the solid solution austenite. This was a subject of contention years ago, and perhaps a major-

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[1] "The Slip Interference Theory of the Hardening of Metals," by Carle R. Hayward, Aug. 3, 1921, p. 181.
"Slip Interference Theory of Hardening," by Haakon Styri, Aug. 24, 1921, pp. 313-14.
"A Discussion of the Slip Interference Theory of Hardening," by Albert Sauveur, Sept. 14, 1921, pp. 509-12.
"The Slip Interference Theory," by Nicholas T. Belaiew, Sept. 28, 1921, p. 584.
"The Constitution of Martensite and Troostite," by D. J. McAdam, Jr., Sept. 28, 1921, pp. 613-618.
"The Slip Interference Theory of the Hardening of Metals," by Dr. Arne Westgren, Oct. 5, 1921, p. 641.
"The Slip Interference Theory of the Hardening of Metals," by E. Heyn, Oct. 19, 1921, p. 728.
"What the X-Ray Spectrometer Tells About the Structure of Solid Solution," by E. C. Bain, Oct. 19, 1921, p. 729.
"On the Theory of the Hardening of Metals," by Kotaro Honda, Nov. 30, 1921, pp. 1001-3.
"What Causes Slip to Halt," by O. A. Knight, Dec. 7, 1921, p. 1036.

ity of metallurgists have come to the conclusion that the carbon is dissolved "as cementite." It has been pointed out by some, however, that the evidence available was insufficient to decide one way or the other. In the light of the recent knowledge of crystal structure and of the constitution of solids, knowledge made available largely by the methods of X-ray analysis, the authors considered it probable that the carbon in austenite is present as individual atoms. The development of their conception of martensite proceeded from this view, but the essentials would not be changed if austenite were regarded as a solution of molecular iron carbide.

The view that cementite dissolves "as such" implies the presence in austenite of physical units or molecules of carbide. The X-ray work of the Braggs, Hull and others has shown that the crystals of many chemical compounds are built up of atoms arranged in definite and repeated patterns and so related that no particular combination of atoms can be picked out as constituting a physical unit or molecule. In sodium chloride, for example, each sodium atom is surrounded by six similarly related atoms of chlorine, and it cannot be said that any particular pair of atoms constitute a molecule. As a result of these studies modern chemical theory is tending to the view that in solid crystals there is in general no unit smaller than the crystal as a whole.[1] In other words, the crystal is the molecule.

There are some crystalline substances in which the unit of structure appears to be a definite group of atoms —that is, a molecule. Examples are sulphur, in which the molecule contains eight atoms, and ice, which is built up of molecules of H_2O. It is characteristic of such substances that they can be vaporized and that the molecule persists in the vapor form.

Cementite Molecule Uncertain

The structure of crystalline cementite is found by the X-ray method to be quite complex and is not yet worked out. Cementite cannot be vaporized without decomposition, and there is at present no evidence of the existence of definite molecules. In the absence of such evidence, it is most simple and logical to consider that the units in the cementite space-lattice are atoms of iron and carbon, and that there is no cementite molecule other than the crystal. The burden of proof lies with those who suppose that molecules of cementite do exist and are present in austenite.

If we assume the existence of iron carbide molecules, they must contain at least three atoms of iron and must therefore be much too large to diffuse as units through the rigid lattice of either gamma or alpha iron. Dr. Westgren contends that the diffusion of carbon in iron may take place by the progressive transfer of carbon atoms from one group of iron atoms to the next, the iron atoms remaining stationary. He considers that in each position of a carbon atom it is part of a definite group or molecule. The authors would not regard a group of iron and carbon atoms as a molecule unless the group retained its identity in such physical changes as diffusion, solution and precipitation. Their difference with Dr. Westgren is perhaps chiefly one of terminology rather than of physical fact, and does not appear to be important for practical purposes.

It may be mentioned that Dr. Irving Langmuir, who stands pre-eminent for his work on the constitution of solids, has been consulted personally by the authors and is strongly of the opinion that carbon is present in austenite as individual atoms.

Condition of Iron in Martensite

The problem of the hardening of steel is considerably simplified if we can state definitely the allotropic form of the iron in martensite. A number of reasons had long existed for supposing the iron to be of the alpha modification, and some metallurgists had formed the opinion that such was the case, but the evidence was not entirely conclusive. In their original paper on Slip Interference, the authors pointed out as a final argument the results of X-ray analysis which show without any question that *most* of the iron in martensite possesses the space-lattice characteristic of alpha iron. Professor Heyn was not convinced by the previous evidence and wrote that he awaited with interest the presentation of the X-ray work referred to. Part of this has since been described in detail in this journal, but similar results were given earlier by Dr. Arne Westgren. Dr. Westgren not only showed that gamma iron and austenite are face-centered, while alpha iron and martensite are body-centered, but he also showed that iron in the so-called beta range of temperatures has the lattice characteristic of alpha iron.

Failure to obtain the gamma iron diffraction pattern from a specimen of hardened steel does not of course show that no gamma iron is present, but merely that there is not enough gamma iron present to give a visible image on the film under the particular conditions of experiment employed. We know, as a matter of fact, that a certain hypereutectoid steel quenched drastically gave both alpha and gamma iron patterns. In this case, both austenite and martensite were visible under the microscope, and the gamma iron pattern was presumably due to the austenite. With lower carbon steels the gamma iron pattern was not found nor was austenite observed. Furthermore, the presence of a small amount of gamma iron would not complicate matters from our present viewpoint, since we cannot conceive any way in which it could act as a cause of hardness.

Grain Size of Martensite

The authors' statement that the ferrite in martensite is of submicroscopic grain size has been questioned by Professor Sauveur, who holds that insufficient evidence was given to substantiate this important point. The crystals of alpha iron, which we know constitute the bulk of martensite, form from austenite in a very short period of time during quenching. Each crystal begins as an extremely small nucleus and would have to exhibit rapid grain growth to attain any large size. When pure iron is quenched from above A_3, well-developed grains of alpha iron, easily visible under the microscope, are always obtained. These grains are formed at and just below 900 deg. C. D. J. McAdam has shown in his discussion how the velocity of grain growth in alpha iron decreases with the temperature, and how the lowering of the transformation temperature by carbon is sufficient to account for a vast decrease in grain size. He believes that any lowering below about 750 deg. C. is insignificant, because of the comparatively low velocity of grain growth in ferrite at this temperature. The authors can not quite agree to this, because the grains involved are very small, and small grains grow readily

[1] "The Constitution and Fundamental Properties of Solids and Liquids," Irving Langmuir, *J. Am. Chem. Soc.*, 1916-17.

at temperatures so low that larger grains are inert. It *is* significant, therefore, that the work of Portevin and Garvin[1] has shown that the actual temperature of formation of martensite is about 300 deg. C. This makes it still more improbable that large grains of alpha iron are formed. We may consider for comparison, although not an exact comparison, pure iron in the severely cold-worked condition. Here we know that the grain fragments are of submicroscopic size and that there are no signs of growth even after long heating at 300 deg. C.

In steel there is an additional factor not present in pure iron—namely, the obstructing effect of carbon. Whether the carbon is considered to be in the form of individual atoms, or of carbide molecules, or of minute crystals of cementite, it must have an important inhibiting effect on the growth of the grains of alpha iron.

It is thus seen that the conditions of formation of martensite favor minute grain size. Obviously there can be no visual observation of submicroscopic grains. The most direct evidence is probably to be obtained by means of the X-ray spectrometer, and in the original article the authors described how this instrument shows qualitatively that the alpha iron grains in martensite are small as compared with the parent austenite grains. The method may be capable of quantitative results, but these have not yet been obtained.

Knowing that the ferrite grains are considerably smaller than the old austenite grains, we may well ask, "By what they are represented in the structure seen under the microscope, if they are indeed large enough to be seen?" To the present writers the absence of any unit resembling "grains" is a strong indication that the grains actually are submicroscopic.[2]

Condition of Carbon in Martensite

Carbon must be present in martensite as carbon atoms, carbide molecules or crystals of cementite. Magnetic analysis of eutectoid martensite fails to show the presence of crystalline cementite. The method is capable of revealing the cementite in steel containing 0.1 per cent carbon, so we must conclude that less than this amount of carbon in eutectoid martensite is in the form of crystalline cementite. The formation of crystalline cementite is accompanied by a contraction in volume, as shown by Andrew, Rippon and Miller, and brought out in the discussion by McAdam and Styri. The tempering of martensite or the spontaneous aging of freshly hardened steel (Brush) causes a contraction in volume, indicating the formation of cementite. The tempering is known to cause the appearance of the magnetic change point of cementite at about 220 deg. C. Whether or not spontaneous aging, or long heating at 100 deg. C. would cause this has not been determined as far as we know. All lines of evidence point to the absence of crystalline cementite in the martensite of freshly hardened eutectoid or hypo-eutectoid steels, and to its formation on reheating even at temperatures so low that there is no decrease in Brinell or scleroscope hardness. What the product of this low temperature heating should be called is a matter of nomenclature. McAdam has raised a question concerning the structure produced by reheating austenitic manganese steel. The first occurrence is probably the precipitation of free cementite. At this stage the authors would say the structure consisted of austenite plus cementite. After martensitization of the austentic matrix the structure would be described as martensite plus cementite.

For those who believe austenite to contain carbide molecules, there is but one conclusion as to the condition of carbon in martensite. It must be in the form of carbide molecules which have not yet had time to associate themselves into cementite crystals. These molecules, like atoms of carbon, cannot be in equilibrium in solution in alpha iron, since the solubility of carbon in alpha iron is very low.

The authors believe that carbon is dispersed in austenite as atoms, and that the only carbide molecule is a cementite crystal. On this basis the carbon in freshly formed martensite must be largely in the form of carbon atoms, since there is no stage between the atom and the cementite crystal which we know to be absent. This view is consistent with the observation reported by Honda, that the tempering of martensite liberates an amount of heat proportioned to the carbon content of the steel and equal to about one-third of the heat given off during slow cooling at Ar_1.

It is not only possible but quite probable that some of the carbon in martensite combines with the iron to form cementite at room temperature. Brush[3] found a heat evolution at ordinary temperature in recently quenched high-carbon steel so marked that he could measure the temperature rise 35 days after quenching. The maximum temperature rise was, however, a few hours after quenching. Heyn found that the maximum rate of heat evolution in freshly quenched steel when heated occurred at about 360 deg. C. All of these results point to the substantial absence of cementite in freshly formed martensite and to a very incomplete formation in martensite aged for long periods at ordinary temperatures.

Can Internal Strain Harden?

"Internal strain" is referred to frequently as a cause of the hardness of martensite. It is seldom explained just what is meant by "internal strain," or how it could cause hardness. The term seems to mean either internal stresses or internal plastic deformation, or both, and both conditions are supposed to result from the volume change involved in hardening.

The internal stresses which we know to exist in hardening steel correspond exactly to stresses which can be set up in any pure metal or alloy by rapid temperature change. In hardened steel bursting often occurs as a result of these stresses, on account of the great brittleness of the metal, whereas a more ductile material would not show such striking signs of its stressed condition. The internal stresses can be proved to be present, however, and can be removed without changing the hardness. It has been shown without doubt that the stresses in cold-worked alpha brass can be removed without causing any appreciable change in strength or hardness. These stresses are general in character. If it is sought to attribute hardness to local stresses, it must further be remembered that the algebraic sum of all the stresses in a piece must be zero, and any effect of a local tensile stress would be exactly neutralized by a corresponding compression stress. We feel that internal stresses can be disregarded as a cause of hardness.[4]

The view that hardening is due to internal deformations analogous to cold-working is somewhat more plaus-

[1] *J. Iron and Steel Inst.*, No. 1, 1919, p. 469.

[2] A note on the grain size of martensite by Bain and Jeffries now awaits publication, and answers Prof. Sauveur, in part.—Editor.

[3] "Thermal Relations in the Treatment of Steel," by Charles F. Brush, *Trans.*, A.I.M.E., 1919.

[4] See discussion on this subject by Howe, "Metallography of Steel and Cast Iron," pp. 195-6.

ible. If we grant that the volume change is capable of producing slip on a large proportion of the possible planes, then this idea has at least this advantage: it offers as a possible mechanism for the hardening the disregistry of potential slip planes. No appreciable amorphization by such internal deformation seems likely, because if the slips are sufficiently numerous to account for the hardening, they must be very slight in extent and, as pointed out in a later paper of the authors on "The Amorphous Metal Hypothesis," such slips probably do not result in the formation of amorphous metal. Since hardness must be attributed to disregistry, or end support of slip planes, the mechanism of hardening on this basis would be very much the same as the hardening due to grain refinement.

The question is then whether the volume change which accompanies martensitization is capable of producing the necessary amount and distribution of internal slip. Although the cases are not entirely similar, we may consider in this connection the hardening effect in relation to the amount of deformation in ordinary processes of cold-working. The change in linear dimensions on hardening a 1.41 per cent carbon steel is 0.38 per cent, according to Brush. A similar change in the external dimensions of pure iron by cold-working would of course produce a practically negligible hardening effect. The exact manner in which martensitization occurs must be at present largely a matter of speculation. We may say, however, that the expansion effect begins with the formation of the less dense alpha modification. The bulk of the steel is at that time austenite, and it seems that any displacements necessary to accommodate the expansion would take place in the austenite rather than in the newly formed and fine-grained martensite. This preference should continue at least until half of the steel is transformed. The effects of any such deformation in the austenite are obliterated when that phase is transformed, except that such deformation may stimulate the formation of ferrite nuclei in the crystallographic planes of the austenite. It does not seem possible that the volume change could result in a condition in all of the newly formed constituents corresponding to extremely severe cold-working.

Fine Grain Is Principal Hardener

The authors stated that the hardness of martensite was due to two things: (1) The submicroscopic grains of ferrite and (2) the hardening effect of the carbon.

They considered that the presence of submicroscopic grains of ferrite was the major and the carbon the minor cause. According to the thesis presented pure iron by virtue of its absolute cohesion has the potentiality to produce the hardness of martensite if one could minimize the effect of planes of weakness—namely, the potential slip planes of the crystal grains. According to this view, it is possible to develop hardness either by great grain refinement or by the dispersion within larger grains of a few per cent of hard particles of critical size. Either of these conditions may be capable of developing maximum hardness. It is not contended, however, that because either condition is capable of developing maximum hardness such a state often obtains in hardened steels. Usually the critical dispersion of hard particles superimposed on a fine-grained structure will harden, and *vice versa.*

Professor Sauveur calls attention to the general similarity of the authors' conclusions concerning the hardness of martensite and certain proposals made by other investigators, particularly Le Chatelier. The authors pointed out a general similarity between their views and those of Grenet and McCance. It is not strange that these similar views should have been expressed on a subject concerning which so many speculations had been published. It is significant, however, that the opinion prevailing in spite of these theories tended almost universally toward an "allotropic" cause of hardness. Howe says in "Metallography of Steel and Cast Iron" (1916), p. 183: "What is the nature of the intermediate hardened state . . . . ? The agreement is almost universal that it is allotropic in the sense that the iron of the hardened steel is not the alpha iron familiar to us in our common annealed steel. Opinion is divided as to the nature of this allotropy."

X-Rays Have Proved That Beta Iron Does Not Exist

The information obtained by X-ray analysis now permits us to say that the iron of the hardened steel is the alpha iron familiar to us in annealed steel. With the mystic causes of hardening eliminated and with alpha iron demonstrated to be the predominant constituent of martensite, we return again to the two conditions mentioned in the original article as the logical causes of hardening. To attempt to give each of these factors its proper value quantitatively might seem to be carrying speculation too far. The authors wish to make it clear that any evaluation of these two factors would be consistent with the Slip Interference Theory of Hardening inasmuch as grain refinement and dispersion of small hard particles both harden by interfering with slip. Le Chatelier attributed most of the hardness of martensite to the carbon in solid solution. It is now known that the carbon can be present as cementite—for example, after tempering a quenched high-carbon steel at 225 deg. C.—and the steel will yet possess a hardness of the same order of magnitude as martensite. Here is a case where the great hardness cannot be attributed to carbon in solution. It is certain, however, that carbon dispersed in iron as atoms would harden the metal. That the attractive force between carbon and iron atoms is very great is proved by the hardness of cementite. These forces, *per se,* must be manifest in austenite. The extreme hardness of cementite would not be possible without great atomic attractions between iron and carbon, but it is the particular structure of crystalline cementite that makes it possible to utilize this great atomic attraction to form a hard body. Since rather large amounts of carbon in solution do not produce marked hardness in coarse-grained austenite, it seems illogical to suppose that one-third as much carbon in solution in coarse-grained ferrite would produce marked hardening.

Having reached this conclusion, it seems necessary to assume that either the fineness of ferrite grain or the association of iron and carbon atoms into small hard particles (keys) accounts for the hardness. The evidence for the existence of submicroscopic grains has been given above. There is no evidence pointing toward large grains. The evidence for assuming a substantial absence of cementite in freshly formed martensite (which is hard) has been considered. There is considerable evidence to the effect that the carbon and iron atoms in martensite associate *during tempering.* It seems logical, therefore, to attribute the major portion of the hardness of martensite to fineness of grain.

Cleveland, Ohio.

Mineral Rubber*

Results of an Investigation Designed to Bring Out the Desirable and Undesirable Properties of Mineral Rubber—Stress-Strain Data—Ultimate Elongation—Hysteresis Loss—Permanent Set—Resilience—Abrasion Loss—Elongation Under Constant Load—Rate of Plastic Flow—Recovery

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MINERAL RUBBER, or MR as it is known in the trade, belongs to the great class of asphaltic products. In fact the first MR to be placed on the market in England several years ago was a variety of natural asphaltic pitch. Later it was found that the combination of this and similar substances with the harder bitumens, such as gilsonite, gave a product more in demand by the rubber industry. Shortly after the introduction of this material, the so-called asphalt and mixed-base petroleums of the mid-continent and Mexican fields began to be developed. It was found that by blowing the still residues from these oils a material similar to the natural asphalts could be obtained. This, when mixed with gilsonite, gives a satisfactory MR. In practice it is customary to mix the gilsonite and still residue previous to blowing. Recently several firms have brought out MR produced entirely from still residues.

The various grades of MR now on the market have largely been developed by the cut-and-try method. There has been practically no co-operation between MR manufacturer and consumer. In the past the manufacturer has submitted samples to the various companies with the request that they try them out. This was done and one sample was marked "the best." The same practice was continued with other consumers and when a sufficient consumption was assured, large-scale production was begun.

This is fundamentally wrong. Neither producer nor consumer obtain the maximum from the material. No one knows the effect of a slight alteration in physical properties. The purpose of this paper is to bring out the desirable and undesirable properties of MR for the benefit of others who use this material and particularly in order that those who prepare it may appreciate more fully how their product is employed and, having an appreciation of the needs of the trade, that they will endeavor to prepare a more satisfactory material, thus permitting its use in larger quantity.

Experimental Data

Materials Used

The rubber used was a carefully selected pale crêpe of excellent quality.

The MR employed was prepared from mid-continent asphalt residue and gilsonite by the usual blowing procedure. A material meeting the specifications outlined below has been in use for several years and has proved eminently satisfactory. Its aging properties are excellent and there are no difficulties met with in the factory:

Ash.....0.5 per cent
Softening point.....190 ± 10 deg. C.

Cube Method: A cube of MR is suspended on a wire in an air bath with the apex 2.5 cm. from the bottom.

Heating is at the rate of 5 deg. C. per minute. Softening point is taken as that temperature at which the MR flows down and meets the bottom.

Penetration.....70 to 90

New York Penetrometer: 150 g. weight (total weight 200 g.); time, 60 seconds; temperature, 75 deg. C. Standard New York Testing Laboratory Penetrometer Temperature maintained constant for 45 minutes previous to beginning tests.

Acetone soluble.....Maximum 55 per cent

MR crushed to 10 mesh, dissolved in 90 per cent benzene. Kahlbaum's reagent acetone or c.p. acetone redistilled over calcium chloride to which has been added two drops *N*/100 NaOH per 100 c.c. is used as a precipitant. Filter through Gooch.

It might be mentioned that this MR, in common with all other grades known to the writer, is partly converted on vulcanization to an insoluble material. Thus for the grade in question, it has been found that subsequent to vulcanization only about 45 per cent of the added MR may be removed by acetone extraction and about 10 per cent by chloroform. The color of the chloroform extract gives a distinctive test for MR, being dark and fluorescent. Approximately 45 per cent becomes insoluble.

The carbon black, zinc oxide and barytes employed were standard high quality materials.

Formulas

The stocks with but one exception consisted solely of rubber, sulphur and the material under test, and the sulphur ratio was 10 per cent on the weight of the rubber. Fillers such as MR, black, zinc oxide and barytes were added in definite volume ratios to 100 volumes of rubber.

The exception noted will be found under resilience, where for purpose of comparison a base formula of 100 pale crêpe, 5 ZnO, 6 sulphur, 3 thiocarbanilide was taken.

Milling

Batches approximated 1,000 g. in weight and were put up on a small laboratory mill. The MR was placed on the cold rolls first.

Curing

Sheets 2 mm. in thickness were vulcanized at 2½, 2¾, 3, 3¼, and 3½ hours at 141 deg. C. in a standard hydraulic press.

Methods of Conducting Tests

Complete stress-strain curves were obtained on a Scott testing machine by the two-observer method.

Stress-strain data at low elongations and hysteresis loops were obtained on a machine developed by R. D.

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Evans, of the Goodyear Research Laboratories. This machine consists essentially of a large balance. One arm carries a bucket into which water flows at a definite predetermined rate (2 kg. per minute).

By means of a floating siphon an outflow of 1 kg. per minute is maintained, making the rate of loading 1 kg. per minute. On the return or down curve of hysteresis loops it is only necessary to shut off the inflow of water, when the release of load is at the rate of 1 kg. per minute. The test-piece is attached to the other arm and the lower mark kept to certain point by means of a small windlass.

The method of adding load is unique. It is our belief that much of the non-agreement of usual stress-strain data is due to the fact that standard test conditions have not been maintained. In the ordinary testing machine the uniform motion of one jaw does not at all

TABLE I—STRESS-STRAIN DATA
Cure 2¾ hours at 141 deg. C.

Vol. MR to 100 Vol. Rubber	Load in Kg. per Sq.Cm. Producing Elongations, per Cent 100	200	300	400	500	600	700	800	900	Break	Elong. at Break, Per Cent	Tensile at Break* Kg. per Sq.Cm
0	4	6	8	12	18	24	36	70	130	138	960	1,440
1	5	8	11	16	20	30	46	76	....	131	880	1,280
3	5	8	10	14	21	30	49	90	167	190	950	1,960
5	4	6	12	14	21	30	49	91	167	211	950	2,210
7	5	8	13	18	25	36	58	109	188	214	930	2,200
10	4	8	14	20	28	40	66	120	201	210	910	2,120
13	5	8	13	19	28	42	67	112	...	196	900	1,960
15	5	10	13	19	28	41	67	116	191	200	910	2,020
20	6	10	15	21	31	44	70	120	...	200	900	2,080
25	5	9	14	20	28	40	64	112	...	180	900	1,800
30	6	11	15	21	29	41	64	110	173	181	910	1,830
35	6	10	15	20	30	44	70	117	.	178	890	1,760
40	7	11	16	22	30	41	63	106	164	170	910	1,720

*See *Rubber Age*, Sept. 10, 1920, p. 461.

mean that different specimens of even the same stock are tested in exactly the same manner. In the Evans machine all specimens are subjected to exactly the same rate of increase of tension per unit area of cross-section. This condition is obtained by changing the position of the bucket on the arm of the balance to correspond to the cross-section area of the test-piece. For example, with an area of 0.5 sq.cm. and a rate of 1 kg. per minute, the bucket and the test-piece being hung at 100 cm. from the knife edge, the tension is 2 kg. per sq.cm. per minute. Should the next specimen have an area of 0.49 sq.cm., the bucket is hung at 98 cm., the test-piece remaining at 100 cm. from the knife edge, and the rate of loading remains constant at 2 kg. per sq.cm. per minute. Highly gratifying results have been obtained with this machine.

Permanent set data were secured by the modified Davies-North method, which consists of three stretches to 60 per cent of the ultimate elongation, holding 3 minutes for each stretch with a 1-minute interval between; measurement 10 minutes after the third release.

Abrasion tests were made with a rough carborundum wheel 20 cm. in diameter; face 5 cm. wide; a weight of 6,800 g. placed 50 cm. from fulcrum; center of abrasion block to fulcrum, 20 cm.; abrasion block, 8.6 x 12.5 x 1.3 cm. Wheel is kept clean by a wire brush and rotates at 20 r.p.m. The volume of material removed in 200 revolutions (10 minutes) is taken as the abrasion loss.

Penetration tests were run on a simple apparatus which consists essentially of a platform mounted on a rod. The contact point is a sphere 9.5 mm. in diameter. A load of 4,500 g. is applied and the penetration of the ball into the rubber (using standard abrasion blocks) in 1 minute is read off in hundredths of a millimeter.

Elongation under constant load experiments were performed by suspending test-pieces which varied within 5 per cent in cross-section under loads of 1 and 3 kg.

The results of these experiments are given in Tables I to XII and in Figs. 1 to 12.

Discussion of Data

Stress-Strain Data

From the stress-strain data given for the 2¾-hour curve at 141 deg. C. in Tables I and IV and Fig. 1, the following observations may be made:

1. At low elongations MR is without stiffening action.

2. Up to 600 per cent elongation the individual stress-strain curves show scarcely any increase in load, but beyond this point the curves take a sharp right-angle bend. Most of the load necessary for rupture is applied in the region from 600 to 900 per cent elongation. This is characteristic of pure gum stocks. In other words, the stress-strain curves of stocks containing from 0 to 40 volumes MR per 100 volumes of rubber are quite similar.

3. Load at break (tensile strength) increases up to 7 volumes MR and then falls off slightly. The slight fall off indicates that MR is without overloading tendencies.

4. Tensile at break (corrected to area at break) accentuates the desirable properties of MR. The range of greatest efficiency is from 3 to 15 volumes and the maximum is reached at about 7 volumes MR to 100 volumes of rubber.

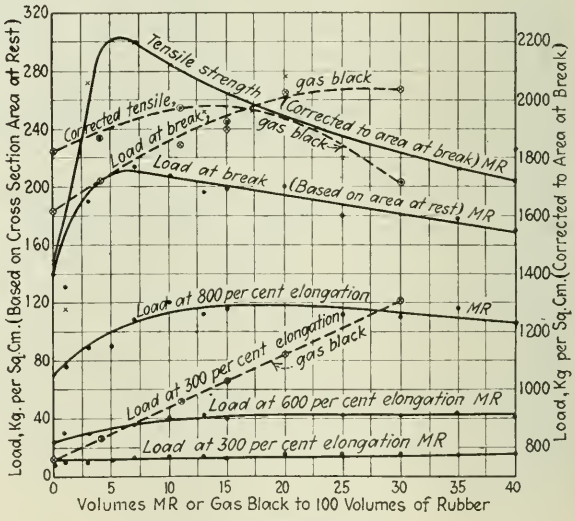

Tensile strength
gas black
Corrected tensile
Load at break
gas black
(Corrected to area at break) MR
Load at break
(Based on area at rest) MR
Load at 800 per cent elongation
MR
Load at 300 per cent elongation
gas black
Load at 600 per cent elongation MR
Load at 300 per cent elongation MR
Load, Kg. per Sq.Cm. (Based on Cross Section Area at Rest)
Load, Kg per Sq.Cm. (Corrected to Area at Break)
Volumes MR or Gas Black to 100 Volumes of Rubber

FIG. 1—STRESS-STRAIN DATA
Cure 2¾ hr. at 141 deg. C.

5. The gas black curve at 300 per cent elongation shows a straight line stiffening action very different from the 300 per cent elongation curve for MR, which is flat.

6. The gas black load at break curve is much higher than MR, but due to higher ultimate elongation (greater necking down of the MR test-pieces) the tensile at break curve for black is somewhat lower than for MR.

The conclusion from these curves is that MR in small quantities, certainly to 10 and for many purposes 15 volumes to 100 volumes of rubber, has a beneficial

TABLE II—STRESS-STRAIN DATA
Cure giving maximum tensile strength.

Vol. MR to 100 Vol. Rubber	Cure at 141 deg. C., Hr.	Load in Kg. per Sq.Cm. Producing—Elongation, per Cent— 100	300	600	800	Break	Ultimate Elongation	Tensile at Break*
0	3	4	10	30	102	211	935	2,190
1	3½	5	13	41	124	168	860	1,610
3	3	5	12	36	114	230	935	2,380
5	3	5	14	35	107	212	945	2,220
7	2½	5	13	36	108	214	930	2,300
10	2½	4	14	40	123	210	910	2,120
13	2½	5	14	38	98	200	930	2,060
15	3	6	14	44	131	220	920	2,340
17	3	4	14	41	130	224	935	2,320
20	3½	7	16	51	146	224	900	2,240
25	3	5	16	48	137	200	875	1,950
30	3	7	18	48	128	191	890	1,890
35	3½	7	17	52	138	190	890	1,880
40	3	7	18	53	112	172	880	1,690

* See *Rubber Age*, Sept. 10, 1920, p.461.

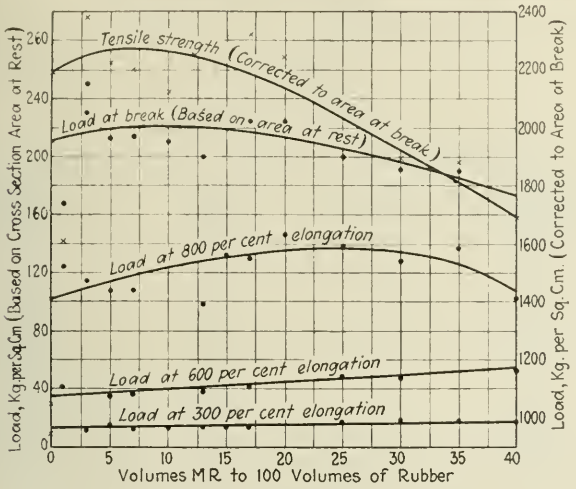

Tensile strength (Corrected to area at break)
Load at break (Based on area at rest)
Load at 800 per cent elongation
Load at 600 per cent elongation
Load at 300 per cent elongation
Load, Kg. per Sq.Cm. (Based on Cross Section Area at Rest)
Load, Kg. per Sq.Cm. (Corrected to Area at Break)
Volumes MR to 100 Volumes of Rubber

FIG. 2—STRESS-STRAIN DATA
Cure selected by highest tensile strength

effect on rubber. Beyond this point it behaves as a diluent, but a harmless one so far as the stress-strain curve is concerned.

In Table II and Fig. 2 the stress-strain data are arranged according to the cure giving the highest tensile strength. The stocks were used in the hysteresis tests described below. The same conclusions may be drawn from these curves but the data are not quite so good.

Ultimate Elongation

In Tables I and II and in Fig. 4 ultimate elongation values are shown for the 2¾-hour cure at 141 deg. C. and for the cures giving maximum tensile strength. A slight decrease with increase in MR is indicated.

Stress-Strain Data at 100 Per Cent Elongation

The work at 100 per cent elongation (Table V and Fig. 5) is important because in actual service we seldom

TABLE III—PERMANENT SET.

Vol. MR to 100 Vol. Rubber	Perm. Set, Per Cent	Vol. Gas Black* to 100 Vol. Rubber	Perm. Set, Per Cent	Vol. ZnO* to 100 Vol. Rubber	Perm. Set, Per Cent	Vol. Barytes* to 100 Vol. Rubber	Perm. Set, Per Cent
0	6	0	6	0	4	0	6
1	6	0.5	10	0.5	5	0.5	10
3	6	2	13.5	2	8	1	10
5	6	4	14	4	7	2	10
7	6	6	15	6	10	3	10
10	6	8	17	11	16	6	10
13	8	11	22.5	15	17	8	10
15	8	15	27	20	22	11	15
17	8	20	32.4	25	24	15	20
20	8	30	40	30	26	20	20
25	10	35	43	35	29	25	25
30	12	40	40	40	27	30	25
35	12	..	....	..	..	35	25
40	14	.	....	..	..	40	30

* See *Rubber Age*, Sept. 10, 1920, p.465.

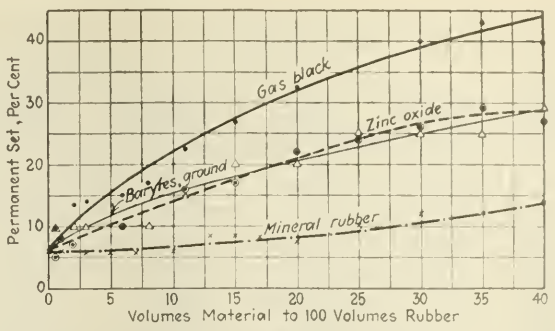


FIG. 3—PERMANENT SET

get much higher elongations—for example, in tires and tubes 100 per cent probably represents the upper limit of flexing.

The curves show the following:

(a) The variations of Scott machine readings as compared with the Evans machine show the Scott to be of little value at this elongation.

(b) First loop, Evans machine, shows a slight stiffening action not observable from Fig. 1.

(c) From a service standpoint we are not interested in the first hysteresis loop, but are greatly concerned with the behavior of our stocks after there has been sufficient flexing to bring about an equilibrium or readjustment within the stock. After five successive stretches there is little change with additional flexing.

TABLE IV—GAS BLACK STRESS-STRAIN DATA

Vol. Gas Black to 100 Vol. Rubber	Load in Kg. per Sq. Cm. Producing 300 Per Cent Elongation	Break	Ultimate Elongation Per Cent	Tensile at Break, Kg. per Sq.Cm.
0	12	182.5	900	1,825
4	26	204	820	1,870
11	51	229	760	1,970
15	66	240	700	1,920
20	84	265	640	1,960
30	121	267	545	1,720

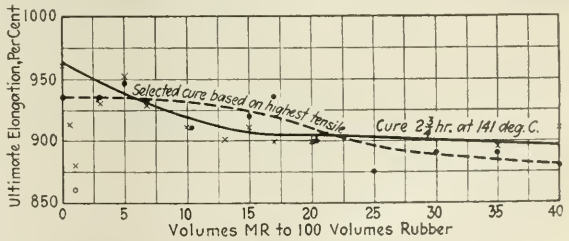

Selected cure based on highest tensile
Cure 2¾ hr. at 141 deg. C.
Ultimate Elongation, Per Cent
Volumes MR to 100 Volumes Rubber

FIG. 4—ULTIMATE ELONGATION

The sixth loop curve (Evans machine) is practically flat, but has a slight downward slant with increase in MR.

Stress-Strain Data at 300 Per Cent Elongation

The curves in Fig. 6 (based on the data in Table VI) show the following:

(a) The variations between the Scott and Evans readings are now less, showing that the minimum elongation above which the Scott becomes fairly accurate has been passed.

(b) All curves show a slight upward trend indicating slight stiffening action.

Energy Input

The hysteresis loops were run to a constant load of 20 kg. per sq.cm. By measuring the area under the

TABLE V.—LOAD PRODUCING 100 PER CENT ELONGATION

Vol. MR to 100 Vol. Rubber	Cure at 141 Deg. C. Hr.	Scott Machine Kg. per Sq.Cm.	Evans Machine: Up Curve, 1st Hysteresis Loop, Kg. per Sq.Cm.	Evans Machine: Up Curve, 6th Hysteresis Loop, Kg. per Sq.Cm.
0*	3	4	5.5	...
1	3¼	5	6.5	5.9
3	3	5	6.3	5.7
5	3	5	5.5	5.7
7	2¾	5	5.7	5
10	2¾	4	5.7	5
13	2½	5	6.2	5.6
15	3	6	6.3	5.5
17	3	4	6.5	5.7
20	3¼	7	6.5	5.7
25	3	5	7	5.9
30	3	7	6.7	5.6
35	3¼	7	7	5.6
40	3	7	6.7	5.1

* This test was run on a different lot of rubber and at a different time from those below.

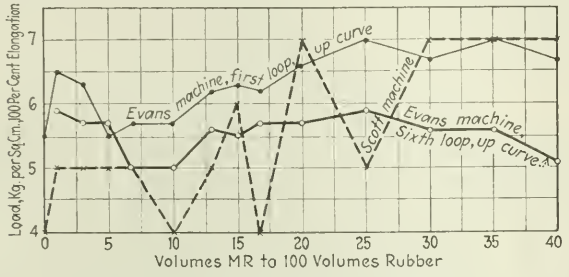

Load, Kg. per Sq.Cm. 100 Per Cent Elongation
Evans machine, first loop, up curve
Scott machine
Evans machine, Sixth loop, up curve
Volumes MR to 100 Volumes Rubber

FIG. 5—STRESS-STRAIN DATA
Load at 100 per cent elongation. Cure giving maximum tensile strength.

up curve and converting it to energy units of kilogram centimeters per cubic centimeter (kg.-cm. per cu.cm.) the energy input is obtained. (See Table VII and Fig. 7.) This corresponds to Wiegand's energy of resilience, but is limited to the lower portion of the curve. As pointed out above, it is this portion of the curve in which we have the greatest interest.

The energy input, or capacity to absorb energy, shows

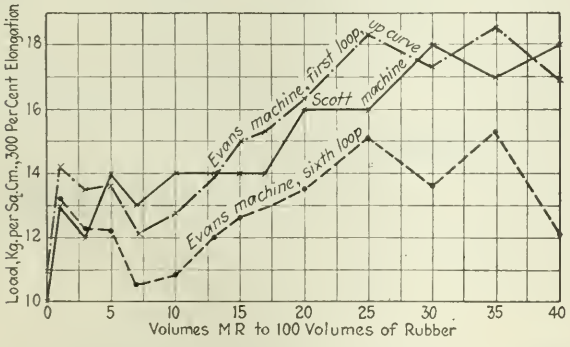

Load, Kg. per Sq.Cm., 300 Per Cent Elongation
Evans machine, first loop, up curve
Scott machine
Evans machine, Sixth loop
Volumes MR to 100 Volumes of Rubber

FIG. 6—STRESS-STRAIN DATA
Load at 300 per cent elongation. Cure giving maximum tensile strength.

TABLE VI—LOAD PRODUCING 300 PER CENT ELONGATION

Vol. MR to 100 Vol. Rubber	Cure at 141 Deg. C. Hr.	Scott Machine Kg. per Sq.Cm.	Evans Machine: Up Curve, 1st Hysteresis Loop, Kg. per Sq.Cm.	Evans Machine: Up Curve, 6th Hysteresis Loop, Kg. per Sq.Cm.
0*	3	10	11	...
1	3¼	13	14.2	13.2
3	3	12	13.5	12.2
5	3	14	13.6	12.2
7	2¾	13	12.1	10.5
10	2¾	14	12.8	10.8
13	2½	14	13.8	12
15	3	14	15	12.6
17	3	14	15.3	12.9
20	3¼	16	16.3	13.5
25	3	16	18.3	15.1
30	3	18	17.3	13.6
35	3¼	17	18.5	15.3
40	3	18	17	12.1

* This test was run on different lot of rubber at a different time from those below.

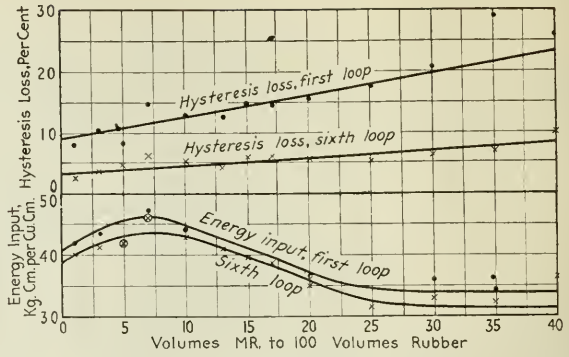

Hysteresis Loss, Per Cent
Hysteresis loss, first loop
Hysteresis loss, sixth loop
Energy Input, Kg. Cm. per Cu. Cm.
Energy input, first loop
Sixth loop
Volumes MR to 100 Volumes Rubber

FIG. 7 (ABOVE)—ENERGY INPUT
Cure giving maximum tensile strength. Run to constant load of 20 kg. per sq.cm.

FIG. 8 (BELOW)—HYSTERESIS LOSSES
Cure giving maximum tensile strength. Run to constant load.

TABLE VII—ENERGY INPUT
Hysteresis loops run to constant load of 20 kg. per sq. cm.

Vol. Mr. to 100 Vol. Rubber	Cure at 141 Deg. C. Hr.	Energy Input: First Loop Kg. Cm. per Cu.Cm.	Energy Input: Sixth Loop Kg. Cm. per Cu.Cm.
0*	3	64.2	...
1	3¼	42	40
3	3	43.5	41.5
5	3	41.8	41.85
7	2¾	47.1	46
10	2¾	44.25	42.8
13	2½	41.3	40.8
15	3	41.1	39.7
17	3	39.8	39
20	3¼	36.8	35.2
25	3	34.1	31.94
30	3	36.2	33.92
35	3¼	34.4	31.70
40	3	51.4	36.6

* This test was run on a different lot of rubber at a different time from those below.

a maximum at 7 volumes MR, beyond which there is a gradual falling off.

An interesting feature is the slight difference between the curves for the first and sixth loops. With gas black or zinc oxide the difference is quite marked. This is but another indication of the plasticity (reversible plastic flow) or MR.

Hysteresis Loss

The hysteresis loss is given in per cent based on the

TABLE VIII—HYSTERESIS LOSS
In Per Cent based on energy input Table VII

Vol. MR. to 100 Vol. Rubber	Cure at 141 Deg. C. Hr.	Hysteresis Loss: First Loop Per Cent	Hysteresis Loss: Sixth Loop Per Cent
0*	3	13.5	....
1	3¼	8	3
3	3	10.25	3.8
5	3	8.3	4.2
7	2¾	14.85	6.2
10	2¾	12.98	5.2
13	2½	12.85	4.9
15	3	14.95	5.6
17	3	14.8	5.7
20	2¾	15.6	5.9
25	3	17.7	5.5
30	3	20.9	6.9
35	3¼	29	7.3
40	3	26	10.2

* Tests run on different lot of rubber at a different time

energy input described above. The following observations may be made from Table VIII and Fig. 8:

(a) Hysteresis losses for MR are straight line functions and show a slight increase with increase of MR. The curves for gas black and zinc oxide are not shown. However, they are straight lines but much steeper. Thus the slopes (tan α) are as follows:

TABLE IX—ENERGY OF RESILIENCE

Scott machine stress-strain curves. Area between curve and elongation axis converted to kg. cm. per cu.cm. Cure 2¾ hours at 141 deg. C.

Vol. MR to 100 Vol. Rubber	Area, Sq. Cm.	Resilience, Kg.-Cm. per Cu.Cm.	Vol. Black * to 100 Vol. Rubber	Resilience Kg.-Cm. per Cu.Cm.
0	41.5	258	0	350
1	40.1	248	5	400
3	55.8	346	10	460
5	65.5	405	20	550
7	67.5	417	30	525
10	67	415	...	...
13	61.2	379		
15	67	415		
17	62.3	386		
20	66.5	412		
25	60.6	376		
30	65.1	404		
35	66.8	414		
40	63.8	395		

* Base Formula;
100 Pale crêpe
5 ZnO
6 S
3 Thiocarbanilide
Cure 1½ hour at 141 deg. C.

Data by W. W. Vogt

	Tan α	
Zinc oxide (3rd loop)	0.39	Data by W. W. Vogt
Gas black (3rd loop)	0.475	" "
MR (1st loop)	0.18	
MR (6th loop)	0.06	

Permanent Set

By permanent set is meant irreversible flow, whether it be plastic or merely due to change in position of the particles of filler. The test employed in these experiments was purposely designed to measure irreversible flow. The results are given in Table III and Fig. 3. It is well known that successive stretching, producing an internal readjustment within the test-piece, greatly increases the tensile strength and also brings out the maximum permanent set.

The stretch was placed at 60 per cent of the ultimate elongation, because it was found that most compounds could be repeatedly stretched to this elongation without having them develop flaws and fail prematurely.

As will be discussed further below, MR behaves as a supercooled liquid. Its plastic flow is reversible. Therefore this test for MR. Its curve lies considerably below those shown for black, zinc oxide and barytes.

There is a peculiar relation between permanent set and hysteresis loss as measured in this experiment. In both these tests adequate time for plastic flow is provided. The curves of hysteresis loss and permanent set are practically straight lines. The following are the slopes (tan α) taken at 25 vol. filler:

	Slope (tan α) Permanent Set	Slope (tan α) Hysteresis Loss	
MR	0.06	(6th loop)	0.06
Gas black	0.58	(3rd loop*)	0.475
Zinc oxide	0.34	(3rd loop*)	0.39

From this comparison it appears that there is more than a mere coincidence in this relationship. It is not improbable that both tests measure the same thing. It is becoming more apparent that a machine is needed which will give accurate hysteresis loops, automatically graphed within very short intervals of time. This is no more than what actually goes on in a tire on the road.

Resilience

The term resilience was first applied in rubber testing by W. B. Wiegand. It represents the energy which has been absorbed or put into the test-piece on being stretched to the point of rupture, and is determined by measuring the area between the curve and the elongation axis. For purposes of convenience this area has been converted into energy units (kg.-cm. per cu.cm.) in Table IX and Fig. 9. The MR data are taken from the curves obtained on stocks cured 2¾ hours at 141 deg. C. Gas black, though compounded in a different formula, is shown by way of comparison.

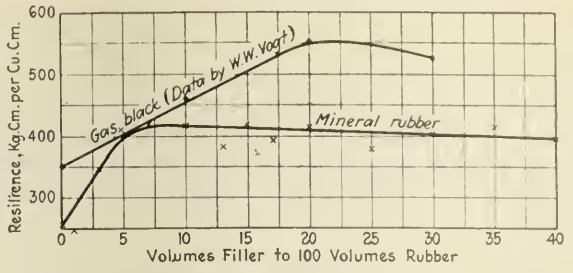


FIG. 9—RESILIENCE

The gas black curve is a straight line up to 20 volumes. The slope of this line is 0.50, which for some reason is almost the same as that of the hysteresis loss, which is 0.475.

The MR curve is somewhat different. Up to 5 volumes of MR it is a straight line (tan $\alpha = 1.5$), showing that within these limits MR does increase the energy absorption capacity of the stock. Beyond this point there is a slight falling off. However, the remainder of the curve is a straight line. This is another illustration of the peculiar inertness of MR when employed beyond the point of its maximum efficiency. As far as the writer can determine the only evidence of its presence in large quantity is in a slight raising of abrasion loss and the loginess, further discussed below.

Abrasion Loss

The effect of MR on abrasion loss has been a matter of interest for some time. The data in Table X and Fig. 10 show that with increased MR the abrasion loss increases. Penetration tests show little if any change in hardness of the stocks with increase in MR.

Elongation Under Constant Load

The old work of Schwartz (Schidrowitz, *Rubber*, p. 241) on this subject is now well known. He found that elongation under load follows the equation

$$x = a + b \ (\log \ t).$$

Where x = elongation at the end of an interval of time t.

a = elongation at the end of the first minute.

b = a constant depending on the plastic flow of the stock.

His work was checked by the writer (*Rubber Age*,

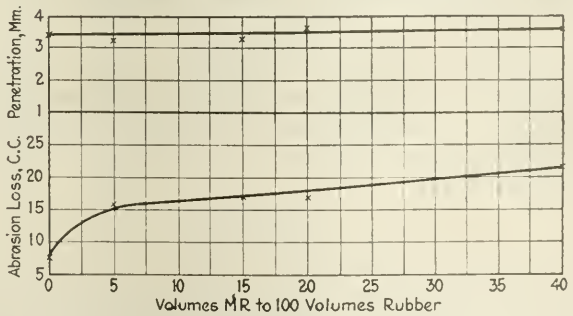


FIG. 10—PENETRATION AND ABRASION LOSS

TABLE X—ABRASION LOSS

Vol. MR to 100 Vol. Rubber	Loss in Weight, G.	Sp. Gr.	Volume Abraded, c.c.	Penetration, mm.
0	7.7	0.97	7.94	3.43
5	13.3	0.98	13.6	3.38
15	16.6	0.98	17	3.43
20	16.6	0.98	17	3.52
40	21.8	1.00	21.8	3.53

Sept. 10, 1920, p. 464) who found that for heavily loaded stocks b actually was a constant and $(x - a)$ plotted against $\log_e$ time gave a straight line.

If b actually is a constant depending on the plastic flow of the stock, it would at once appear that this value determined for each stock when plotted against volumes of MR should show an increase with increased MR ratio to rubber.

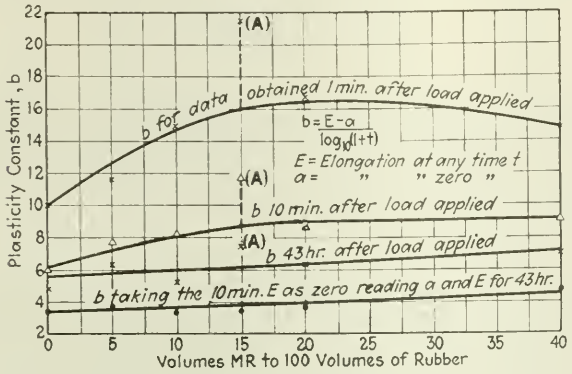

Plasticity Constant, b
Volumes MR to 100 Volumes of Rubber
(A)
b for data obtained 1 min. after load applied
b = E - a / log(1+t)
E = Elongation at any time t
a = " " zero "
b 10 min. after load applied
b 43 hr. after load applied
b taking the 10 min. E as zero reading a and E for 43 hr.

FIG. 11—PLASTICITY

NOTE—The observations marked (*A*) checked in another experiment. If correct, the similarity to the jump in viscosity of olive oil-water emulsions at 80 per cent oil might be pointed out.

TABLE XI—PLASTICITY

Vol. MR to 100 Vol. Rubber	*b* Taken at 1 Min. After Load Is Applied	*b* Taken at 10 Min. After Application of Load	*b* Taken at 2,600 Min. After Application of Load	*b* Using 10 Min. Readings as Zero and 2,600 Min. (43 Hr.) After Application of Load
0	10	6	4.7	3.4
5	11.6	7.66	6.3	3.7
10	14.9	8.13	5.2	3.3
15	21.5	11.7*	7.4	3.4
20	16.5	8.6	6.24	3.7
40	14.9	9.1	7	4.66

* This value checked 10.5 on another test.

The original equation is not well written from a mathematical standpoint, since at zero time, the log of which is infinity, we have $x = a$.

If E = the elongation at any period of time t
a = elongation at zero time—i.e., when the load is just applied.
b = a constant.

$$E = a + b\ [\log_e\ (1 + t)].$$

Now in zero time the second member becomes b times zero and therefore $E = a$, which is correct.

The so-called plasticity constant then equals

$$b = \frac{E - a}{\log_e\ (1 + t)}$$

Since the question of natural or Briggs logs merely introduce a constant ratio, $\log_{10}$ may be employed. Therefore the work summarized in Table XI and Fig. 11 was done with

$$b = \frac{E - a}{\log_{10}\ (1 + t)}$$

Using this method, b values were obtained for compounds containing 0, 5, 10, 15, 20 and 40 volumes MR to 100 volumes of rubber. Values of b were calculated for readings taken 10 minutes and 2,600 minutes (143 hours) after application of load. Intermediate readings were taken, but since it was impossible to maintain temperature conditions within reasonable variation, only the four sets of values are given. It will be seen at once that the b values for 10 and 2,600 minutes are not the same. The variations range from 20 to 50 per cent. However, the readings in each group are comparable since they were made under exactly similar conditions.

Using the 10-minute values, it appears that plasticity (if b value indicates it) increases up to 15 volumes and then falls off slightly. In 2,600 minutes there can be no conclusion unless that in this time MR has reached a final position, since b values are practically constant.

In order to check this theory the readings obtained at 10 minutes were taken as zero and calculated in conjunction with those taken in 2,600 minutes. A remarkable agreement is shown. With the exception of the 40-volume compound the other constants show a variation from the mean of but 6 per cent, which points to the hypothesis that within 10 minutes the MR has become adjusted to the new conditions and therefore it is no longer a factor in b value, which now approximates that of pure gum.

If the flow of MR is really responsible for the peculiar results obtained, it would be expected that greater variation would be found shortly after load is applied. The b values calculated for readings taken 1 minute after application of load show marked variation but a progressive increase in b value up to 15 volumes of MR, after which a falling off is indicated.

Rate of Plastic Flow

In view of the fact that the b of the Schwartz equation is so obviously not a constant, it occurred to the writer that the rate of flow (millimeters extension per minute) is a much more logical method of attack.

Table XII shows the rates of extension at different times for the various MR stocks. From the data obtained when the test-pieces were suspended under a load of 1 kg., the following conclusions may be drawn:

(a) Average of all the rates determined over 43 hours show about double the pure gum velocity for all a stocks containing MR.

(b) After 43 hours suspension, flow is very small.

(c) One minute velocities show gradual increase with increase in MR up to 20 volumes, when its filling effects retards the rate.

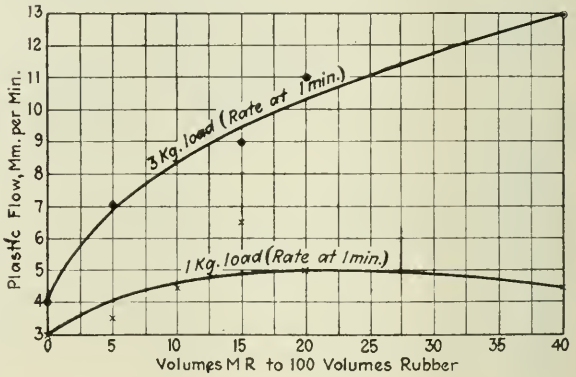


FIG. 12—RATE OF PLASTIC FLOW

The experiments with 3 kg. load were carried only to 1 hour. Due to the increased elongation the conclusions that may be drawn are somewhat different from the above. For example,

(a) The averages of all the rates determined within the hour show a gradual increase with increase in MR.

(b) A very decided increase in rate of extension with 3 kg. load in 1 minute is shown. At 40 volumes MR the pure gum velocity is more than trebled.

The rate of plastic flow appears to be quite susceptible to temperature change.

TABLE XII-A—RATE OF PLASTIC FLOW

Load 1 kg.; rate in mm. per min.

Vol. MR to 100 Vol. Rubber	Rate at 1 Min.	Rate at 10 Min.	Rate at 70 Min.	Rate at 43 Hr. (2,600 Min.)	Average Of All Rates	Average Over Entire 2,600 Min.
0	3	0.4	0.05	0.002	0.048	0.005
5	3.5	1	0.033	0.0018	0.1	0.008
10	4.5	0.6	0.033	0.0017	0.07	0.007
15	6.5	1	0.033	0.0036	0.109	0.010
20	5	0.9	0.024	0.002	0.097	0.008
40	4.5	0.85	0.01	0.004	0.094	0.009

Load 3 kg.; rate in mm. per min.

Vol. MR to 100 Vol. Rubber	Rate at 1 Min.	Rate at 11 Min.	Rate at 60 Min.	Rate Over Entire 60 Min.	Average All Rates Determined
0	4	0.5	0.03	0.217	0.74
5	7	0.5	0.054	0.334	1.31
10	Developed flaws				
15	9	0.5	0.11	0.384	1.52
20	11	0.5	0.135	0.485	1.83
40	13	0.5	0.11	0.535	2.16

From the above data it is conclusively shown that MR does increase the plastic flow of stocks containing it. The amount of this flow depends on the quantity of MR present and on the load applied.

Recovery

As mentioned above, the flow of MR is reversible. MR behaves as a true supercooled liquid. The test-pieces used in elongation under constant load experiments were measured at intervals after the recovery noted. The following conclusions are in order:

(1) Load 1 kg.; time 24 hours. (See Table XII-B.)

(a) Average rates of recovery (mm. per min.) taken from the ten readings over the 24-hour period show about the same values for pure gum and stocks containing 5 and 10 volumes MR. For 15, 20 and 40 volumes MR the rate is appreciably decreased (75 per cent of that for pure gum).

(b) Proportional recovery as shown by 1-minute readings, based on pure gum shows no change until 15 volumes MR is reached, when it drops to about 75 per cent of that shown by pure gum.

(c) Proportional recovery for the entire 24 hours shows the same recovery for MR stocks as for pure gum.

(2) Load 3 kg.; time 1 hour. (See Table XII-C.)

(a) Average of six readings during 1 hour shows about same rate of flow for pure gum and stock containing 5 volumes MR. For 15, 20 and 40 volumes the rate shows an increase with increase in MR.

(b) The proportional recovery over 1 hour is only 66 to 85 per cent of that shown by pure gum.

(c) A similar conclusion may be drawn from the 2-minute readings. The 5-volume MR and the pure gum have the same proportional recovery, but the others are considerably lower—85.5, 95 and 77.8. Had a 1-minute reading been taken, there would have been a greater contrast.

The general conclusion from these experiments is that MR does not greatly retard the ultimate recovery. However, it introduces a time factor in that the come-back within the first minute or two after release is considerably retarded when over 15 volumes of mineral rubber are introduced.

In other words, MR, being a viscous or supercooled liquid, flows with the rubber when strained and is forced back by the contraction of the rubber when released. To use a common illustration, it behaves like a door check. It not only appreciably prevents ultimate recovery but it has a decided damping effect on immediate comeback.

It is because of this property that loaded stocks containing MR are frequently logy or sluggish. In many cases this is a serious defect. For example, consider a high MR solid tire tread. In service it receives shocks of more or less magnitude all the time. If the speed is such that the tire cannot regain its original contour from blow to blow, the effect is to strain the stock in progressively increasing amounts until the elastic limit is approached and failure begins. Such a tread flattens down, cuts and gives very low life. In pneumatic tire treads, high MR produces loginess, which in turn causes tread separation and excessive wear.

This is the chief criticism of the MR of today. If it were possible to alter its physical properties so as to eliminate the tendency to produce loginess, there is little doubt that such a mineral rubber would be more extensively employed and in larger quantities.

TABLE XII-B—RECOVERY, 1 KG. LOAD

Vol. MR to 100 Vol. Rubber	Recovery in 24 Hr. Mm.	Set Shown Immediately on Release, Mm.	Recovery in 24 Hr., Based on Immediate Set, per Cent	Proportional Recovery Based on Pure Gum as 100	Rate of Flow: Average of All Rates Mm. per Min.
0	4.75	8	59.5	100	0.168
5	5.	8	62.5	105	0.215
10	4.	6.5	61.5	103	0.164
15	4.5	7.	64.3	108	0.117
20	4.	6.	66.7	112	0.113
40	4.75	7.25	65.5	110	0.13

Vol. MR to 100 Vol. Rubber	Recovery in 1 Min., Mm.	Set Shown Immediately on Release, Mm.	Recovery in 1 Min. Based on Immediate Set, per Cent	Proportional Recovery Based on Pure Gum as 100
0	1.5	8.	18.8	100
5	2.	8.	25.	133
10	1.5	6.5	22.	117
15	1.	7.	14.3	76
20	1.	6.	16.7	89
40	1.	7.25	13.8	73.7

TABLE XII-C—RECOVERY, 3 KG. LOAD.

Vol. MR to 100 Vol. of Rubber	Recovery in 1 Hr. Mm.	Set Shown Immediately on Release Mm.	Recovery Based on Immediate Set per Cent	Proportional Recovery Based on Pure Gum as 100	Rate of Flow: Average of All Rates, Mm. per Min.
0	3.5	6	58.4	100	0.237
5	3.	6	50.	86	0.215
10	Flaws	..	....	....	....
15	4.	9	44.5	76.4	0.278
20	3.5	9	38.9	66.6	0.29
40	5.5	11	50.	85.5	0.368

Vol. MR to 100 Vol. of Rubber	Recovery in 2 Min., Mm.	Set Shown Immediately on Release, Mm.	Recovery Based on Immediate Set, per Cent	Proportional Recovery Based on Pure Gum as 100
0	1.75	6	29.2	100
5	1.75	6	29.2	100
10	Flaws	..	....	....
15	2.25	9	25.	85.5
20	2.5	9	27.8	95
40	2.5	11	22.7	77.8

Summary

1. MR has a beneficial effect on the physical properties of rubber when employed in proportions from 3 to 15 volumes to 100 volumes of rubber. The maximum effect is found at 7 volumes per 100 volumes of rubber. This statement is proved by experiments on tensile at break, energy input and resilience.

2. Beyond 15 volumes to 100 volumes of rubber, MR

is practically inert, as is shown by stress-strain curves, ultimate elongation, energy input and resilience.

3. MR is essentially a plastic material and while it is subject to considerable plastic flow very little of this flow is irreversible. This is demonstrated by: hysteresis loss in experiments in comparison with black and zinc oxide, permanent set experiments, elongation under constant load and recovery.

4. A remarkable agreement is shown by a comparison of the slopes of the curves for permanent set with hysteresis loss for MR, ZnO and gas black. It is recommended that a machine for automatically graphing hysteresis loops within short intervals of time be developed.

5. When present in compounds in excess of 15 volumes of MR to 100 volumes of rubber, a decided loginess is imparted. The limit at which loginess first appears is considerably dependent on the quantity of other filler present. In pure gum 15 volumes is the limit. This loginess is simply a slowing up of the recovery. MR thus acts similar to a door check, and while the eventual recovery is the same as for pure gum, this is a most serious objection to more extensive use of MR. In service complete recovery from blow to blow is prevented and the effect of successive impacts becomes more serious than if the stock had the property of rapid recovery.

6. Mineral rubber is today one of our cheapest compounding ingredients. It is hoped that the above data will prove of value to both consumer and manufacturer of MR and that the time is not far distant when an MR will be placed on the market free from any tendency to produce loginess.

Industrial Conditions in Polish Upper Silesia

A SURVEY of the industries acquired by Poland in the Upper Silesian territory by the decision of the League of Nations is given in *Commerce Reports* for Jan. 30, 1922.

The coal production for 1913 of the mines assigned to Poland was 32,829,000 tons; in 1920 these mines produced 24,637,000 tons and those in present German territory 7,114,000 tons. The net coal production of the former Polish territory (Congress Poland and Galicia) at present may be put at about 6,000,000 tons. It is estimated that, with the acquisition of the Upper Silesian territory, Poland can export about 10,000,000 tons in 1922.

Iron Ore Resources

The deposits of iron ore in Upper Silesia are nearly exhausted. However, there is every reason to believe that within the next few years the large deposits of ore in Congress Poland will be further developed and able then to furnish practically the entire ore requirements of the Upper Silesian furnaces. The present low value of German and Polish currency is an inducement to the development of these ores as against purchases from Sweden or other countries with a high rate of exchange.

Estimates of the reserves of iron ore in Congress Poland range from 300,000,000 to 600,000,000 tons. In the Radon and Kielce districts of Congress Poland there are deposits of ferromanganese ores.

In September, 1920, there were twenty-five active blast furnaces in Upper Silesia and twelve inactive. Of these, fifteen active and seven inactive furnaces are now on the Polish side. During the period April 1, 1920, to March 31, 1921, the production of pig iron was 624,000 tons, of which 407,000 tons was produced in the furnaces now located within Poland. The production of steel-converting plants for the same period was 1,147,000 tons (chiefly Martens steel), of which 838,000 tons was produced in what are now Polish plants. The production of finished steel product in the rolling mills was 793,000 tons, of which 628,000 tons was produced in present Polish property.

Zinc, Silver and Lead

Practically the entire zinc-smelting and manufacturing industry will be in Polish territory. All of the thirteen roasting plants (about 250 furnaces), the sixteen zinc smelting plants (316 furnaces) and the two lead smelters will be in Polish territory, together with five of the eight zinc-plate rolling mills. The production of raw zinc in Upper Silesia fell from 169,400 tons in 1913 to 81,400 tons in 1920. The production of lead in the two lead and silver smelting plants which are now in Poland was 41,800 tons in 1911 (the maximum year), but only 17,200 tons in 1920, while the silver production fell from 10,620 to 3,110 kilos. The total output of zinc plate in 1913 was 49,200 tons, of which the mills now allocated to Poland produced 42,500 tons. The output of all these plants in 1920 was 34,170 tons.

Other Industries

The production of sulphuric acid as a byproduct of the zinc ore roasting industry is an important acquisition for Poland. The output of sulphuric acid in 1913 was 255,600 tons (50 per cent acid), while that in 1920 was 183,300 tons. The Upper Silesian sulphuric acid will also be important for the local manufacture of superphosphates in Poland.

In connection with the acquisition of coking plants in Upper Silesia, Poland now obtains as a byproduct of that industry a large quantity of material for the manufacture of superphosphate, as well as the basis for developing a substantial chemical and dye industry. The products of dry coal distillation in Upper Silesia in 1920 included 112,413 tons of tar, 32,146 tons of ammonium sulphate and 26,153 tons of benzene. Plants producing about half of this output are now located within the boundaries of Poland. The large superphosphate plant in the Kattowitz district falls to Poland, as well as the nitrogen fertilizer factory in Chorzow. The output of materials in the Polish part of Upper Silesia is sufficient for the requirements of these plants and their finished products, together with Thomas slag from the phosphoric Polish iron ores, will go far to provide for Polish requirements of phosphatic and nitrogenous fertilizer.

Opportunities for American Export

The annexation of Silesian territory to Poland is likely to offer increased opportunities for American exports to Poland and for a change in their prevailing character. Hitherto, apart from the temporary shipments of foodstuffs to Poland, most of the American exports to that country have been raw cotton and railway equipment. The annexation of this territory will open a large field for American machinery and tools, both in Upper Silesia itself and in the industries of other parts of Poland, which will be developed as the result of the acquisition of coal and materials from that district.

Extraction of Nickel and Alumina From Cuban Iron Ores

Sulphatizing and Leaching Cuban Ore Will Extract Profitably 70 per Cent of the Nickel, 50 per Cent of the Alumina and 60 per Cent of the Manganese, Leaving a Beneficiated Iron Ore and Producing Gypsum and Iron Oxide Pigment as Byproducts

By CARLE R. HAYWARD

Associate Professor of Metallurgy, Massachusetts Institute of Technology

IRON ORE from the deposits on the north coast of Cuba contains 0.80 per cent nickel. Most of this nickel is retained in the iron during blast-furnace operations and finally reports in the steel. The nickel content of the steel made of North Coast ore is only about 1.5 per cent; whereas the nickel steels commonly used contain about 3.5 per cent. Although the presence of the small amount of nickel is claimed to be beneficial, it is not usually possible to get an additional price commensurate with the value of the nickel.

In 1914, F. A. Eustis asked the co-operation of the writer in working out a commercial process for extracting the nickel from Cuban ores. The subsequent work was conducted in the metallurgical laboratories of the Massachusetts Institute of Technology and extended over about 5 years, during which period a great mass of data was collected.

An attempt will be made in this paper to state clearly, even though briefly, all phases of a long and systematic research involving a number of novel features and resulting in several patents. Much of the work should be of general interest aside from its direct application to Cuban iron ores. During the research the writer had various assistants, to whom credit is due; H. M. Schleicher and F. O. Stillman were especially helpful. To them is due much of the success of the research. Mr. Eustis and C. M. Weld were also in close touch with the work at all times.

The Ore

The work was done on several lots of ore from the Moa Bay Iron Co., and some from Mayari deposits. Typical analyses in the natural state are as follows:

	Moa Bay	Mayari		Moa Bay	Mayari
Fe	33.25	33.30	Cr	1.17	1.26
SiO_2	2.68	4.00	Comb. H_2O	9.50	10.00
Al_2O_3	9.63	7.55	Hyg. H_2O	27.00	27.00
Ni	0.55	0.65	P, S, etc	0.73	0.50
Mn	0.48	0.50			

The ore was treated as received. There were a few hard lumps up to ½ in. in size, but the remainder was much finer. Over 80 per cent would pass a 100-mesh screen. One lot of ore which seemed most amenable to treatment was largely in the form of pellets ½ in. or less in size, formed by the balling up of fine material, but when or how this occurred is unknown.

Chloridizing Tests

The first attempt to render the nickel soluble was by subjecting the ore to a chloridizing roast in the muffle furnace shown in Fig. 1. It was mixed with salt varying from 1 to 10 per cent by weight and with pyrite varying from 0 to 10 per cent by weight. Temperatures varied from 400 to 650 deg. C., and the time of roasting varied from 2 to 6 hours. Roasted ore was leached with water and with varying strengths of HCl hot and cold. Extractions were all low (under 30 per cent) except with 10 per cent acid; in these cases an excessive amount of iron was dissolved. Chloridizing was therefore abandoned.

Leaching Tests

Numerous tests were next made with direct leaching. Leaches with ammonia gave no extraction of nickel. Hydrochloric acid was little better, as was dilute sulphuric. An extraction of 30 per cent nickel was obtained with a 10 per cent solution of sulphuric acid boiling for 5 hours, but with it came a large amount of iron. Ferric chloride and sulphate solutions were also inefficient. The results were not encouraging, so attention was turned to sulphatizing.

Sulphatizing Tests

The first tests to render the nickel soluble by sulphatizing were made by roasting the ore with pyrite. Three variables were used: temperature, time and per cent of pyrite. A series of tests between 400 and 700

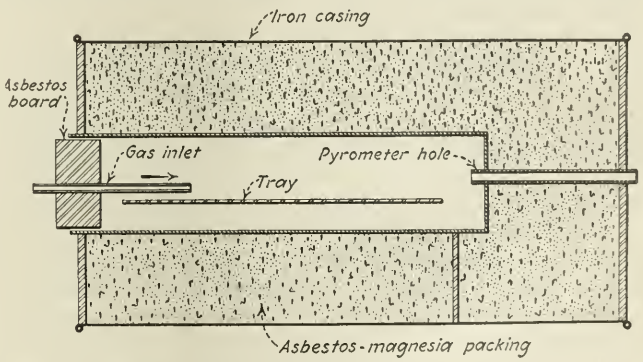


FIG. 1—4-IN. TUBE FURNACE USED FOR ROASTING EXPERIMENTS

deg. C. indicated that 475 deg. was the most suitable temperature. The nickel extractions[1] increased with time up to 4 hours, after which the extractions were practically constant. Pyrite up to 5 per cent of the weight of the ore was beneficial, but larger quantities seemed to have only slightly increased sulphatizing effect.

In most cases the extraction was between 35 and 40 per cent, 50 per cent being reached at times. Various changes were made in the procedure, such as heating slowly from a low to a high temperature and vice versa, giving the ore a preliminary oxidizing roast, giving it a preliminary reducing roast with coal, subjecting it to a preliminary heating in saturated and superheated

[1] In all the sulphatizing tests the usual method of leaching was to boil the roasted ore in a flask for about 1 hour with from three to five times its weight of water. After leaching the pulp was filtered and washed and an aliquot part of the solution taken for analysis.

steam, and so on. In some cases the extractions of nickel were distinctly lower, but in no case were they higher.

It was always possible to get better extractions by leaching with sulphuric acid solution up to 20 per cent in strength, but the amount of iron which went into solution was excessive.

After a study of the data and the methods of treatment it seemed evident that part of the nickel was in a form easily attacked by SO_2, while the remainder was more difficult to sulphatize. The pyrite was quickly exhausted and the sulphatizing power of the atmosphere in the furnace gradually lowered.

Use of Hydrofluoric Acid to Decompose Silicates

Assuming that the nickel which resisted solution was in the form of silicate (garnierite?), a series of attempts was made to decompose them. For this purpose fluorspar was mixed with the ore and the mixture roasted with pyrite. The results obtained were lower than when using pyrite alone. Addition of a small amount of steam did not improve the result; there was evidence that hydrofluoric acid was formed and attacked other minerals in preference to those of nickel.

Considerable time was spent in attempting to make garnierite soluble. Samples of that mineral were treated with hydrofluoric solutions and leached directly or after subsequent sulphatizing. In some cases sulphuric acid was used with fluorspar and the residue leached directly or sulphatized subsequently with and without steam. The highest extractions of nickel obtained were less than 40 per cent. There was evidence that the presence of hydrofluoric acid was not beneficial and in some cases was harmful.

Sulphatizing by Means of SO_2 Gas

In order to give the ore the treatment required, it seemed necessary to maintain a strong atmosphere of SO_2 throughout the period of the roast. In order to accomplish this the pyrite was put in a separate alundum boat beside the boat containing the ore and replaced by a boat of fresh pyrite every half hour. The first test showed an increase in extraction of nickel to 60 per cent. A few minor changes in manipulation and more frequent replenishing of pyrite brought the extraction up to 80 per cent. It was evident from these results that contact between ore and pyrite was not necessary and that satisfactory results could be obtained if SO_2 could be maintained in the atmosphere in the furnace.[2]

Having established the fact that contact of pyrite and ore was not necessary, it was a logical step to turn to liquid SO_2 as a constant source of gas for the experimental work. This was done with success and except where otherwise stated all subsequent work with SO_2 was carried on by introducing the gas into the furnace from a cylinder of the liquid.

In order to discover the best operating conditions a number of tests were made. First the SO_2 was used with varying amounts of air and finally with air excluded. Apparatus for accurate measurements was not available, but it was found that the highest extraction was obtained with the ratio of gas to air at about 1:4. When too much air was used the extraction of nickel dropped off; likewise with small amounts of air the extraction was very low.

Temperature in the latter tests was 475 deg. C. which had been previously established as the best temperature for sulphatizing the nickel. A series of low-temperature tests was made: It was found that passing a mixture of 3 parts air and 1 part SO_2 for 2 hours through a tube containing the ore caused the following absorption of gas:

Temp., Deg. C.	SO_2 Grams per Kg. Ore	Temp., Deg. C.	SO_2 Grams per Kg. Ore
100	19.6	200	44.5
150	27.6	350	59.0

There was a slight solubility of sulphates at 350 deg., but none at the lower temperature. This is important as indicating that if enough ore can be put in train either in the roasting furnace itself or in a preheater, very little of the SO_2 will be lost in the flue gas.

The SO_2 when mixed with illuminating gas did not render any of the nickel soluble.

Some tests were made drying the air and gas and also introducing small amounts of moisture. The best results were obtained with dry gases.

Since in practice it was probable that CO_2 would be present in the gases, some tests were made with equal amounts of air, SO_2 and CO_2. These showed no lowering of soluble nickel and there was some evidence that the CO_2 improved the extraction slightly, but this was not followed to a definite conclusion.

Use of SO_3 Gas

The solubles obtained in the experiments with SO_2 gas were all sulphates, tests for sulphites being negative. This fact made it seem advisable to try SO_3 as a sulphatizing agent.

The first tests were made by using $FeSO_4$ as a source of SO_3. Temperatures between 300 and 475 deg. C. were used with the $FeSO_4$ mixed directly with the ore or in separate boats with frequent renewal. The extractions of nickel were very low, usually not over a trace.

In order to test further the effect of SO_3, a tube of the solid anhydride was obtained and used as a source of the gas. The first test seemed encouraging when an extraction of nearly 50 per cent of the nickel was obtained at 475 deg. C. In further tests the extractions fell off to nearly zero. It is probable that in the first test some moisture was present in the cool part of the furnace so that virtually sulphuric acid was being used.

Aluminum in the Leach Liquor

Up to this time only two points had been kept in view. The main object had been to extract as much nickel as possible without rendering the residue unmarketable as an iron ore. It now seemed desirable to accept 80 per cent as the maximum Ni extraction, make a study of the composition of the leach liquor obtained, and consider methods of recovering the nickel from the solution.

Several hundred grams of ore was roasted with SO_2 gas at 475 deg. C. for 4 hours (the conditions established for maximum extraction) and leached by adding hot water and boiling 1 hour. Since the resulting solution contained only 1.5 g. nickel per liter, an attempt was made to concentrate it by evaporation, but on reducing it to about one-third its volume it became thick and of a sirupy consistency with aluminum sulphate.

It was at once evident that a high concentration of nickel could not be obtained without the removal of the aluminum. Attempts to crystallize it as an alum were

[2] This work was done in December, 1915, and January, 1916, thus antedating by about 2 years the Coolbaugh patents (U. S. Pat. 1,315,761, applied for Feb. 23, 1918) for sulphatizing the oxides produced in roasting sulphide ores with SO_2 obtained in roasting.

made, but the crystals carried nickel in prohibitive amounts. Several reagents were considered, but they did not look promising commercially; the most feasible seemed to be limestone, and numerous tests were conducted with it. It was found that simply passing the liquor over lump marble soon coated the lumps with gypsum, but by rotating the marble in a wire cylinder dipped in the liquor the aluminum could be successfully precipitated. Powdered limestone could also be used, but the lump method seemed more satisfactory. In this work it was found that the aluminum was first precipitated, followed by the iron and lastly by the nickel. One test will serve to illustrate this point.

	Solutions — Original	Solutions — After 3-hr. Contact
Fe_2O_3, grams per liter...	0.57	0.17
Al_2O_3, grams per liter...	3.21	0.02
Ni, grams per liter.....	0.30	0.31

Analysis of Air-Dried Precipitate	Per Cent
Fe_2O_3.....	2.3
Al_2O_3.....	22.1
CaO.....	19.1
SO_3.....	39.6

A few tests indicated that the aluminum could be leached from this precipitate by means of dilute H_2SO_4.

Larger Scale Roasting Work

It was thought wise that before proceeding it would be well to confirm the roasting data on a larger scale and at the same time obtain a larger quantity of leach liquor for precipitation experiments.

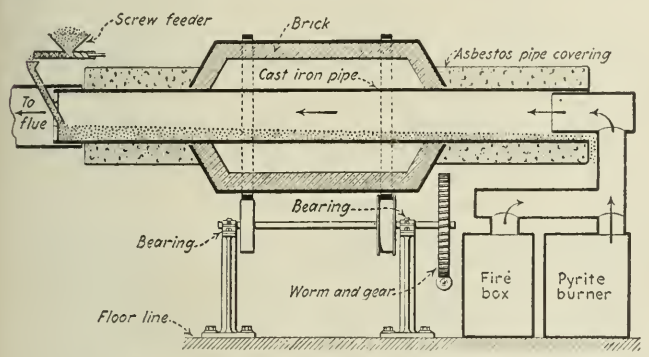


FIG. 2—MODIFIED BRUCKNER ROASTING FURNACE

The first test made was to mix a charge of 25 kg. ore with 2.5 kg. pyrite and roast it in a small brick coal-fired reverberatory furnace. It was difficult to get absolute control of the temperature, but it was kept as near as possible at 475 deg. C. for 4 hours. The results obtained from several of these tests confirmed the small-scale work that mixing the ore with pyrite would give only about 40 per cent nickel extraction.

It was therefore decided to construct a larger furnace in which SO_2 gas could be introduced. A laboratory Bruckner furnace 5 ft. long and 3 ft. in diameter was available, but since this was intermittent in operation it was used as a rotating device for a 12-in. cast-iron water pipe 12 ft. long which was inserted through the end openings as shown in Fig. 2. Firing was regulated to keep the temperature at the discharge end as near 475 deg. C. as possible; variation under regular running was ± 20 deg. C.

After numerous preliminary trials a run was made lasting 97½ hours. Ore was fed at the rate of 1.57 kg. per hour and the average extractions obtained gave Ni 53.6 per cent, Fe 2.5 per cent, Al_2O_3 51(?) per cent. It was evident that the low nickel extraction was due to the fact that the ore was subjected to the 475-deg. temperature for too short a time, since only a portion of the pulp could be maintained at this heat.

It was next decided to take the water pipe used in the previous tests, support it on suitable rollers and build a brick flue around it so it could be heated externally. This would keep the sulphatizing gases separate from the products of combustion and at the same time permit a more uniform temperature to be maintained. The feeding arrangement was kept as before, but in this case it was possible to incline the pipe slightly to facilitate the flow of ore. SO_2 was supplied from a cylinder and mixed with air. By this method nickel extractions between 70 and 80 per cent were obtained with SO_2 and air in the ratio of 1:2 by volume.

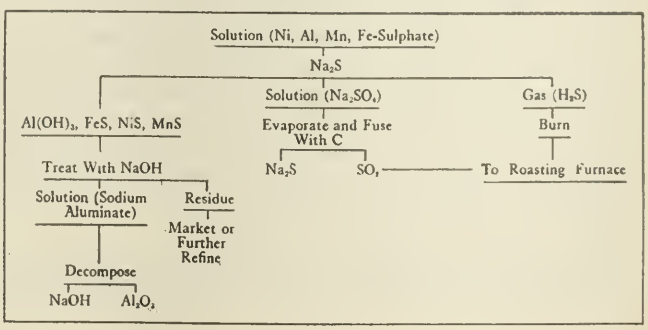
Results With Wedge Furnace

Soon after completing the experiments in the furnace just described, the Institute of Technology moved to its new site in Cambridge and a laboratory type Wedge roasting furnace was added to the metallurgical equipment. Sulphatizing tests on the Cuban iron ore were tried in this furnace with very satisfactory results. The furnace was equipped with gas burners and thermocouples on three hearths, a pipe was inserted at the lower hearth for introducing the SO_2-air mixture, and all air leaks were carefully sealed. The speed of rotation was regulated so that it took 4 hours for the ore to pass through the furnace. When the furnace was running normally, ore could be fed at the rate of 4 kg. per hour. Temperature regulation was surprisingly easy and three small gas flames kept it at the desired point. Flue gases contained only 1.5 per cent SO_2.

Numerous tests in the Wedge furnace confirmed to a surprising degree the results of the small test in the electric tube furnace. It was evident that extractions of 70 per cent nickel and 70 per cent manganese could be expected in large-scale operations. Extractions of iron could be kept as low as 10 per cent; some tests indicated 6 or 7 per cent. Aluminum extraction fluctuated between 40 and 70 per cent, depending probably on the relative amounts of clay and bauxite. Even with 10 per cent iron and only 50 per cent aluminum extracted, the iron in the residue was higher than in the original ore.

Treatment of Solutions With Na_2S

Having confirmed the small-scale roasting tests and obtained several barrels of leach liquor, experiments were next made to work out a satisfactory method for treating the solutions. A preliminary economic survey in the light of the data collected made it evident that in order to develop a commercial process it would be necessary to recover not only a fair percentage of the nickel but also the aluminum extracted from the ore and the sulphur from the roasting operation. The use of marble which has been previously discussed was therefore abandoned and some tests made with Na_2S as a precipitant. It seemed possible to work out a satisfactory process according to the following tree:



All tests indicated the entire technical feasibility of the above process. A high-grade $Al(OH)_3$ product was obtained suitable for the manufacture of metallic aluminum. The nickel-manganese-iron product was not further treated, but there seemed to be no reason why it could not be fused to a ferronickel product or otherwise treated for recovery of refined nickel. Apparently about 80 per cent of the sulphur in solution would be recovered. Unfortunately the best data obtained for the evaporation of the liquor and reduction of Na_2SO_4 to Na_2S indicated such a high cost for this step that a commercial process seemed doubtful and another method was sought.

Decomposition of Sulphates

Most metallic sulphates decompose readily when heated with carbon at red heat. It was thought that if the entire leach liquor could be evaporated to dryness and the resulting sulphates heated with carbon at a suitable temperature, the SO_2 could be recovered for direct use in the roasting furnaces and the alumina removed by leaching with caustic soda solution, from which it could be easily recovered. The residue from the caustic leach could be worked up for metallic nickel or a nickel alloy. The leach liquor used for these tests contained in grams per liter:

Al_2O_3	14.7	Cr_2O_3	1.03
NiO	1.83	Fe_2O_3	13.8
Mn	2.04	SiO_2	0.69

It is evident that the final residue would be too high in Fe_2O_3 to make a satisfactory nickel product, so some of the iron was removed by adding freshly prepared aluminum hydroxide to the liquor, which precipitated 80 per cent of the iron and all the chromium. If a stronger leach liquor is used some nickel is also precipitated by this treatment. Aluminum hydroxide remaining in the precipitate was easily removed with caustic and the residue after this treatment made a fair red pigment after proper calcining.

After the aluminum hydroxide treatment the liquor was evaporated to dryness, giving a residue of the following composition:

	Per Cent		Per Cent
Al_2O_3	16.2	Fe_2O_3	2.94
NiO	1.54	SiO_2	0.54
MnO	1.79	Hygroscopic water	3.90
Cr_2O_3	0.73	Combined water and SO_3	71.40

A series of tests was made to determine the best conditions for desulphurizing this material, and the following points were established: (1) The sulphates should first be dehydrated at approximately 400 deg. C. (2) Soft coal is the best carbonaceous material to use. About 15 per cent should be mixed with the sulphates and a blanket of coal placed on top. The latter precaution is necessary to prevent the alumina from becoming insoluble in caustic. (3) About 700 deg. C. is a satisfactory temperature, but good results were obtained between 600 and 700 deg. Roasting time is ½ hour.

It was found that the material after the above treatment still contained small quantities of sulphur, probably as basic sulphate, but this was readily removed by a dilute sulphuric acid leach. Strong caustic solution dissolves a large part of the alumina from this product, but a more complete extraction is obtained if the desulphatized material is first sintered with sodium carbonate and then treated with caustic.

Having established the feasibility of the process as far as technical considerations were concerned, the process was viewed from a commercial standpoint in the was probable after charging off the usual interest, depreciation, etc. The evaporation cost was again a very important item in the total cost and efforts were directed toward treating the leach liquor more economically.

Direct Leaching for Alumina

It has been previously noted that the presence of aluminum sulphate causes the solutions to become sirupy when concentrated and is troublesome in the recovery of the nickel. Furthermore the aluminum consumes a large part of the SO_2 used, and thus increases the expense. There are two well-known solvents for alumina —viz., caustic soda and hydrofluoric acid—and it was decided to try leaching the ore directly with these previous to sulphatizing.

A 45 per cent NaOH solution was used as in the Bayer process. On boiling the ore for 1 hour it was found possible to extract 60 per cent of the aluminum with 5 per cent of the chromium and 6 per cent of the silica. Nickel and iron were insoluble. This seemed encouraging, but considerable losses of caustic were entailed because of difficulty in washing the ore; even with large amounts of wash water much expensive caustic was lost and much evaporation would be required to concentrate the solutions. This treatment was therefore abandoned.

An attempt was made to use the Doremus hydrofluoric acid process. This process was devised for treating clay with a 15 per cent hydrofluoric acid solution. The reaction causes the temperature to rise and when it reaches a maximum the pulp is filtered. In using it on Cuban ore it was soon found that an excess of acid caused considerable solution of iron, nickel and manganese. In all tests a maximum of 50 per cent of the aluminum was rendered soluble, so tests were made using only enough hydrofluoric acid to dissolve this amount. The result was a lowered aluminum extraction. More encouraging results were obtained with a 15 per cent hydrofluoric acid solution sufficient to unite with 75 per cent of the aluminum. Under these conditions the pulp had the consistency of a thin mud. Dry ore was stirred into the solution, causing a rise in temperature of 75 deg. C. in about 2 minutes. The pulp was at once filtered, and contained at most 48 per cent of aluminum, 8.8 per cent of the iron and 10.9 per cent of the nickel and 7.8 per cent of the manganese. It was found that adding $Al(OH)_3$ to the solution after filtering would precipitate more than half of the iron, but did not affect the other constituents. Washing the ore caused much of the aluminum to hydrolyze and it was evident that great difficulty would be encountered in producing a satisfactory leach without considerable loss of acid. Sulphatizing tests on the residue were entirely satisfactory, but in view of the leaching difficulties and the contamination of the soluble by excessive solubility of iron, nickel and manganese the treatment did not look attractive.

Final Process

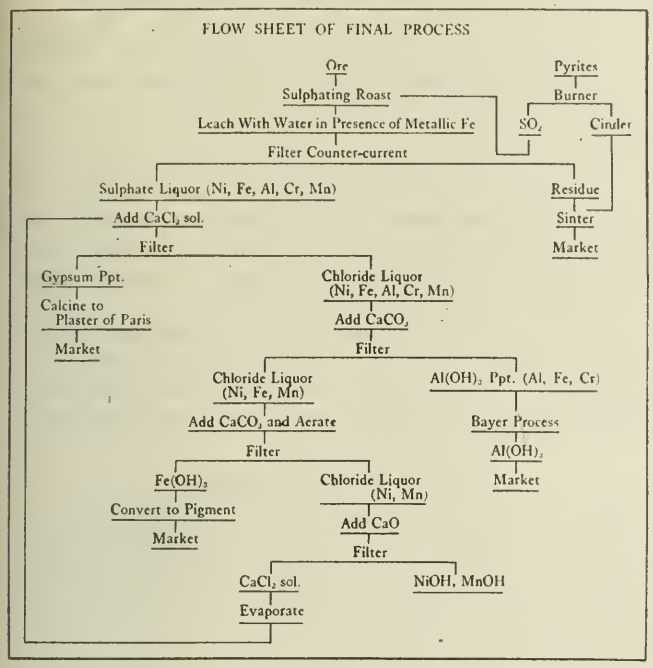
As a result of considerable further study and research a process was finally developed which was simpler than the previous treatment and so far as laboratory tests and calculations would indicate was both a technical and commercial success. It will be best understood by first presenting the flow sheet and follow it by a discussion of some of the research establishing each step.

Step 1. Tests indicated that if the ore was mined by hydraulicking, a considerable portion of the chromite in

the ore might be recovered by installing riffles in the sluiceways.

Step 2. The outstanding features of the sulphatizing roasting have already been discussed. Since the reaction is exothermic, very little heat will be required in addition to that brought in by the SO_2 gas.

Step 3. Leaching should be conducted in a suitable form of agitation tank with scrap iron present to reduce the iron in solution to the ferrous state. This makes



the solution non-corrosive and makes it possible to separate the iron and aluminum as described under step 5. After agitation the pulp goes to a filter, where after suitable washing the cake goes to a sintering machine, the product of which is sold as iron ore. If pyrite is used as a source of SO_2 the cinder is added to the ore residue for sintering.

Step 4. $CaCl_2$ solution is now added to the leach liquor. The gypsum formed accomplishes two important objects, the recovery of the sulphur in a marketable form and the elimination of a considerable portion of the water as water of crystallization, thus cutting down the amount to be evaporated. The sulphate leach liquor is also changed to chloride by this step and the separation of the constituents is facilitated.

There are several points of general interest which were brought out in studying step 4. If any of the iron in the leach liquor is in the ferric state, some of it is carried down by the gypsum and colors it brown. If the iron is all ferrous, the gypsum will be perfectly white. A long time was spent in establishing the best conditions for precipitating the gypsum, but after numerous experiments a method was finally established by which a product was obtained which would calcine properly, giving the characteristic "boil," and give a product which would set satisfactorily—in short equal to the highest grade plaster of paris.

Step 5. Several series of tests were made to study the effect of powdered marble as a precipitant. There was placed 100 c.c. of the solution in open bottles which were large enough to rotate on their sides without spilling, marble was added in varying amounts and the bottles rotated cold for 8 hours. After standing over night the tests were diluted to 250 c.c., filtered and the precipitates carefully washed. The results are given in Table I.

This table confirms what was indicated in some earlier work with lump marble—that aluminum has the greatest tendency to precipitate, with ferric iron a close second. There is much less tendency for the divalent metals to precipitate. Two courses are therefore open. Leaching the ore in the presence of scrap iron may be omitted, leaving the iron dissolved from the ore largely in the ferric condition and precipitating it with the aluminum and chromium, thus obtaining at once a separation of iron and aluminum from nickel and manganese. This has the disadvantages incident to handling highly corrosive ferric solutions and furthermore a precipitate relatively low in alumina is obtained. The other alternative is the one used in the flow sheet, where the iron is reduced to the ferrous state, the alumina precipitated relatively pure by limestone and the iron subsequently precipitated by limestone as described in the next step. The precipitation of aluminum from the reduced solution was carefully studied.

TABLE I—ANALYSIS OF FILTRATE

		Nickel		Ferrous Iron		Ferric Iron		Manganese		Alumina	
Test No.	Grams $CaCO_3$	Grams per Liter	Per Cent of Total	Grams per Liter	Per Cent of Total	Grams per Liter	Per Cent of Total	Grams per Liter	Per Cent of Total	Grams per Liter	Per Cent of Total
Original Liquor	0	1.43	100	0.75	100	6.42	100	1.30	100	?	100
1	1.0	1.42	100	0.75	100	1.28	200	1.30	100	1.17	?
2	1.5	1.42	100	0.75	100	0.26	4.0	?	?	0	0
3	2.5	1.41	99.3	0.75	100	0	0	1.30	100	0	0
4	3.0	1.40	98.6	0.75	100	0	0	1.28	100	0	0
5	3.0	1.39	97.9	0.73	97.4	0	0	1.30	100	0	0
6	4.0	1.36	95.8	0.64	85.4	0	0	1.25	96.1	0	0
7	4.5	1.30	91.6	0.42	56.0	0	0	1.09	83.9	0	0
8	5.0	1.22	85.9	0.00	0.00	0	0	?	?	0	0

It was found desirable to agitate the solution for 2 or 3 hours, otherwise the precipitate will be contaminated by basic chlorides. The precipitate obtained in this step after washing and drying is readily soluble in caustic soda solution from which pure aluminum hydroxide is precipitated by the usual methods.[3]

Best results in precipitating the aluminum with limestone were obtained by conducting the agitation in a closed pebble mill. This accomplished three principal objects: Decomposition of basic chlorides, use of less limestone, and finally exclusion of air, which last prevents oxidation and precipitation of iron. A study of the precipitation indicates that much of the aluminum is first precipitated as a basic chloride which is subsequently decomposed by the limestone. A slight excess of finely ground limestone is usually desirable.

Both hot and cold precipitation were tried. At 60 deg. C. there was less trouble with basic chlorides, but there was more loss of nickel. It seems wiser, therefore, to precipitate in the cold and give sufficient time and agitation to decompose any basic chloride which forms.

Step 6. After the aluminum has been precipitated the iron may be removed by aëration at 60 deg. C. with the addition of powdered limestone. Laboratory work was

[3]It was found that the precipitate from the leach liquor usually contained a small amount of nickel. This was unexpected and no explanation was found for it. The nickel thus precipitated is recovered by returning the residue from the caustic treatment back to the ore leaching.

carried out in a cylindrical glass cell with a canvas bottom, below which was an air chamber. The solution was kept hot by an electric coil. In a few tests no nickel was precipitated by this method, but in most cases an appreciable amount was carried down by the iron. It is probable that some condition exists where a nickel-free precipitate can be obtained, but this has not been definitely determined and at present a 15 per cent loss is assumed. The best results were obtained by adding the limestone finely pulverized and mixed with water to a thin paste. It should be added slowly. The precipitate obtained in this manner was granular and filtered very readily; after drying it was brown in color and bulky for its weight (19 lb. per cu.ft.). Analysis showed it to be practically an artificial limonite. Where a finely divided ferric oxide is desired this product should prove useful in its original state or it can be easily calcined to form a pigment.

Step 7. There now remains a $CaCl_2$ solution containtaining nickel and manganese. These are readily precipitated by burnt lime, leaving the solution to be concentrated by evaporation and returned to the gypsum precipitation.

Step 8. The nickel-manganese product may be fused to produce pig nickel or dissolved in sulphuric acid and electrolyzed, giving pure nickel cathodes and manganese dioxide at the anodes. The electrolyte is kept neutral by circulating it over fresh precipitate.[1]

The anode deposit of manganese dioxide was of sufficient purity to be used in dry cells.

Conclusions

All the foregoing results are in the nature of a summary of prolonged and systematic research. Much of the work did not lead to the desired end, but the facts brought out have metallurgical importance aside from their relation to the treatment of Cuban iron ores.

In the end a process was developed which, starting with ore from the north coast of Cuba and using as reagents pyrite (or SO_2 gas) and limestone, ends with:

1. A beneficiated iron ore.
2. Gypsum (or plaster of paris).
3. Alumina (or metallic aluminum).
4. Electrolytic nickel.
5. Manganese dioxide.
6. A pure finely divided, hydrated oxide of iron (or pigment).

An economic discussion is not within the province of this paper, but this side of the problem has been carefully considered and the results are favorable to the process.

One fact has not been mentioned in the paper which has impressed itself on all who have worked on this problem and may occur to one reading the preceding pages. This is the long, devious and rough road the research worker must often travel to reach a desired goal. In commercial research the failure of promising leads often brings the decision to give up the work. This is especially true where the men who appropriate the money are unfamiliar with the technical aspects of the problem. Again and again in the work described above there was every reason to lose hope and stop. The final success was due as much to the men who financed the operations as to those who worked in the laboratory.

[1] It was only when some of the electrolytic experiments were made that the presence of cobalt was discovered. The ore used contained a very small amount which escaped detection in the analysis. The electrolytic nickel produced contained 10 per cent cobalt and it would be necessary to make a separation if pure nickel is desired.

Reducing Eye Hazards in Industry

Definite steps to remove the eye hazard, which is increasing at an alarming rate in industry, will be taken during the coming year by the Department of Labor and Industry of Pennsylvania.

After more than 2 years' study of conditions causing eye losses, the Industrial Board has completed revision of safety standards governing head and eye protection. The head and eye code was completed and adopted by the board last July after a year of public hearings and revision and is now printed for distribution. The Division of Hygiene and Engineering performed an exhaustive investigation and prepared recommendations which it submitted to the board in July, 1920, on the eye hazard.

Seven separate occupations are enumerated in the new code where protectors are required, as follows: Oxy-acetylene and other compressed gas welding and burning, chipping, electric arc welding, grinding-wheel dressing and rough emery, iron tapping at cupola, sand and shot blasting and thermit welding.

Goggles, masks, helmets, hoods and shields are recommended as protectors for certain lines of work. In every one of the mandatory occupations goggles are required with the exception of sand and shot blasting, in which case a hood is required.

Extent of Eye Injuries

Recognition of the element of negligence in the enforcement of this code has resulted in the injection of strong arguments for the purpose of bringing home to workers and employers the danger in eye accidents. The fact that eye cases number more than all other permanent injuries put together for which compensation is paid brings home a lesson to the responsible parties. Another lesson, which confronts the workers particularly, is found in the fact that eye losses are permanent in the sense that such cases almost preclude rehabilitation in any form. A worker who loses a hand or a foot may be trained in some gainful occupation where his loss is not substantially felt, but a man who loses one or both eyes stands less chance of getting back as a producer. The employer will realize what it means when one of his employees loses an eye through having failed to take the necessary precautions when he knows that $1,005,414 was awarded last year for 677 eye losses, while $1,275,487 in compensation was awarded for 648 leg, arm, hand and foot losses combined.

Compensation is also required now under an act passed at the last session of the Pennsylvania Legislature for facial disfigurement. This hazard would be minimized by compliance with the new head and eye protection code. The first case coming under this provision of the compensation law was disposed of in an award of $600 for the loss of an ear.

The code sets forth employers' and employees' responsibility in carrying out its provisions. Every employer "or person exercising direction or control over any person or persons who remove any safeguard or safety appliance or device, or over any person or persons for whose protection it is designed shall have such safeguard, safety appliance or device so removed promptly and properly replaced," it is stated.

Employees are required under the code to "use all safeguards, safety appliances or devices furnished for their protection." Each employee is responsible for carrying out safety standards which may concern or affect his conduct.

Building Up Worn Metal Parts by Electrodeposition

A Discussion of the Relative Merits of Copper, Nickel and Iron for Building Up Worn Bearings and Other Metal Parts by Electrodeposition—Factors Which Should Be Considered in Choosing the Proper Metal for a Particular Application

By W. E. HUGHES, B.A. (Camb.)

THE impetus given by war necessities to the practical application of the electrodeposition of metals has manifested itself in several directions. Prominent among the uses made of the art is the restoration to gage of worn parts of airplanes and other mechanisms. This process has come to be known as "building up"; and it was adopted and practiced, more or less successfully, in a number of government workshops in France, England and America during the war. The metal deposited upon the worn and under-gage parts was usually iron, though copper was employed in some cases, especially where the deposit had to serve the purpose rather of a bushing than a bearing surface. Since the armistice (and infrequently before it) nickel has been used to the same end.

The object of the present paper is to examine critically the advantages and disadvantages of the use of the three named metals, the idea being impartially to assist in his choice of metal any engineer who may contemplate using the "building-up" process. This appears to be the more necessary as there seems to be an idea prevalent that there is something new in the use of electrodeposition for "building-up" work. There is, indeed, nothing new in this use at all. The extention of the methods of electrodeposition to the end under consideration is not, in itself, new; what has happened, in fact, is that it has now been recognized that such methods can be employed more generally and for a greater number of similar ends. No claim to a patent covering the idea involved could be for a moment substantiated in a court of law; the element of novelty would be wanting.

General Remarks

It is necessary at the outset to make a few general remarks in regard to the electrodeposition of metals as practiced by those seized by sudden enthusiasm for it to this or that end. Almost all such persons seem to think that they have discovered something; and they do not therefore hesitate to style themselves inventors.

Such displays were common in 1914. The excellent work already done long before by C. F. Burgess and C. Hambuechen,[1] A. Pfaff,[2] F. Foerster and his pupils[3]—to mention only a few serious investigators—was unknown in general. Alexander Watt[4] and M. von Jacobi[5] were spectral beings of the past! The same illusions may quite well exist in regard to building up with nickel. The text-books still contain recipes for making nickel solutions that are based upon the out-of-date double sulphate of nickel and ammonia. Such solutions are quite useless for the formation of thick electrodeposits of nickel. The reasons why this is so have been pointed out elsewhere; it is sufficient to state here that only such solutions as are based upon the "single salts"—nickel sulphate—are of any real use for building-up work.

Solutions Recommended

Before discussing the main theme of this article—namely, the relative merits of copper, iron and nickel for "building-up" work—it will perhaps be useful to indicate briefly one solution which can with advantage be employed for depositing each of the metals mentioned, respectively.

For depositing copper, there is no more useful solution than that composed of copper sulphate (2½ to 3 lb. of pure crystals per gal. of solution) and sulphuric acid (4 to 6 fluid ounces of pure 1.84 acid per gal.). This is known as the acid copper bath. The current density which should be employed varies according to whether the solution or work is to be moved or agitated during the process of deposition, or not. If not, then the current density should be 10 to 12 amp. per sq.ft. of surface to be deposited upon; if movement is employed, more current—a higher current density—can be used.

For depositing iron, one of the best solutions to use is that composed of ferrous chloride and calcium chloride. The following proportions of ingredients have been found to give excellent deposits up to an inch in thickness: 9 lb. of ferrous chloride, 10 lb. of (anhydrous) calcium chloride and 1½ gal. of water.[6] These will make approximately 3 gal. of solution. The solution should be heated to above 80 deg. C. The current density employable is from 80 amp. per sq.ft. upward, yielding a thickness of deposited iron of from 0.004 in. upward per hour.

For depositing nickel, a bath composed of nickel sulphate (about 3 lb.), magnesium sulphate (6 to 8 oz.), powdered boric acid (1 to 4 oz.) and 1 gal. of water is of very general service for "building-up" work. The solution is worked at the ordinary temperature and at a current density of 10 to 15 amp. per sq.ft.

In general, it may be said that the operations required to prepare the surface to receive the deposit are as important as the deposition process itself. That surface must be clean and free from all scale, dirt and grease. Unless it is, failure will almost certainly result, for the deposits will not adhere to the articles on which they are formed. Failure will cause waste of time and money, and it is essential in such a process as that called "building up" that the matter of cost should always be in the forefront of the worker's mind. It may be mentioned here that reliance on any cleaning property that the plating solution may possess is mis-

[1] *Trans. Am. Electrochem. Soc.*, 1904, vol. 5, p. 201.
[2] *Zeit. Elektrochem.*, 1910, vol. 16, p. 217.
[3] *Abhandl. der deutsch. Bunsen Gesells.*, No. 2, 1909.
[4] *The Electrician*, 1887 and 1888.
[5] *Bull. de l'Acad. Imper. des Sci. de St. Petersburg*, 1869, vol. 13, p. 40, and *ibid., Brit. Assoc. Rap.*, 1869, p. 67.
[6] D. R. P. 212,994 (1908).

placed; no one who indulges such reliance should ever be in charge of a plating plant.

Choosing the Proper Metal

Each of the three metals copper, iron and nickel has its uses in "building-up" work. But before any one of them is employed for that purpose, careful stock should be taken to insure that the metal adopted in any particular case is the best of the three to use for the purpose it has to serve. The decision in each case will be affected by considerations of efficiency and economy. The former involves a survey of the physical (including mechanical) properties of the three deposited metals; the latter will be very largely affected by the costs of materials and process. On the one hand, it is useless to employ a comparatively soft and tough metal like copper in cases where a hard metal is required; and, on the other hand, if a cheap metal, such as iron, will serve the purpose one has in view, it is obviously a needless increase of cost to use nickel or copper, other things being equal. Again, both the ease and general costs of deposition must be considered. It will therefor be of advantage to consider each metal separately (though at the same time comparatively) from the points of view of efficiency and economy.

Applications of Copper

During the late war the writer used copper for "building up" such work as pump-sleeves, ball races, airplane engine cylinders, and the like. In many cases the metal had to serve as well the purpose of a sort of binder, similar to the purpose served by lead in the instances cited by G. B. Hogaboom.[1] In other cases it was necessary that the metal used should be a good conductor of heat or electricity. In such cases as these copper was the only metal that would suit all the purposes required. Hence copper was used; it was the only one available and thus could not but be the most economical and efficient.

Applications of Nickel

If a modern nickel solution is employed, nickel-plating is certainly not uneconomical, where nickel is the proper metal to use. Rapid work can be done and cathode losses are small; those facts, separately or together, mean in effect that floor space is minimized, and overhead and other charges, such as rent, outlay on plant, laid up capital and so on, are reduced. But the question as to whether nickel is the proper metal to use is an important one. As compared with copper, its electrical conductivity is lower; so also is its heat conductivity. Hence it cannot be efficient to use nickel if it is important that the plated article should not suffer as a whole in respect to heat or electrical conductivity. That is one instance. Another is where grip or binding is advantageous. If, as sometimes happens, it is necessary to "build up" the threaded end of some piece of mechanism, the use of nickel would result in a less efficient product than if copper were employed, because copper would make a better joint than would nickel, since the former is both tougher and more malleable than the latter. Still another case is where some amount of machining or cutting is required to be done on the plated article. The consequence to machining tools of using nickel for copper was brought home to the writer a few years ago. Complaints reached him that the cutting edges of tools in the machine shop were being seriously injured through their use on deposited nickel, and the employment of that metal had to be abandoned.

Applications of Iron

It may be stated quite generally that, unless some special reason exists for using copper or nickel, iron should always be used for "building-up" work. It has been said lately that there is no reason to use iron, because nickel is cheaper. As a general statement this is grossly inaccurate in as far as "building-up" work is concerned. In the first place, pound for pound, nickel anodes (cast or rolled) are much more costly than Swedish (or any other) iron. Then, on the cathode side of the bath, there is no nickel solution known that will give, in everyday workshop practice, good, close-grained deposits of metal at a current density of 100 to 150 amp. per sq.ft. Such can be obtained with the greatest ease from the ferrous calcium chloride solution.

The writer has obtained excellent deposits 0.02 in. in thickness, at a working current density of 200 amp. per sq.ft. and under still-vat conditions. Moreover, working at that current density, deposits can be formed at the rate of 0.009 to 0.010 in. per hour. The refined method of the Oettel's coulometer is not necessary to prove this; the screw-gage is sufficient. The theoretical thickness of deposited iron per hour from a bath worked at 20 amp. per sq.ft. is (very approximately) 0.001 in. Hence there is but very little less of cathode efficiency when working with the double chloride bath at the current density mentioned (200 amp. per sq.ft.) and under ordinary workshop conditions. Thirdly, gallon for gallon, the cost of a modern nickel solution—and no other than a modern one is of any use—is greater than the cost of a good iron-depositing solution. Fourthly, the working costs other than those of upkeep of the bath—costs such as labor, rent and other dues, and so on—will certainly not be greater in the case of iron than in that of nickel. Under proper management they should be much less, since, other things being equal, the greater the output of a bath the less the cost of the product; and it cannot be gainsaid from workshop experience that the output of an iron-depositing solution, such as the ferrous calcium chloride bath, is several times greater than that of any nickel bath yet invented, even though the latter be worked hot.

To take a specific instance—it is required to plate a crankshaft, say, with 0.006 in. of metal. This can be done with ease in the iron bath mentioned in from 1 to 1¼ hours, working at a current density of only 140 amp. per sq.ft.; the writer has done it many times. In a nickel bath the time required would be at least 3 hours, even allowing that nickel bath could be worked, commercially, at 40 amp. per sq.ft. Hence the iron bath can give more than double the output from the nickel bath; or, alternatively, for a given output the vat room required for iron deposition is less than half that required for nickel deposition. And on the score of relative cost there are many other arguments in favor of iron. But apart from actual net working cost, there is efficiency to be considered. This depends in great part on the nature and properties of the product; an inferior product is too costly at any price. As regards the product in iron deposition, it may truly be said that much more is known about it than about deposited nickel. The structure that iron will have is known, no matter what the type of bath used (sulphate or chloride) or the conditions under which it is formed. Little

[1] *Trans. Am. Electrochem. Soc.*, 1919, vol. 35, p. 399.

indeed is known of the structure of nickel deposits. Since in the case of deposited metal, structure governs or determines properties, it follows that one can obtain from iron-depositing solutions whatever kind of metal one needs within the limits of the properties of electro-deposited iron. Control therefore is well-nigh complete. Again, when one has obtained a nickel deposit, it is not easy to do anything with it. It is difficult to machine, and it cannot be heat-treated to produce a case-hardened effect or to be made one with the base metal. Both these things have been proved possible with deposited iron on iron or steel.

Nevertheless it would not be true to say that there are not occasions when it is preferable to use nickel rather than iron. The point here is that iron should be used wherever possible, unless there is some overriding reason for the employment of nickel or some other metal. And further, to say generally that nickel deposition is cheaper than that of iron is to state that which is contrary to fact.

The importance of the structure of the deposited metal has been already mentioned. This is indeed a matter for serious consideration when the question as to which metal shall be used for "building-up" work has to be decided.

Thermal Stresses in Car Wheels

MORE than 2 years ago a research was started at the Bureau of Standards to investigate the stresses in the plates of chilled iron car wheels caused by heating the rim, a condition approximating that of service where on long grades, it is said by some railroad men, the tread reaches a dull red temperature.[1] Later, a similar investigation on steel car wheels was started.

In the special thermal stress tests for both investigations, the wheel was mounted on a hollow water-cooled 6-in. axle. The axle in turn rested upon cast-iron and concrete support, such that the bottom of the wheel was 2 ft. 8 in. above the floor. A soft steel resistor 3½ in. in width and ¼ in. in thickness was placed on the tread of the wheel but insulated from it by a thin sheet of perforated asbestos, and an alternating current of 1,000 to 1,500 amp. at 15 to 30 v. from a 30-kva. transformer was passed through the resistor. As the wheel was in an upright position and remained stationary throughout the test, it was readily possible to bring the resistor itself to a red heat within 5 to 10 minutes. Undue radiation of heat into the air was prevented by the use of asbestos covering. The tread of the wheel attained a maximum temperature of approximately 380 deg. C. (716 deg. F.) in each experimental run.

In order to interpret the results of these tests it was necessary to determine satisfactorily the distribution of temperature in the wheel from tread to hub. Copper-constantan thermocouples of No. 30 B. & S. gage wire were used; seven couples were used along a vertical radius at approximately 2 in. intervals, and seven others similarly located along the horizontal radius. Readings were taken along both radii for the purpose of obtaining duplicate results. Two other thermocouples were inserted into the treads of the wheel; thus four couples, one in the resistor, were placed at equidistant points in the tread of the wheel and assurance was given that uniformity of tread temperature was attained.

A 2-in. Berry strain gage was used for measuring the deformation, readings being taken at 1-in. intervals on both the vertical and horizontal radii. It will be observed that these readings were taken over a considerable area, this being the only manner of satisfactorily determining the point of maximum stress.

Identical rates of power input were maintained for each test in order to obtain comparative results. It was necessary to increase the power input near the end of the test to attain the desired tread temperature in a comparatively short time.

The strain gage readings represent the deformations due to thermal expansion of material and strain due to tension caused by expansion of the rim of the wheel. Having determined the coefficient of expansion and tensile properties of material in auxiliary tests, the value of the strain was obtained by deducting expansion due to temperature from the total deformation and the strain in turn was translated into stress in pounds per square inch on the stress-strain curves.

In the investigation of chilled iron wheels, twenty-eight wheels of several weights and designs were tested at the bureau and of this number 57 per cent developed circumferential cracks near the hub, of various magnitudes. All but two of these wheels were double-plate M. C. B. and Arch plate type and all the failures occurred in the face plate of these types, while of the two single-plate wheels tested no failures occurred.

Results obtained in the tests of sixteen steel wheels may be summarized as follows:

(1) None of the steel wheels failed.

(2) Because of the movement of the hub with respect to the rim, on account of the heating of the rim, a beam effect is produced in the plate which induces tensional stresses near the hub and stresses in compression near the rim on the face of the plate, while on the back of the plate the stresses are approximately equal in magnitude but reverse in nature.

(3) These effects were observed in new wheels, while the stresses on the face of the plate of old wheels were in tension near the hub and at the rim they decrease to practically nothing, this difference from the new wheel probably being due to the quantity of metal worn away.

(4) The magnitude of the maximum stresses developed approximated the yield point of the material as determined in tensile tests.

(5) After the first series of observations had been completed on the new wheels, an apparent set was obtained which was not the case in succeeding series of observations nor in tests on old wheels. The maximum stresses were in the surface of the plates and were beyond the yield point of the material.

[1]This paper has been completed and will appear shortly as a Technologic paper.

New Public Service Power Map Issued

A map of New Jersey showing the location of the power stations and transmission lines used in public service and the names of the public utility companies has just been published by the United States Geological Survey. This map will be of interest to municipalities, manufacturing companies and other organizations contemplating the use of electricity for power or light. Similar maps are now available for New York, Pennsylvania, Massachusetts, Rhode Island, Connecticut, Maryland, Delaware, District of Columbia, Vermont and New Hampshire. Maps may be purchased of the Director for 50 cents each.

Synthetic Cast Iron, Made in California

By Larry J. Barton
Metallurgist, Southern Pacific Railway Co.

A STEEL mill was put into operation in April, 1920, at the general shops of the Southern Pacific Co., Sacramento, Cal., for the production of steel castings, forging and rolling ingots. Necessary ingot molds were made at our own iron foundry from ordinary pig iron, but it was immediately found that these molds were not suitable. They cracked badly in use; some would crack the full length of the mold, while others would crack completely around the top. Failures were very heavy, some molds going only one heat before having to be scrapped. Upon chemical examination the trouble was thought to be in the phosphorus content, the percentage found ranging from 0.40 to 0.70 per cent. (See Table I of chemical analyses.)

A purchase of the ordinary grade of bessemer iron, with phosphorus below 0.20 per cent, was then made. Molds cast from such iron proved to be satisfactory in every detail, the average number of heats from each mold being about 70. (See Table I.) As this pig iron

TABLE I—CHEMICAL ANALYSES OF PIG IRONS AND INGOT MOLDS THEREFROM

Item	Carbon	Mn	Si	P	S
Defective mold No. 1	3.70	0.80	1.60	0.681	0.081
Defective mold No. 2	3.40	0.60	1.50	0.445	0.092
Standard U. S. mold	3.50 to 4.00	0.40 to 0.60	1.75 to 2.00	0.150 or less	0.100 or less
French mold	3.25 to 3.50	1.75 to 2.25	1.50 to 1.80	0.100 or less	0.050 or less
Purchased bessemer iron	3.35	1.05	1.08	0.136	0.036
Molds from above bessemer iron No. 1	3.71	0.79	1.73	0.340	0.028
Molds from above bessemer iron No. 2	3.60	1.08	1.08	0.330	0.060
Electric furnace iron desired	3.00 to 3.50	1.50 to 1.75	1.75 to 2.25	0.100 or less	0.050 or less
Iron obtained (Table II)	3.12	1.71	2.25	0.060	0.016
Mold from above	3.24	1.67	1.82	0.180	0.085
Purchased electric furnace iron	2.70	0.44	1.39	0.180	0.084
Mold from above	3.50	0.65	1.16	0.331	0.064

was purchased for trial, it soon was used up and we were again faced with prospective mold trouble. There was no available bessemer pig for ready delivery on the coast at the time, and as a last resort we turned to the electric furnace.

Believing that iron made from steel scrap would be as good as the general bessemer pig, we determined to manufacture some. Having noted some time before that a French concern used high manganese in its ingot molds, we decided to try its analysis. As this iron was to be experimental, we did not care to move all the molders' rigging from the iron foundry to the steel mill, so it was decided to pour the iron into pigs, and then remelt it in a cupola and pour the molds at the iron foundry, where all the accessories for doing this kind of work were located. With this in mind, it was decided to get the carbon in our pig iron somewhat lower than finally wanted, believing that the pick-up in the cupola would counterbalance any small amount left out in the electric furnace. Furthermore, it has been found that in making synthetic iron it is a very easy matter to get the carbon up to about 3.00 per cent, but from there on many difficulties are encountered. Table I shows the analyses desired—somewhat lower in Mn and higher in Si than the French mold we were imitating.

The furnace is a standard 6-ton Heroult, basic lined. Electrical equipment was made by the General Electric Co.

As shown in Table II, we were going to use steel scrap, and were not forced to slag off to reduce phosphorus; therefore we turned our attention to reducing sulphur. First, old electrodes were broken into pieces about 4 in. in diameter and thrown on the hearth. This was to give the required carbon to convert the steel into cast iron and formed a necessary reducing atmosphere during the melting-down period. While this worked well, it was found better to use ground coke instead of the lumps of carbon. Lumps tend to rise and interfere

TABLE II—CHARGE BURDEN

Item	Wt.	C	Wt.	Mn	Wt.	Si	Wt.	P	S
Spring steel	4,650	0.90	41.9	0.50	23.3	0.20	..	0.04	0.04
Borings steel	5,200	0.50	26.0	0.50	26.0	0.20	..	0.04	0.04
Forge flashings	1,000	0.20	2.0	0.40	4.0	0.20	....	0.04	0.04
Charge	10,850	0.65	69.9	0.49	53.3	0.20	21.7	0.04	0.04
Carbon	500	60.0	300.0	....	....	....	....	....	....
Ferromanganese	210	6.0	12.6	80.0	168.0	1.00	2.1	....	....
Ferrosilicon	465	0.3	1.4	....	....	50.0	232.0	....	....
Total charge	12,025	3.20	383.9	1.84	221.3	2.14	255.8	0.04	0.04
Final metal	11,550	3.12	....	1.71	....	2.25	..	0.06	0.016
Melting loss	475 lb. or 3.96 per cent.								

with the slag after the metal has been melted. We charged the coke first, then a coating of lime (180 lb.), enough to make one-half of our slag, or 1½ per cent of the charge. Old spring steel was charged next, then the borings, and the forge flashings on top to give a good contact. As the charge melted down and the electrodes dug holes, they were filled with the remainder of the forge flashings.

Furnace Log

9:55 a. m. Current on.

12:00 m. Melted down, and all scrap knocked off side walls. During above period the rest of the slag, or another 1½ per cent of the charge, added around the electrodes. This slag is now foaming slightly and powders white on exposure to the air.

12:05 p. m. First metal test taken. Poured flat into sand mold. When black, quenched in water and broken. Fracture shows clear, white iron. This sample could be drilled only a small amount. Analysis: Carbon 2.48 per cent, manganese 0.27 per cent. Quite a few pieces of the old electrodes floating on bath were raked off, and an equivalent amount of finely ground coke added.

12:30 p. m. 100 lb. more lime added to bath, together with 32 lb. of ground fluorspar. Slag tests powdering white and giving off a very strong odor of acetylene.

2:00 p. m. Second metal test taken. Showed clear white and was too hard to drill. 140 lb. ferromanganese added.

2:15 p. m. 300 lb. ferrosilicon added. Test taken showed a very close-grained gray iron, which was still too hard to drill.

2:30 p. m. 70 lb. ferromanganese and 165 lb. ferrosilicon added. Test showed a very fine gray iron, rather close grained. Drilled easily, but was apparently very tough from the high manganese. Analysis: Carbon 2.85 per cent. Added about 50 lb. of finely ground coke and kept rabbling this into metal for ½ hour.

3:00 p. m. Trapped. Final test gave an excellent appearing gray iron, hot and running well in the pig bed.

These pigs were then taken to the iron foundry, remelted in a cupola and made into ingot molds. While the phosphorus and sulphur increased 0.12 and 0.07 respectively in the cupola (see Table I), these molds stood up better than any we had ever had. The original high-phosphorus molds averaged 30 heats, molds from purchased bessemer iron averaged 70 heats, while molds from synthetic iron made as above described averaged 110 to 130 heats. These molds no doubt would have stood up even better had they been cast directly from the electric furnace, thus eliminating the pick-up of phosphorus and sulphur from the cupola.

The economic possibilities of this process here on the Pacific Coast are great. In districts where blast furnaces are common there is not much need to worry

about the supply of available pig iron, but here it is a different matter, especially when freight rates and time of delivery are considered. During 1920 the average cost of pig iron laid down in Sacramento was $45 per net ton. Of this cost $22.40 was for freight alone. Add to this the cost of coke and the other incidental expenses for remelting in the cupola, and then compare this sum to the cost of molten electric furnace iron, which we figure is less than $25 per ton.

If cast-iron borings could be obtained, the expenses of melting would be even less, due to a saving on ferro-alloys, together with lower melting costs. The most logical method would be to annex a molding floor to the steel plant and pourcast directly from the electric furnace. A heat of cast iron could be poured and then a heat of steel, making the one furnace do the work of several, as at present. In addition, the castings would possess high quality; the metallurgist is enabled to meet any specification with ease; and the plant can handle scrap impossible to melt in any other way, since the possibilities for refining are not to be excelled.

A New Dye Standardizing Machine

THE importance of satisfactory mixing and standardizing equipment in the dye industry is not likely to be overestimated. That the manufacturers produce dyes which can be safely guaranteed as to strength and color is one of the fundamental requirements of the consumer. The selection of the machine to be used for this purpose, therefore, demands the very careful consideration of the manufacturer. One type of mixer, which has recently been developed by the Stevens-Aylsworth Co. of New York, has a number of interesting features. It combines the principle of the mechanical agitator with the tumbling action of a revolving drum. The latter feature prevents the accumulation of any quantity of unmixed material in the space that must necessarily exist for the clearance of the revolving agitator in the stationary type of mixer. The accompanying figures will perhaps be of value in explaining the principles and operation of this machine.

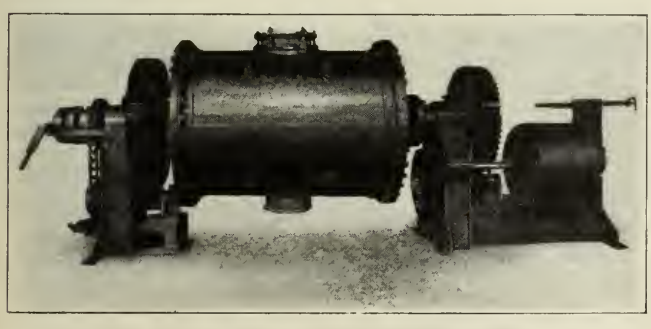


FIG. 1—MIXING MACHINE SET UP FOR TEST RUN

The agitators are in the form of two opposed helical spirals which toss the materials about inside of the drum, moving them from the ends of the machine toward the center. As they throw the material past the center in each case, the materials in the center are forced to the ends, thus thoroughly blending all parts of the mixture.

The vanes are made of flat plates which cut through the material and roll it over on itself on its way to the center and they also in each revolution force some of the materials from the bottom up to the top.

In addition to the revolutions of the vanes the drum itself revolves, but in the opposite direction from the vanes—that is to say, if the vanes revolve clockwise, the drum revolves counter-clockwise.

In the operation of this machine, as well as in all other machines in which there are agitators, there is a tendency for the material to adhere to the ends and sides of the drum, but as the latter revolves these materials will fall back into the mix when the drum has brought them up to the top. Furthermore, the slight vibration of the machine will assist in shaking off the materials adhering to the sides.

The loading and unloading of the mixer are practically dustless operations and it has been found possible to

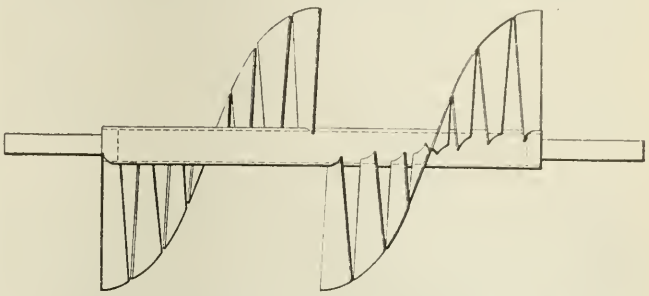


FIG. 2—INTERIOR AGITATING MECHANISM OF MIXER

unload into barrels for shipment a charge of over a ton in less than 13 minutes.

The small openings shown on the sides of the machines are for taking out samples of the mix. These small openings can be placed in various positions around the periphery of the drum and if desired also on the ends. At a specified time samples are taken from various parts of the mix and submitted to the dye application laboratory for test to determine whether they are up to standard. If so, the mixer is then unloaded.

During the loading of this machine the stirrers or vanes may be kept in motion while the drum is held stationary until all of the materials are charged. After the mix has been brought to the proper standard the drum is stopped and by continuing the revolution of the paddles the machine completely empties itself. Since these spiral vanes overlap each other, any portion of the mix which might lag behind one vane is immediately picked up by the succeeding vane and moved toward the center, thus emptying the machine completely.

The various openings into the machine for loading, unloading and for taking out samples are carefully fitted and are flush with the interior, thus eliminating pockets into which the material could otherwise lodge and escape the action of the paddles.

Recovery of Potash From Wool Washing

A small wool washer for recovering potash from fleeces in a solution of sufficient concentration to make the recovery of the potash profitable has been designed and is being tried out by the Bureau of Chemistry. It is said that the average fleece contains about 4 per cent of potash by weight, but in the ordinary method of washing wool it comes out in such dilute solution that it does not pay to recover the salt.

About 600,000,000 lb. of wool is scoured in the United States each year, and if only 3 per cent of potash is recovered it would amount to 18,000,000 lb. of actual potash that would be available for use in fertilizers.

Secretary Weeks Analyzes Ford's Offer for Muscle Shoals

Secretary of War Transmits Recent Offer for Nitrate Plants and Water-Power to Congress with Business Analysis of Ford's Proposal and His Recommendations—Modified Proposal of Jan. 13, 1922, More Advantageous to the Government Than the First Offer—Original Text

SOON after I assumed the duties of Secretary of War suggestions were made to me by those interested in the development of the power plant and navigation at Muscle Shoals that I should recommend to Congress that an appropriation be made to complete Dam No. 2 (Wilson dam). In response to such suggestions I stated that when a proposal was made which would assure the government a reasonable return on at least the additional money required to complete the project, and an effective use of the development for commercial purposes, I would send it to Congress, as the power to dispose of these plants is vested in that branch of the government.

Ford's First Proposal

On July 8, 1921, in consequence of this statement and of some negotiations with the Chief of Engineers, United States Army, Henry Ford presented a proposal in writing, in which he offered a fixed annual rental of $1,200,000 for Dam No. 2 and its power plant and appurtenances, such rental to commence 6 years after the installation of equipment capable of producing 100,000 hp., and a rental of $200,000 to be paid annually during the first 6 years of the lease. On proposed Dam No. 3 he offered a fixed annual rental of $480,000 commencing 3 years after 80,000 hp. should be developed, and $160,000 per annum for the first 3 years of the lease period. Provision was made for certain upkeep charges and payments to be made toward a sinking fund estimated to be sufficient to amortize approximately $48,000,000 of the cost of the dams. Under this proposal the United States was to undertake the completion of Dam No. 2 and the construction of Dam No. 3. This offer was conditioned upon the United States selling to Mr. Ford Nitrate Plants Nos. 1 and 2, the Waco Quarry and its equipment and the Gorgas-Warrior steam plant and transmission line and appurtenances, all for the price of $5,000,000.

The cost of completing the two dams is estimated by the Chief of Engineers to be, at this time, in round figures, $50,000,000. Consequently, I did not believe that the proposed rental was an adequate return on the government's proposed investment, and suggested that Mr. Ford modify his offer so that it would be based upon an annual payment equivalent to a rate of interest on the total cost to the government completing the projects. On Jan. 13, 1922, Mr. Ford presented to me a proposed modification of his previous offer, by which he agreed to undertake the construction and completion, at actual cost and without profit, of the work referred to in his offer of July 8, 1921, and when completed and ready for operation he offered to pay the United States as annual rental of the property an amount equal to 4 per cent of the total cost of such construction.

At my suggestion Mr. Ford placed in one instrument his offer as modified, which was signed by him on Jan. 25, 1922, and delivered to me on Jan. 27, and which I have the honor to transmit herewith for such action as Congress may deem appropriate.

Modified Proposal

In brief, Mr. Ford offers to undertake the completion of Dam No. 2 and the construction of Dam No. 3 according to the government's plans, for which he shall be reimbursed the actual cost, and to lease the dams and power plants at an annual rental equivalent to 4 per cent of the cost to the government of completing Dam No. 2 and constructing Dam No. 3 (exclusive of the cost of acquiring lands and flowage rights necessary for Dam No. 3). The rentals of 4 per cent are to commence, respectively, in 6 years after Dam No. 2 has been completed to the point where equipment for 100,000 hp. is installed and ready for service, and 3 years after the equipment to develop 80,000 hp. is installed and ready for service at Dam No. 3. In the meantime, during the 6-year and 3-year periods, respectively, he offers to pay upon Dam No. 2 an annual rental of $200,000 and on Dam No. 3 $160,000.

His offer places upon the United States the responsibility for repair and maintenance of the two dams other than the power houses, which power houses and electrical equipment he agrees to maintain at his own expense in efficient operating condition. As compensation to the United States for the repair and upkeep of Dam No. 2 and locks he offers to pay the sum of $35,000 annually, and of Dam No. 3 and lock the sum of $20,000 annually. He also agrees to furnish electricity for operating the locks at each of these dams without charge to the government, and in addition he agrees to pay the sum of $23,373 semi-annually, for the purpose of building up a sinking fund to return to the United States at the end of the lease period, a sum of money which he estimates if invested at 4 per cent will be approximately $49,000,000.

As a condition of this offer he asks that the United States sell to him Nitrate Plants Nos. 1 and 2, the Waco Quarry and the Gorgas-Warrior steam plant, with all appurtenances, for the sum of $5,000,000, payable $1,000,000 down and the balance in annual installments of $1,000,000 each, with 5 per cent interest on deferred payments. As a further consideration to the government he agrees to operate Nitrate Plant No. 2 at the approximate present annual capacity of its machinery and equipment in the production of nitrogen and other fertilizer compounds throughout the lease period, and to maintain it in its present state of readiness, or its equivalent, for immediate operation in the manufacture of materials necessary in time of war for the production of explosives. He further agrees that the fertilizer produced at Nitrate Plant No. 2 shall not be sold at a profit in excess of 8 per cent of the actual annual cost of production thereof, and to turn over to the United States Nitrate Plant No. 2 whenever it shall be required for the national defense. He likewise asks for a preference in opportunity to purchase or lease the property at the end of the lease period and for the right, for a period not stated, to be supplied with electric power at reasonable rates in an amount equal to his average consumption during the previous 10 years, in case the plant is operated and his company does not purchase or lease it. He also states that his proposal must be accepted as a whole and not in part.

In order that you may the more readily understand just what Mr. Ford is proposing to buy and to lease I shall state briefly what has occurred in connection with government development at Muscle Shoals and the character of the government-owned property there.

Description of Property Involved

Without going into the preliminary history in connection with the proposals for the development and improvement of the Tennessee River, which might, if necessary, be traced to the year 1827, it is deemed sufficient for present purposes to invite attention to the letter over the signature of the Secretary of War, dated June 28, 1916, and printed as Document H.R. 1262, Sixty-fourth Congress, First Session, transmitting, with a letter from the Chief of Engineers, reports on preliminary examination and survey of Tennessee River between Browns Island and the railroad bridge below the City of Florence, wherein is contained a full discussion of Dam No. 2, now known as the Wilson Dam, and the proposed Dam No. 3, referred to by Mr. Ford but as to which no construction work has yet been undertaken. The commencement of construction work on the Dam No. 2 resulted from the authority contained in Section 124 of the national defense act of June 3, 1916 (39 Stat. 166,

215, under which the President, in a letter dated Feb. 23, 1918, authorized the construction of said dam, as a result of which allotments have been made at various times amounting to $17,159,610.42 for its construction. The total expenditures on Dam No. 2 have been $16,251,038.14; the greater part of the balance unexpended will be required to meet payments on contracts for power machinery for the dam. A large construction camp has been built, a railroad track laid to the site, complete construction plant assembled, and the dam itself approximately 30 per cent completed.[1]

Water Power Property

Dam No. 2, when completed, will have a total length of 4,267 ft., of which 2,890 ft. is a spillway section, 1,221 ft. will be the power house section and 156 ft. abutments and approaches. The height of the dam above present low water is 95 ft., including crest gates 18 ft. in height. The total height from the bottom of the excavation for the foundations to the roadway on top of the dam will be 132 ft. There have been no expenditures on Dam No. 3, which is located 14.7 miles upstream from Dam No. 2. Dam No. 2, when constructed, will render 14.7 miles of Muscle Shoals navigable, while Dam No. 3 will overflow the remaining portion of the rapids and will improve conditions of navigation for a distance of 63 additional miles. The present estimates of the Engineer Department for the completion of both Dam No. 2 and Dam No. 3 is $50,000,000. Engineers for Mr. Ford have presented a lower estimate, but Mr. Ford has not seen fit to guarantee the construction for this lower figure.

Nitrate Plant No. 1

Situated about 6 miles southwest from Dam No. 2, at Sheffield, Culbert County, Ala., adjacent to the city and along the Tennessee River, is United States Nitrate Plant No. 1, constructed by the United States during the war under an agreement with the General Chemical Co., approved by the Secretary of War on June 14, 1917, for use of its process, and at a total cost of $12,887,941.31. The plant was built under the supervision of the Ordnance Department of the Army to produce 22,000 tons of ammonium nitrate per annum, using the direct synthetic ammonia (modified Haber process) of the General Chemical Co. The details of the process were not sufficiently perfected, however, and the plant proved unsuccessful in a test operation. The construction of the plant was started from an appropriation contained in the national defense act of June 3, 1916, and completed from appropriations made for the national security and defense, armament of fortifications and ordnance service. The total acreage of land embraced within the plant site is approximately 19,000 acres. The plant is now in an idle standby condition, with part of the land leased for farm purposes. The cost of maintenance during the fiscal year 1921 was $75,506.42.

Nitrate Plant No. 2

At Muscle Shoals, Culbert County, Ala., 4 miles northeast of Nitrate Plant No. 1 and 2 miles distant from Dam No. 2, is located[2] United States Nitrate Plant No. 2. This plant was constructed under contract with the Air Nitrates Corporation for the production of munitions of war under contract dated and executed June 8, 1918, at a total expense, including Waco Quarry, of $67,555,355.09. The plant was built for an estimated capacity of 110,000 tons of ammonium nitrate per annum, using the cyanamide process of the American Cyanamid Co. The plant was successful in a 2 weeks' test operation with one-fifth of the plant in use, during which time 1,700 tons of ammonium nitrate were produced, as well as 2,200 tons of cyanamide not converted. The cost of building said plant was paid out of the appropriation for armament of fortifications and ordnance service. The plant site, not including Waco Quarry, embraces 2,306 acres acquired at a cost of $237,711. The plant is now in an idle standby condition, except the 80,000 kw. power plant located thereon, which was leased, together with a transmission line, to the Alabama Power Co. under the provisions of the act of July 28, 1892 (27 Stat. 321) by an instrument dated Nov. 17, 1921, but revocable at any time. The cost of maintenance of said plant for the fiscal year 1921, including Waco Quarry, was $201,674.63.

Waco Quarry

Situated about 20 miles south of Plant No. 2 in Franklin County, and 5 miles southeast of Russellville, Ala., is located what is known as Waco Quarry, acquired by the United States in connection with the operation of Nitrate Plant No. 2, embracing an area of 160 acres, acquired at a total cost of $52,962.88. This quarry has a crushing plant sufficient to produce 2,000 tons of crushed and sized limestone per day. The total cost of said quarry, including buildings and plant, was $1,179,076.80, included, however, as an element of the total cost of Nitrate Plant No. 2. The plant is now in an idle standby condition and a portion of the land is leased for farm purposes.

Gorgas Power Plant

Situated about 88 miles southeast of Nitrate Plant No. 2, in Walker County, Ala., is located what is known as the government-owned Warrior steam plant at Gorgas, Ala. This plant was constructed under contract with the Alabama Power Co., dated Dec. 1, 1917, on land owned or acquired by the said company. It was built in the vicinity of a coal mine with a view to using coal direct from the mines. It has a capacity of 30,000 kw. and the electric power produced at said plant is carried over a transmission line extending a distance of about 88 miles to Nitrate Plant No. 2, to furnish power for the operation of said plant. The total cost of the plant was $4,979,782.33. It was built and paid for from appropriations for armament of fortifications. This property is now being operated as a part of the Alabama Power Co.'s system on a rental basis as provided for in the contract for the consideration thereof, and during the calendar year 1921 netted the government approximately $75,000.

Opinion of Judge Advocate General

Some question was raised in my mind as to the binding effect of certain provisions appearing in the contract for the construction of Nitrate Plant No. 2 by the Air Nitrates Corporation and in the contract for the construction of the Gorgas-Warrior steam plant and transmission lines by the Alabama Power Co., which purported to give said companies options to purchase under certain conditions, but I have submitted these questions to the acting Judge Advocate General, who is of the opinion that at the time these contracts were made there was no authority to sell said properties and hence no authority to give an option for the purchase of same. He holds that as the Constitution vests in Congress the sole power to dispose of and make all needful rules and regulations regarding the property of the United States, and Congress not having authorized the Secretary of War to sell the same, the plenary power to dispose of such property still rests solely in Congress. The acting Judge Advocate General has also held that the provision contained in section 124 of the national defense act directing that the plant therein authorized be operated solely by the government and not in conjunction with any other industry or enterprise carried on by private capital is applicable to the plant as a whole and is a restraint upon its sale. This construction, if justified, would prevent the lease or rental of the plant for private operation. The solution of the numerous legal questions involved naturally occasioned more or less delay in the consideration of the proposals.

Air Nitrates Corporation Option to Buy

In this connection I may say that the Air Nitrates Corporation has notified me in writing that it claims the right to exercise the option which it claims to have under the terms of its construction contract to purchase Nitrate Plant No. 2 on as favorable terms as those offered by Mr. Ford for the property, should the United States determine to accept Mr. Ford's offer. The Alabama Power Co. may make a similar claim in regard to the Warrior plant and line.

To briefly summarize Mr. Ford's offer for the above properties the considerations running to the government are:

[1] See CHEM. & MET. ENG., Feb. 1, 1922, p. 230, for picture showing present condition of dam construction.

[2] See CHEM. & MET. ENG., Feb. 1, 1922, p. 231, for picture showing dam and Plant No. 2.

(*a*) Four per cent on part of the capital necessary to complete the construction of the power projects; (no interest is proposed to be paid upon that part of the government's investment which goes to pay for lands and flowage rights for Dam No. 3, which item is estimated by the engineers to exceed $2,000,000 in probable cost.

(*b*) The payment of a sum semi-annually into a sinking fund calculated to produce about $49,000,000 at the end of the lease periods. This payment amounts to $46,746 annually. In other words, Mr. Ford proposes to pay approximately $49,000,000 at the end of the lease period provided the government has been able to invest his payments at 4 per cent per annum.

(*c*) Mr. Ford proposes to pay $35,000 a year for the upkeep of Dam No. 2 and its locks and the sum of $20,000 a year for the upkeep of Dam No. 3 and its lock. These payments are expected to meet the ordinary upkeep expense with which the government is charged. Mr. Ford assumes the responsibility for upkeep and repair of the power houses and equipment so that ultimately such equipment is expected to be turned back to the government in approximately as good condition as when received.

(*d*) The proposal requires Mr. Ford's company to operate Nitrate Plant No. 2 to its approximate present capacity, which is estimated to be a production of 110,000 tons of ammonium nitrate per annum, and to sell such material at a price not to return a net profit in excess "of 8 per cent of the actual annual cost of production."

(*e*) Mr. Ford's company is to maintain Nitrate Plant No. 2 in its present state of readiness for immediate operation for the production of explosives and is to turn it over to the government, together with such of its personnel as may be required for the national defense.

(*f*) The government will be saved the expense of maintaining and operating the present imperfect facilities for navigation at Muscle Shoals amounting to from $35,000 to $85,000 per annum.

Advantages to Government in Last Proposal

There are a number of advantages to the government in the present proposal that were not apparent in the first offer. Mr. Ford's original proposal of July 8, 1921, contained two paragraphs dealing with the matter of amortization of the cost of construction of the two dams. The first of these paragraphs was numbered 2 and reads as follows:

> At the beginning of the seventh year of the lease period, and annually thereafter, the company will pay to the United States a sum not greater than $39,537 to retire, during the remaining period of 94 years, the total cost of the Wilson Dam and its power house, substructures, superstructures, machinery and appliances, including locks, all taken at $40,000,000; the sinking fund investments to bear the highest rate of interest obtainable, but not less than 4 per cent per annum.

The other paragraph was numbered 7 and reads as follows:

> At the beginning of the fourth year of the lease period, and annually thereafter, the company will pay to the United States a sum not greater than $7,010) to retire, during the remaining period of 97 years, the total cost of Dam No. 3 and its power house, substructures, superstructures, machinery and appliances, including lock, all taken at $8,000,000; the sinking fund investments to bear the highest rate of interest obtainable, but not less than 4 per cent per annum.

In the present proposal the subject of amortization is covered in one paragraph, numbered 10, which reads as follows:

> For the purpose of enabling the government to create and provide a sinking fund to retire the cost of Dam No. 3 at the end of 100 years, the company will, at the beginning of the fourth year of the lease period and semi-annually thereafter for the remaining term of the lease, pay to the United States Government the sum of $3,505; and for the purpose of enabling the government to create and provide a sinking fund to retire the cost of Dam No. 2 at the end of 100 years, the company will, at the beginning of the seventh year of the lease period and semi-annually thereafter for the remaining term of the lease, pay to the United States Government the sum of $19,868.

It will be observed that the provision for amortization in the last proposal is very much more favorable to the United States than it was in the offer of July 8, 1921. By the earlier proposal the maximum amount which the government could realize from the payments made by Mr. Ford at the end of the lease periods would be not to exceed $48,000,000 ($40,000,000 in the case of Dam No. 2 and $8,000,000 in the case of Dam No. 3). The annual payments were in no case to exceed the amounts stipulated, which are the same as in the present proposal as in the former proposal, but the former proposal contemplated a reduction in amount of annual payments to correspond to the excess over 4 per cent interest which might be earned by the sinking fund, whereas under the present proposal the annual installment for amortization is to be paid regardless of the rate of interest earned by the fund. Therefore, if the United States should be able to invest the money at a higher rate of interest than 4 per cent the sinking fund at the end of the lease periods would amount to very much more than $48,000,000. This may be best shown by the accompanying table:[3]

AMOUNT RETIRED BY MR. FORD'S SINKING FUND AT VARIOUS RATES OF INTEREST (COMPOUNDED SEMI-ANNUALLY)

Account of	Semi-Annual Payments	Life of Fund (Years)	Amount Retired at Following Interest Rates		
			4 Per Cent	4¼ Per Cent	4½ Per Cent
Dam No. 2	$19,868	94	$40,919,798	$48,783,949	$58,319,359
Dam No. 3	3,505	97	8,152,137	9,786,054	11,780,690
Total			$49,071,935	$58,570,003	$70,100,049
				5 Per Cent	6 Per Cent
Dam No. 2	$19,868	94		$83,718,097	$176,030,810
Dam No. 3	3,505	97		17,150,545	37,103,880
Total				$100,868,642	$213,134,690

Should the dams be constructed at a cost of not to exceed $42,000,000, as estimated by Mr. Ford's engineers, there would be left to apply on the investment of the government heretofore made whatever the amortization payments would produce in excess of the $42,000,000. If the amortization fund should be invested continuously at 4 per cent there would be at least $7,000,000 to be thus applied, but should it be invested at a greater rate of interest the amount would be increased as shown by the table.

Renewal of Leases

The provision for renewal of the lease which was contained in the proposal of July 8, 1921, was numbered 11, and reads as follows:

> At any time prior to the expiration of said lease period of 100 years the company shall have the right to negotiate with the government for a renewal of the leases for the two above dams, their powerhouses, etc. In the event of disagreement as to terms of the renewal, the United States and the company shall each appoint an arbitrator, and these arbitrators shall choose a third. The decision of the arbitration board of three shall be final and binding upon both parties.

The effect of this provision was to bind the United States to a renewal of the lease for 100 years on such terms as should be determined to be just by a board of arbitration. Under the new proposal the renewal clause is contained in paragraph 17, which reads as follows:

> In order that said company may be supplied with electric power and the farmers with fertilizers after the termination of the said 100-year leases, should the United States elect not to operate said power plants but determine to lease or dispose of same, the company shall have the preferred right to negotiate with the United States for such lease or purchase and upon such terms as may then be agreed upon. If the said leases are not renewed or the property covered thereby is not sold to said company, its successors or assigns, any operation or disposal thereof shall not deprive the company, its successors or assigns, of the right to be sup-

[3] Payments are to be made into sinking fund semi-annually at the beginning of each semi-annual interest period. This sinking (or retirement) fund has nothing to do with Mr. Ford's interest payments, but represents a separate fund to be invested at the highest interest rate obtainable for the purpose of returning to the government within the lease period the largest amount possible, with the above semi-annual payments, consistent with safe investment.

plied with electric power at reasonable rates and in amount equal to its needs, but not in excess of the average amount used by it annually during the previous 10 years.

This paragraph does not bind the United States to renewal of the lease and is in no way an attempt to control the policy of Congress beyond the 100-year period of the present lease, except to preserve to Mr. Ford's company "the preferred right to negotiate with the United States for such lease or purchase and upon such terms as may then be agreed upon." It also attempts to preserve for the company a right to be supplied with electric power for a period not stated "at reasonable rates" in the event the power plants are operated or disposed of to someone other than the company.

Obligation for Maintenance Rests on Mr. Ford

In Mr. Ford's offer of July 8, 1921, no provision was made except possibly by inference, as to who should bear the expense of renewals, repairs and maintenance on the power houses, machinery and appliances which will be erected and installed in connection with the dams. Paragraphs 4 and 8 of the present proposal impose the obligation upon Mr. Ford's company of making such renewals and repairs and effecting such maintenance at its own expense. These provisions impose upon Mr. Ford a considerable obligation.

Lessor to Construct

Under the first proposal the United States was to undertake the building of the dams and power plants, but under the present offer Mr. Ford's company is to do the construction work in accordance with plans and specifications prepared or approved by the Chief of Engineers.

The proposal of July 8, 1921, contained no provision for a termination of the leases in case of default. Paragraph 18 of the present proposal applies substantially the same provisions to Mr. Ford's proposed leases as are contained in the present water-power act.

Paragraph 19 of the present proposal, except the first sentence thereof, has no counterpart in the original proposal of July 8, 1921. The new matter reads as follows:

> Upon acceptance, the promises, undertakings and obligations shall be binding upon the United States, and jointly and severally upon the undersigned, his heirs, representatives and assigns, and the company, its successors and assigns; and all the necessary contracts, leases, deeds and other instruments necessary or appropriate to effectuate the purposes of this proposal shall be duly executed and delivered by the respective parties above mentioned.

Assurance of Contract's Execution

Apparently this is an attempt on Mr. Ford's part to express a personal obligation to assure the performance of the contracts which are to be made by the company which he is to organize. It might be contended that this language is susceptible of a construction to the effect that Mr. Ford is personally bound only to see that his company enters into the contracts required to carry out the terms of the proposal, and this point should be cleared up so that there can be no question as to its proper construction. There should be some assurance that the contracts made by the proposed company will be carried out or some penalty imposed for failure to perform.

Must Maintain Plant No. 2

In the event Mr. Ford's proposal is accepted, the government must make new appropriations amounting to $40,000,000 to $50,000,000, of which Mr. Ford will have the benefit for approximately 100 years at 4 per cent. The company is, of course, bound to keep Nitrate Plant No. 2 in a condition to produce explosives, which, as a matter of preparedness, is of great value to the government, as no doubt a plant fully organized and in production would be available far sooner than one maintained merely in standby. Nevertheless Mr. Ford is offering but $5,000,000 for the title to the two nitrate plants, the Waco Quarry, the Gorgas-Warrior steam plant, transmission lines and appurtenances. That you may the better understand the value of the property for which Mr. Ford is offering this $5,000,000 I am attaching to this letter, as Exhibit "A," a brief statement prepared by the Chief of Ordnance showing the cost and estimated salvage value of these properties. From the table contained in this statement it will be seen that these properties cost the United States approximately $85,000,000 and that as scrap they are estimated to be worth $8,812,000. However, the last column of the table in Exhibit "A" indicates that the Chief of Ordnance believes the War Department can dispose of the property for $16,272,000. Mr. Ford is bound by his proposal to operate Nitrate Plant No. 2 but there is no legal obstacle to prevent his disposing of the other properties to which he gets title. Should he be able to obtain what the Chief of Ordnance estimates that the government can secure for the various items—namely, $3,000,000 for the Warrior plants, which have an installation of 40,000 hp., and $600,000 for Nitrate Plant No. 1 and dispose of the Warrior-Muscle Shoals transmission line, as a transmission line and not as scrap, for $675,000, and should he obtain $357,000 for the Waco Quarry, he would have left the Nitrate Plant No. 2 with its 80,000-hp. steam plant at a cost to him of less than $400,000. The interest on the proceeds of such possible sales would amount to a very large sum during the term of the proposed contract. The present revenue from rental of the power plant at Nitrate Plant No. 2 is a minimum of $120,000 per annum with a possibility that, in event of operation, it may run to $260,000. The cost of maintenance of Nitrate Plant No. 2 was approximately $200,000 during the fiscal year 1921. The total horsepower developed by the three steam plants to which Mr. Ford will get title is 125,000, which practically doubles the all-season or primary horsepower to be developed at Dam No. 2 (approximately 500,000 of the horsepower that is to be developed at Dam No. 2 will not be available 365 days in the year).

Congress Must Decide

Inasmuch as I am without authority in law to accept Mr. Ford's offer or dispose of the property as a whole, either by sale or by lease, it is peculiarly the province of Congress to weigh the considerations which will pass to the respective parties to the proposed arrangement, and to determine whether or not the advantage to the government in having Nitrate Plant No. 2 maintained in readiness for the manufacture of explosives and in actual production of fertilizer, together with the improvement to navigation, is of sufficient importance to justify the proposed departure from the present policy of the law in regard to dealing with the water-power resources of the nation and to warrant leasing to Mr. Ford government property for so long a period at the rental proposed.

Modifications of Offer Suggested

If Mr. Ford's proposal be accepted by Congress I suggest that there should be certain modifications made to safeguard the government's interest. As heretofore stated, there should be some assurance that the contracts made by his proposed company will be carried out.

I also suggest that the cost of acquiring the lands and flowage rights necessary for Dam No. 3 should be included in the sum upon which Mr. Ford is to pay 4 per cent interest as rent. The omission of the cost of these lands from this computation is more serious than would be the omission of the provision for a sinking fund, for the annual interest at 4 per cent on the cost of such lands and rights if used for that purpose would amortize a sum much larger than that provided for in paragraph 10 of Mr. Ford's proposal.

In case the proposed company sells any or all power developed at either or both of these dams it should be required to do so under terms and conditions imposed by the Federal Power Commission or the Public Service Commission of Alabama in the manner required of other power companies.

I believe it would be better policy to limit the contract to a term of 50 years to conform to the established policy of the Federal Government as set out in the water-power act. In my opinion a contract such as that proposed for a period of 100 years is not a wise general policy in view of the unknown possibilities surrounding water power developments and the probability of changes which may be made, especially in the transmission of power.

While paragraphs 4 and 8 of the present proposal provide that Mr. Ford's company is to pay to the United States

annually the sum of $35,000 on Dam No. 2 and $20,000 on Dam No. 3 for repairs, maintenance and operation of the dams, gates and locks, Congress may well consider whether it would be more desirable to have Mr. Ford maintain the property and omit these payments.

Wilson Dam Should Be Completed

If Mr. Ford's proposal be not accepted it is my opinion that Dam No. 2 (Wilson Dam) should be completed by the government and that the power requirements for commercial purposes, the benefits to navigation, as well as the possible needs of the government, would warrant this expenditure. If this were done the government may itself undertake to sell the product to the best advantage. In such case the amount of the government's present proposed investment would be very materially reduced, because Dam No. 3, costing from $18,000,000 to $25,000,000, would not be built. At Dam No. 2 it would not be necessary to make the full installation of power plant until the market should require such installation. This partial installation would effect a saving of present investment in at least the sum of $3,000,000, leaving, according to the Chief of Engineers' estimate, not to exceed $22,000,000 to be invested by the government at this time instead of $40,000,000 to $50,000,000. The analysis made by the Chief of Engineers (hereto attached as Exhibit "B") shows a loss in excess of $15,000,000 due to delay in the receipt of returns from rentals. Such a large loss would hardly be justified in case the investment is to ultimately bear but 4 per cent interest if there were not other considerations which are beneficial to both the government and the people of that vicinity.

Will Help Labor Situation

At this time when there is a large amount of unemployment it is not without importance to consider the advantage to the nation of the employment of the large amount of labor required in undertaking this development. I therefor urge that Congress give early consideration to this matter not only to settle a controverted question but to furnish employment on a large scale.

Chief of Ordnance's Opinion

In summarizing the Ford offer from the standpoint of the Ordnance Dept., Major-General Williams states that acceptance has the very important advantage of materially assisting in the development of nitrogen preparedness and has the disadvantages of conflicting with the contractural obligations with the American Cyanamid Co. and the Alabama Power Co. and of making a net return to the government of less than $5,000,000 for properties which have an estimated salvage value of some $16,000,000.

The difference, $11,000,000, appears therefore to be the price which the United States is paying for nitrogen preparedness. If the plant is diverted to any purposes which do not include nitrogen fixation, this asset is lost to the government.

Chief of Engineers' Opinion

Major-General Lansing H. Beach summarizes the indirect benefits accuring to the United States on acceptance of the offer to be as follows:

(*a*) The maintenance of a nitrate plant in readiness for a war emergency.

(*b*) The production, in the interest of the public welfare, of large amounts of fertilizer at a cost not exceeding the reasonable cost of production, providing that the production of nitrate adapted to fertilizing purposes is found to be practicable.

(*c*) The elimination of the cost of maintaining and operating the present imperfect facilities for navigation at Muscle Shoals, amounting to from $35,000 to $85,000 per annum.

(*d*) The advantage to interstate commerce and navigation of the far superior facilities to navigation that will be secured through the construction of the dams and locks.

The funds that have been expended on Dam No. 2 have not been included in the analysis, for the reason that neither the acceptance nor the rejection of Mr. Ford's offer would restore any substantial portion of them to the public treasury. If Dam No. 2 be not completed, either by Mr. Ford's company, the United States, or otherwise, the work done will be wholly without value within a brief period of years, and the only recovery possible from the investment already made will be the scrap value of such machinery as can be disposed of, too small in amount to affect the present analysis.

Rate Relief on Basic Commodities Urged by Hoover in Railroad Statement

The statement of Secretary Hoover to the Interstate Commerce Commission on Feb. 3, in which he laid before the Commission what is believed to be the Administration's idea as to how railroad rates may be reduced without serious injury to the carriers, is of interest alike to producers and consumers of chemical and metallurgical products. Mr. Hoover's statement was studiously prepared and it is believed that his recommendations will be given careful consideration by the Commission.

In advocating reductions in rates on basic commodities, a view that President Harding has maintained, Mr. Hoover treated the whole subject from a point of view of full sympathy for the railroads and the fundamental dependence of the country on railroad transportation. He urged reduction of railroad operating costs and restoration of credit so that the railroads might expand.

"One thing is absolute," declared Mr. Hoover, "Our transportation facilities are below the needs of our country, and unless we have a quick resumption of construction, the whole community—agricultural, commercial and industrial—will be gasping from a strangulation caused by insufficient transportation the moment that our business activities resume. For the past 5 years, we have had no consequential expansion to our railway transportation machine.

Railroad Construction Necessary

"I wish to emphasize that unless we can have an immediate resumption of construction and equipment, our commercial community will pay treble the cost of the whole of them in their losses of a single season. The very moment that we reach anything like normal business we shall see a repetition of car shortages, followed by an increase in the cost of coal to the consumer from $1 to $3 a ton; we shall again see premiums of 20 cents a bushel for the use of cars for moving grain; we shall in fact see a shortage of commodities to the consumer; and we shall see gluts upon the hands of the producers. We shall see factories filled with orders again closed for lack of cars; we shall see large intermittency in employment; and we shall see the usual profiteering in commodities due to a stricture between the producer and consumer.

Urges Freight Rate Reduction

"If I were to discuss the rates charged today I should say at once that a decrease in passenger rates is not nearly so vital to the community as freight rates, for passenger rates do not enter into the 'spread' in proportion to the relative volume of earnings. If I were examining the freight rates, I should at once say that coal, metals, wood and agricultural and other producers' goods should be reduced to the bottom before less than carload lots and class rates are touched.

"I would be willing to go even further and say that I am convinced that even if the Commission cannot at the present moment justifiably reduce railway incomes a single dollar, it is warranted in investigating the possibility of some relief to the more distressed commodities by a revision of some rates upward. There is perhaps no great field for changes in this direction, but it is worth inquiry. As mentioned above, an economic analysis of our industry will show that less than carload lots and class rates are far too low compared to the rates on primary commodities.

"With the gradual return of the traffic to normal, with decreased operating costs, relief in rates will be available, and it would be an economic crime to apply such relief by horizontal reductions to all rates, thus giving relief to higher priced goods and travel, when the vital mainspring of our economic life, our agriculture and fuel and metals, are choked."

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Industrial Developments of the Week

Glass. The Macbeth-Evans Glass Co., Elwood, Ind., has started up eight additional furnaces at its plant, giving employment to an increased working force.

The American Window Glass Co., Farmers' Bank Building, Pittsburgh, Pa., with plant at Arnold, Pa., is operatng at about 60 per cent capacity, with expectation of early increase.

Leather. The Standard Kid Co., Wilmington, Del., has resumed operations at close to full capacity, with production totaling about 750 dozen skins per day.

The Liberty Morocco Co., Wilmington, Del., has recently resumed production at its plant.

The Martin Leather Co., Wilmington, Del., is operating at close to regular capacity at its local plant.

Cement. The Lehigh Portland Cement Co., Ormrod, Pa., has resumed production at its Mill F, following a period of inactivity. The company is planning for the early reopening of its Mill D, in the same vicinity.

The Coplay Cement Mfg. Co., Coplay, Pa., is arranging for the immediate resumption of manufacture at its Mill C, following an idle period.

Rubber. The Electric Hose & Rubber Co., Wilmington, Del., is maintaining capacity production at its local plant, and has orders on hand to insure continuance at this rate for several months to come.

Powder. The du Pont Powder Co., Wilmington, Del., will increase production at its plant at Carney's Point, N. J., to handle an order received from the Argentine Government for 1,000,000 lb. of smokeless powder, insuring a high rate of manufacture at the plant for a number of months to come.

Oil. The Fort Worth Cotton Oil Co., Fort Worth, Tex., has reopened its plant at Niles City, near Fort Worth, following a period of curtailment, giving employment to about sixty men.

Tin. The Fallcon Tin Plate Co., Niles, Ohio, has resumed operations at its mill at Canton, Ohio, formerly the plant of the Carnahan Tin Plate & Sheet Co.

The American Sheet & Tin Plate Co., Sharon, Pa., has placed additional hot mills in operation at its Mercer works, putting the plant on a full capacity basis. The company has also resumed full operations at its plant at Farrell, Pa.

The American Can Co., Chicago, Ill., is operating eighteen of its nineteen plants in this section, despite the fact that this normally is a low production period. About 10,000 workers are employed. It is expected to increase production considerably during the next 60 days.

Iron and Steel. The Bethlehem Steel Co. has placed another open-hearth furnace in operation at its Steelton, Pa., works, effective Jan. 30.

The Republic Iron & Steel Co., Youngstown, Ohio, is operating two merchant bar mills at its plant following an extended shut-down.

The Allegheny Steel Co., Brackenridge, Pa., has reopened four hot mills at its local plant, following a suspension of about a year.

The Newton Steel Co., Newton Falls, Ohio, has all of the ten hot mills in operation at its local plant.

Miscellaneous. The Newport Tar & Turpentine Co., Pensacola, Fla., has resumed operations after a shut-down of over a year.

Following a shut-down since December, 1920, the Grasselli Chemical Co. is arranging for the early resumption of operations at its plant at Terre Haute, Ind., giving employment to about 450 men. Production will be concentrated upon metallic zinc. A coal mine is now being opened by the company in this district to be used exclusively for company plant service, with capacity of about 1,000 tons per day.

The Peet Brothers Co., Kansas City, Mo., manufacturer of soaps, is operating its plant at close to normal, giving employment to the regular working force.

The Corn Products Refining Co., Kansas City, Mo., has commenced filling the elevators at its new plant at North Kansas City, which has been in course of construction for about a year past, and will place the works in full operation at once.

Finance Committee Hearing Shows Sentiment Favoring American Valuation

It is generally believed by those who attended the special tariff convention of the National Association of Manufacturers in Washington, Jan. 30 and 31, that the American valuation plan will be indorsed by the Senate Finance Committee.

The delay on the part of the Finance Committee in agreeing to the plan laid down in the bill passed by the House of Representatives has been due to the determined opposition of two Republican members of the committee. This was revealed when delegations of manufacturers called on the Senators and Representatives of their respective states. The names of the two Senators who are held to be responsible for the delay were not disclosed.

The gathering of several hundred manufacturers from all parts of the country demonstrated that there is little division of opinion among them as to the necessity for levying the ad valorem duties on American prices. This opinion is so universally held from the fact that manufacturers generally believe that no equitable foreign value can be arrived at with currencies in a jumble and with opportunities favoring more than ever the undervaluation of foreign-made goods.

The convention listened with careful attention to a detailed statement by H. E. Miles, of Racine, Wis., who appeared in opposition to American valuation.

Undervaluation by Foreign Producers

One of the most significant features of the convention was the establishment beyond any reasonable doubt that undervaluation and fraud are practiced to a very considerable extent by many foreign producers. The testimony of men who have first-hand information in this connection was convincing on that point. Among the others who brought out that phase of the situation was William Burgess, of the United States Tariff Commission. He told of several trips which he had made abroad to investigate fraud in the valuation of commodities intended for sale in the United States. The extent of undervaluation "went far beyond my anticipation or greatest guess," he said.

"The great body of the importers," continued Mr. Burgess, "is just as honest as the great body of manufacturers, but one dishonest importer can have a very demoralizing influence. He can import his goods, valuing them at a price that will demoralize the other importers and compel them either to go out of business or to follow his example. I have made six trips to different parts of Europe and another to the Orient to look into the matter of valuation. I was made to realize the impossibility of finding true foreign market values. On one trip I developed the fact that I could not get a wedge into any information for 2 months after my arrival. Afterward I found that it was on account of a ring, tied up with certain officials of our own government, who had advised the manufacturers on the other side that I was coming over and to look out for me. I had a commission from one of the largest houses in this country to make such purchases for their account

as to establish a true wholesale selling value abroad. The man who was honestly endeavoring to find out the prices and purchase the goods for me was boycotted. Orders were issued from New York to see that he got no more goods. Every manufacturer in that line in France, in Germany, in Holland and in Belgium refused to sell him goods. He was ruined financially."

Walter Camp, of Connecticut, in the course of his remarks said: "This is the Garden of Eden. This is the place where they all want to come. This country is the place where they want to fish and they want us to cut bait. Do not be deceived by those who are interested in telling us that we must have a big export trade now that our factories are so expanded. Do not follow false counsel and let those who give it come in behind you and take the domestic trade which constitutes 90 per cent of our business, while you are chasing poor credit customers who consume 10 per cent of our output."

It was contended that the American valuation plan is only a form of administration and has nothing to do with rates. It was declared repeatedly that it is the only recourse against fraudulent valuations and is absolutely necessary to break up the practice of manufacturers who ship their goods to themselves in this country. If a manufacturer invoices goods to himself he can value it at nearly any price that he may choose, it was declared.

Impossible to Get Foreign Values

One of those who spoke told how the Board of Appraisers at New York had sent a highly qualified agent to Germany in an effort to get the proper value of the German product. He went to the manufacturing town and endeavored to get the value. His presence was discovered and both the mayor and the chief of police advised him to leave the town as soon as possible. In fact he was followed through the streets and was branded as an American spy. He was denied all information. This was cited as characteristic of the difficulty in establishing values in a foreign country.

Herbert J. Wynne, of Rochester, N. Y., told of a trip he made to Germany last October. Out of 400 first-class passengers, 300 were men headed for Germany to buy anything they could buy. One of the passengers confided to Mr. Wynne that he had a letter of credit in his pocket for $250,000 and he expressed the hope that he would be able to spend every cent of it in Germany. "You know you get very intimate on shipboard," said Mr. Wynne, "and I was told more tricks than I ever believed existed. I was told how to cheat the United States Government and particularly how I could cheat the German Government."

Mr. Miles, who appeared in opposition to American valuation, pointed out that it would take a duty of 500 per cent to protect some specialties, as, for example, the cutlery industry, and that it would be necessary to cut loose forever from England, our greatest buyer; from Canada, our second greatest buyer, and from all the peoples with whom we fought in the war. "Prices of 329 different articles retailed in stores increased 260 per cent from 1914 to 1919," Mr. Miles said. Under American valuation the tariff would go up 260 per cent. He urged that the tariff be handled so that the people will respect it and not turn on it and force it down to an unreasonable level.

Rochester Section, A.C.S., Hears Chemical History

"The Chemical Awakening of America" was the topic of an address delivered before the Rochester Section of the American Chemical Society, Jan. 23, by W. J. Hale, director of the research laboratory of the Dow Chemical Co. To show how America has reached her present place in the science Dr. Hale traced briefly the history of chemistry from the early Egyptian efforts through the successive eras to the present time. He pointed out that Germany awakened in 1875 to the need for quality production, but that it took the world war to arouse England and America to the importance of quality as well as quantity production, a fact which is responsible for the present keen competition from German goods.

Plea for Reduction of Freight Rates Advanced by Manufacturing Chemists' Association

The Manufacturing Chemists' Association has adopted resolutions calling for a percentage reduction in freight rates by the Interstate Commerce Commission.

In hearing fertilizer interests in its investigation of the rate situation, the Commission was requested by these interests to make a 25 per cent reduction in the rates on fertilizer materials and on the complete fertilizer. It was argued that fertilizer is a necessity in the agricultural industry and the lower freight rates would increase production and thereby reduce prices.

The Manufacturing Chemists' Association requested the Commission to make a horizontal reduction in the rates the same as they had been increased, applying to all classes and commodities. It was pointed out that in the last 5 years the freight rate increases applying to fertilizer and its materials when compounded represented an advance of more than 100 per cent over the rates prior to 1916.

Agricultural and Fertilizer Interests Record Opposing Views on Muscle Shoals

The sentiments of those favoring the acceptance of the Ford offer for the Muscle Shoals plant are epitomized in a resolution adopted by the National Agricultural Conference, the text of which follows:

> To accomplish results without any further delay whatsoever, we urge the Secretary of War to recommend and the Congress to accept Henry Ford's proposal to take over the hydro-electric power and air-nitrate plant at Muscle Shoals, under a guarantee to operate same for 100 years at its present capacity of approximately 100,000 tons of ammonium nitrate per annum, opening the Tennessee River to navigation, cheapening the production of fertilizer, metals and other commodities, and assuring the United States nitrogen independence in peace or war.

Charles H. MacDowell, president of the National Fertilizer Association, in opposing the resolution endeavored to make clear the basis of the opposition of the fertilizer industry. "Inasmuch as this resolution specifically refers to the fertilizer industry," he said, "and as the press has recently stated that the impression prevails in certain quarters that the fertilizer industry was maintaining a lobby to prevent development of the Muscle Shoals projects, it is only fair for me to state that the fertilizer industry is opposing some of the features connected with this matter, but that it is doing so openly over its own name in the publicity it has disseminated, and I also am now speaking openly that there may be no doubt that our opposition is above board and entirely proper.

Questions Soundness of Accepting Ford Proposal

"The fertilizer industry, as far as I know its position, is in favor of the development of navigation on the Tennessee River and the construction of a hydro-electrical plant, providing it is carried out along sound engineering and financial lines. It does, however, question the soundness of the suggestion that large sums of government money be utilized in developing a project to be leased at an unknown rate of return on the final cost, when the total capital expended is for the benefit of an individual over a period of 100 years or more, as against the 50-year limitation of the national water-power bill. It feels that it is not fair that an individual should be given a monopoly on the use and sale of this electric power over that period, permitting him to profit largely in the disposal of the power to farmers, to small town and city consumers and giving him a power production cost on his own industrial activities so low that he would be placed in position to compete unfairly in the markets of the country, not only on fertilizer, but on other basic productions, as against those industries operating on their own capital and at materially higher cost.

"There has been much talk about the production of this plant, and the word 'nitrates' is generally used. The farmer when thinking of nitrates has in mind 'nitrate of soda,'

a product which comes from Chile. This plant would not make nitrate of soda, nor would its operation do away with the necessity for nitrate of soda in agriculture and for other purposes, inasmuch as it has its own peculiar value. The credits derived by Chile from its sale are also their dollars to buy flour, meats, boots, shoes and the Yankee notions from the United States. The product which the plant was designed to make, and I am quite familiar with its development, was ammonium nitrate, a high explosive, very concentrated, absorbing moisture, difficult to handle, and not generally suited for fertilizer manufacture.

"While the capacity of the nitrate plant at Muscle Shoals is large, the 100,000 tons it is proposed to manufacture there would provide nitrogen in the grade of fertilizer best suited for cotton and general production for from three to four million acres of land. The territory adjacent to Muscle Shoals and which could be served from that point now has under the plow something like seventy-five million acres. It is evident that a wide distribution from that point could not be secured.

"The product which normally would be made at Muscle Shoals is sulphate of ammonia. During the war the United States Government financed the building of a number of byproduct coke plants, so that the ammonia production in this country increased from something like 250,000 tons to 550,000 equivalent. Only 135,000 tons of this was used by agriculture in 1920, and the manufacturers have been forced to find foreign markets in competition with the world for 130,000 tons in 1920, in which year they carried over 40,000 tons. It does not seem to the fertilizer industry that it is good economics to make a product at labor and material expenditure which is already largely overproduced.

"The fertilizer industry does not make sulphate of ammonia. It is a buyer of this product, so that this proposed production is not directly competitive with the fertilizer industry.

"The fertilizer industry feels that the operation of the nitrogen-fixation plant at a time when there is such a serious overproduction is not sound.

"This is the position of the fertilizer industry, openly announced."

Society Offers Practical Aid to Glass Research

For the purpose of encouraging research work on glass the research committee of the Glass Division of the American Ceramic Society has made arrangements for providing glass of desired composition and desired form for investigators in this field. The material will be supplied free of charge and no limitations as to the nature of the research will be imposed. The recipients of the material will be under no obligations except that of publication of the results of their investigations.

Persons who are interested are requested to address their inquiries to one of the following members of the committee on research: E. C. Sullivan, Corning Glass Works, Corning, N. Y.; E. W. Washburn, University of Illinois, Urbana, Ill.; R. B. Sosman, Geophysical Laboratory, Washington, D. C.

Metallurgy Course Organized by Steel Society

Under the auspices of the Detroit, Mich., Chapter of the American Society for Steel Treating, a class in elementary metallurgy has been started at the local Cass technical high school. The first session was held on Jan. 31, and the classes will meet hereafter every Tuesday evening until next June. The work will consist of special studies, recitations and lectures.

Society for Steel Treating Changes Meeting Plans

The American Society for Steel Treating has changed the plans for its sectional meeting in New York on March 3, which will be held in the Hotel McAlpin instead of at the Engineering Societies' Building as previously announced.

Chemical Laboratory for Brown University

Plans have been entirely completed and bids taken for the erection of a new chemical laboratory at Brown University, Providence, R. I. The building will be three-story and basement, brick and fireproof construction, 50 x 224 ft. It is expected to commence work at an early date. Day & Clauder, Philadelphia, Pa., are architects for the structure, and French & Hubbard, Boston, Mass., engineers.

Personal

F. C. Clark has resigned his position as manager of the industrial paper section of the American Writing Paper Co., Holyoke, Mass., to become manager of the Pejempscot Paper Co., at Brunswick, Me. Previous to his connection with the sales department, Mr. Clark was for 2 years head of the department of technical control of the American Writing Paper Co. In recognition of his services to the Connecticut Valley Section of the Technical Association of the Pulp and Paper Industry he was tendered a dinner and presented with a set of golf clubs by his fellow members.

Mortimer E. Cooley, dean of the University of Michigan, is about to embark on a tour of the country in the interest of fostering unity among engineers. Dean Cooley is president of the American Engineering Council of the Federated American Engineering Societies and is striving to bring the concerted efforts of American engineers to bear on the problems of elimination of waste in industry, the establishment of a national department of public works, Patent Office reform and superpower development.

Elwood Haynes, metallurgist and president of the Haynes Automobile Co., Kokomo, Ind., was elected to honorary membership at the recent convention of the American Society for Steel Treating, Indianapolis, Ind.

Chester H. Jones has resigned his position as Industrial Editor and has been appointed Western business representative in the Chicago territory for Chemical & Metallurgical Engineering. His headquarters will continue to be in the Old Colony Building, Chicago, Ill. This transfer is in line with the policy of Chemical & Metallurgical Engineering to improve its technical service to advertisers and readers alike.

Dexter S. Kimball, dean of Cornell University and president of the American Society of Mechanical Engineers, will visit the Pacific Coast in May to promote closer harmony between engineers of the East and West in the attainment of engineering ideals.

Charles H. Smith has resigned his position as chemical engineer with the Chemical Warfare Service at Edgewood Arsenal to accept a chemical engineering position in the development department of the Goodyear Tire & Rubber Co., Akron, Ohio.

Henry Traphagen, consulting metallurgist of the Toledo Steel Castings Co., Toledo, Ohio, gave an interesting address before the members of the Detroit (Mich.) chapter of the American Society for Steel Treating at its January meeting, on the subject of "Fatigue of Steel."

Ernest T. Trigg, Philadelphia, Pa., head of John Lucas & Co., paint manufacturers, and president of the National Paint, Oil and Varnish Association, was a guest of honor at a banquet given by the Pittsburgh (Pa.) Paint, Oil and Varnish Club, Jan. 20, at the local Chamber of Commerce Building. His address was on "A Great Industry Realizing Its Opportunity."

Alan G. Wikoff, Assistant Editor of Chemical & Metallurgical Engineering, has been transferred to the Chicago office as Industrial Editor, succeeding Chester H. Jones, who has been transferred to the business department.

E. D. Winkworth, president of the Semet-Solvay Co., has been elected president of the Solvay Process Co., succeeding E. L. Pierce, who resigned on Jan. 31. Mr. Pierce also resigned his place as one of the vice-presidents of the Allied Chemical Co.

Obituary

Twenty-nine years of fruitful professional life and with nearly as many more which he could easily have counted upon! And yet today we record the passing of CHARLES BASKERVILLE!

It is doubtful if many chemists have been more widely known. It has been the writer's experience never to have mentioned Dr. Baskerville's name to a fellow chemist at home or abroad and have it received as that of one unknown.

The audience of a chemist is large. He deals in matters so vital to the everyday person and in facts so stimulating to the imagination that whenever one of our profession wishes to speak he receives a respectful hearing. Dr. Baskerville often had a message, and he spoke it so well that it went far and reached many. In addition, who in our circle has had a kindlier personality or was more of a man among men? One of his greatest pleasures was making and holding friends. One of the college group who have been doing what they could to help during these last few days said to the family, "We are merely the visible ones who represent almost an army anxious to help." Surely, his friends are a host.

If we look over his field of work, we are impressed with his versatility; he has written, in all, 186 papers. His first appeared in 1893 in the *Journal of Analytical and Applied Chemistry* and was entitled "Rapid Methods for the Estimation of Phosphorus in Titaniferous Ores."

It was in no limited field that he worked. Some of us prefer atomic weights, others do marvels in delicate analysis, and a lesser number are more interested in refining oil or developing a new electric furnace compound. His taste, however, made him interested in all branches. In his earlier years we find him investigating analytical methods, but if a list of his papers be consulted, it will be seen that since then he has shown his interest in almost every branch of chemistry. The following fields received special attention: Vegetable and mineral oils and their refining; lead coating; atmospheric pollution; oil shales; paper manufacture and the recovery of paper stock; textile fibers; rare earths; radio-activity; anæsthetics; utilization of surplus munitions (war gases).

In addition to his many recorded papers, there is a package a foot high to which he used to casually refer as "unpublished research."

His books are:

"School Chemistry and Key," 1898, B. F. Johnson.

"Radium and Radio-Active Substances, Their Application Especially to Medicine," 1905, Williams, Brown & Earle.

"General Inorganic Chemistry," 1909, D. C. Heath.

"Laboratory Exercises to Be Used With General Inorganic Chemistry" (with R. W. Curtis), 1909, D. C. Heath.

"Municipal Chemistry" (Editor), 1911, McGraw-Hill Co.

"Course in Qualitative Chemical Analysis" (with L. J. Curtman), 1910, Macmillan.

"Progressive Problems in General Chemistry," 1910, D. C. Heath (with W. L. Estabrooke).

"Anæsthesia" (with J. T. Gwathmey), 1914, Appleton.

Charles Baskerville was born on June 18, 1870, at Deer Brook, Miss. His father was Charles Baskerville, his mother Augusta Louisa (Johnston). He studied at the University of Mississippi, 1886-87; University of Virginia, 1888-90; Vanderbilt University 1891; University of North Carolina, B. S., 1892, Ph.D., 1894; Berlin University, Ph.D., 1893. In 1895 he married Mary Boylan Snow. He was instructor 1891-94, assistant professor of chemistry, 1894-1900, professor of chemistry 1900-04 at the University of North Carolina. From 1904 to the time of his death on Jan. 28, 1922, he was professor of chemistry and director of the chemical laboratories, College of the City of New York.

His wife, his son, Charles, and his daughter, Elizabeth, survive him.

He was a member of the Chemists' Club, American Chemical Society, Society of Chemical Industry, Société de Chimie Industrielle (vice-president of New York Section), Century Club, Engineers' Club, American Institute of Chemical Engineers, American Association for the Advancement of Science, American Electrochemical Society (chairman, New York Section), Washington Academy of Sciences, N. C. Academy; New York Academy of Sciences and a Fellow, London Chemical Society. He was also chairman of the committee on occupational diseases in the chemical trades, A.C.S., and of the American Committee on the Ramsay Memorial Fund, and was a member of the committee on atmospheric pollution, American Institute of Chemical Engineers.

DR. CHARLES BASKERVILLE

The writer is very glad to have this opportunity to record what many others must have experienced for themselves. In 17 years of close professional association, I have been with one of the most loyal friends, one whose personality so pervaded every part of our department, that even his passing has not removed his spirit from among us.

H. R. MOODY.

GEORGE R. COMINGS, U. S. assayer at the United States Assay Office, New York City, died on Tuesday, Jan. 17, at his home, 51 Quincey St., Brooklyn, N. Y., after being in the government service 48 years. Funeral services were held on Thursday evening, Jan. 19, and burial the following morning in Greenwood Cemetery. He was born in Cos Cob, Conn., June 2, 1860, received his education in New York City schools and obtained degree in chemistry from Cooper Union. Mr. Comings entered the Assay Office at the age of thirteen and worked under Dr. Torrey, the first assayer in the history of the office and who was succeeded by his son, Herbert G. Torrey, Mr. Comings succeeding the latter on Nov. 1, 1910. He had been in poor health since an illness of 6 weeks last summer. On Jan. 2, at the Assay Office, he suffered an attack of heart trouble which confined him to his home until the time of his death. Besides his widow he leaves one daughter, two sisters and one brother.

GEORGE C. SYKES, secretary of the Lehigh Portland Cement Co., Allentown, Pa., died at his home in that city, Jan. 23, at the age of forty-nine years.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Our Foreign Trade in 1921

Official figures recently announced by the Department of Commerce confirm the prediction that our total foreign trade in 1921 would show a larger percentage reduction than in any single year in the history of the country. The combined imports and exports, which had reached the peak value of 13.5 billion dollars in 1920, fell to less than 7 billion during the past year. This represents a decline of 45 per cent in exports and 52 per cent in imports as compared with 1920.

The excess of our exports over imports in 1921 had an approximate value of $1,976,000,000. As will be noted from the figures in the accompanying table, our favorable trade balance has shrunk to less than one-half that of 1919. However, it is still considerably above the pre-war average. Furthermore, during 1921 we imported gold and silver in excess of our exports to the extent of more than $679,000,000. This further reduces our net balance of exports of merchandise, gold and silver to $1,297,000,000. In 1919 the corresponding figure was $4,457,000,000.

TABLE I—COMPARISON OF IMPORTS AND EXPORTS OF MERCHANDISE, 1913-1921

(Figures in millions of dollars)

	Exports	Imports	Excess Exports
1913	$2,484	$1,793	$691
1914	2,114	1,789	325
1915	3,555	1,779	1,776
1916	5,483	2,392	3,091
1917	6,231	2,952	3,279
1918	6,149	3,031	3,118
1919	7,920	3,904	4,016
1920	8,228	5,278	2,950
1921	4,485	2,509	1,976

The contraction in the value of both imports and exports appears to have extended to practically every great group of commodities. The National City Bank has pointed out that the imports of raw materials show a decline of 53 per cent in total value, foodstuffs 63 per cent and manufactures 43 per cent. The relatively smaller decrease in manufactures is probably to be explained by the activity of importers bringing in manufactured goods in anticipation of the enactment of a higher tariff. On the export side, raw materials fell off 48 per cent, foodstuffs 33 per cent and manufactures 51 per cent.

The primary cause of this tremendous reduction is probably the word-wide fall of prices. The import value per unit of quantity is in many cases only about half the corresponding figure for the preceding year. Crude rubber, for instance, averaged 34c. per lb. over 1920 and only 14.3c. during the past year. Cattle hides entered at 19.3c. in 1920 and 11.9c. in 1921. In the chemical schedule equally striking examples may be noted. The import value of oxalic acid, the first on the list, fell from 34c. to 14.5c. per lb., fusel oil from 22.6c. to 18.6c., crude potassium chloride from $105 to $66.50 per ton, and the crude sulphate from $154 to $65.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	147.33
Last week	144.60
February, 1921	166
February, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The continued rise in the price of linseed and cottonseed oils caused the rather unusual increase in this week's index number. Slightly lower prices for sulphuric, hydrochloric and citric acids, caustic soda, caustic potash and soda ash were not of sufficient weight to counterbalance the upward trend of the index number.

CHEMICAL IMPORTS AND EXPORTS

Our "chemical trade balance," however, has shown a slight improvement in 1921 as compared with 1920. In both years, however, the balances were "unfavorable"—that is, our imports of chemical products were in excess of our exports. This of course was the condition that existed prior to the war, but for the 4-year period 1916 to 1919 our export trade in chemicals quite materially exceeded our imports.

TABLE II—A COMPARISON OF IMPORTS AND EXPORTS OF CHEMICAL PRODUCTS

	Exports	Imports	Excess of Exports
1914	$27,079,092	$94,519,912	—67,440,920
1915	46,380,986	79,273,398	—32,892,412
1916	124,478,474	109,155,705	15,322,769
1917	187,890,822	124,800,762	63,090,060
1918	180,318,954	151,832,065	28,486,889
1919	133,739,066	126,048,538	7,690,528
1920	168,999,706	211,528,099	—42,528,393
1921	61,111,293	95,603,912	—34,492,619

The detailed statistics for the principal chemical products, as given in Tables III and IV, show that in general the quantities decreased as well as the values. The imports of "chemicals, drugs, dyes and medicines" entering free of duty fell from $145,585,995 to $66,767,678. The dutiable

TABLE III—IMPORTS OF CHEMICAL AND RELATED PRODUCTS, BY PRINCIPAL COMMODITIES, 1920 AND 1921

	1920 Quantity	1920 Value	1921 Quantity	1921 Value
Chemicals, drugs, dyes and medicines:				
Acids (except coal-tar acids)—				
Oxalic....lb. dut	1,858,141	631,238	1,256,320	184,487
All other....lb. free	26,843,262	1,153,517	10,180,050	353,833
All other....lb. dut	4,450,093	2,901,359	4,974,390	1,126,631
Ammonia, muriate of, or sal ammoniac....lb..dut	6,755,171	708,204	4,618,275	271,398
Argols, or wine lees....lb..dut	35,577,388	4,464,998	16,087,934	1,176,546
Arsenic, and sulphide of, or orpiment....lb..free	8,160,089	684,016	6,686,570	531,322
Calcium, acetate of, chloride of crude, carbide and nitrate....lb..free	82,489,270	3,209,650	84,750,243	3,440,019
Coal-tar products—				
Group 1, crudes—				
Acid, carbolic....lb..free	192,692	19,848	214,185	22,849
Benzene....lb..free	486,619	10,868	1,722,085	42,370
Cresol....lb..free	10,318,070	901,381	3,353,882	253,886
Dead or creosote oil gal.free	18,427,152	3,796,399	33,239,432	4,756,618
Naphthalene....lb..free	15,012,171	530,221	4,495,796	135,941
Tar and pitch, coal..bbl.free	20,681	50,162	21,968	48,048
Toluene....free	.....	.....	.....	.....
All other....free	.....	204,381	.....	21,718
Group 2, intermediates....dut	.....	841,754	.....	356,865
Group 3, finished products—Alizarin and alizarin dyes....lb..dut	441,756	343,519	375,112	510,038
Colors or dyes....lb..dut	3,486,873	$5,258,802	3,106,355	$4,445,348
Imported from—				
Germany	1,155,501	1,565,300	1,050,028	1,718,776
Switzerland	1,372,490	2,693,653	1,504,970	2,005,265
United Kingdom	346,078	394,892	290,877	360,553
Other countries	612,804	604,957	260,480	360,754
Indigo—				
Natural....lb..dut	152,204	305,428	52,489	85,695
Synthetic....lb..dut	766,422	481,292	408,262	200,903
Total coal-tar products	.....	12,985,277	.....	11,225,688
Fusel oil, or amylic alcohol, and butyl alcohol....lb dut	3,887,403	879,206	1,046,434	195,511
Glycerine, crude....lb..dut	22,411,025	2,934,371	2,806,758	397,366

TABLE III (Continued)—IMPORTS OF CHEMICAL AND RELATED PRODUCTS, BY PRINCIPAL COMMODITIES, 1920 AND 1921

		1920		1921	
Chemicals, drugs, dyes and medicines:		Quantity	Value	Quantity	Value
Camphor—					
Crude, natural	lb. dut	3,833,252	5,207,196	1,078,784	636,884
Refined and synthetic	dut	1,143,801	2,246,033	480,044	373,405
Iodine, crude or resublimed	lb. free	293,941	593,672	646,211	1,430,664
Casein	lb. free	21,238,822	2,431,666	9,717,238	842,753
Lime, chloride of	lb. dut	2,474,617	86,873	12,438,484	229,113
Lime, citrate of	lb. dut	12,490,196	3,027,823	988,969	151,811
Magnesite, not purified	ton free	43,154	780,078	52,483	776,384
Potash (see also Fertilizers)—					
Carbonate of, including crude or black salts	lb. free	33,380,205	1,218,851	7,517,710	282,310
Cyanide of	lb. free	14,448,887	1,088,247	3,771,687	319,683
Hydrate of, containing not more than 15 per cent of caustic soda	lb. free	1,712,319	451,274	10,910,399	487,182
Nitrate of, or saltpeter, crude	lb. free	37,632,131	1,599,346	16,593,849	590,200
All other	lb. dut	4,172,799	582,976	8,127,521	486,851
Soda—					
Cyanide of	lb. free	7,590,495	1,091,443	8,707,537	913,091
Nitrate of	tons. free	1,321,892	63,131,035	369,173	17,982,977
All other salts of	free	.....	563,637	.....	312,287
	dut	.....	1,925,131	.....	945,771
Sulphur or brimstone	tons free	44	1,722	4	226
Sumac	lb. free	12,996,611	428,522	9,856,491	215,817
Vanilla beans	lb. dut	1,230,711	2,406,335	984,374	1,379,922
All other chemicals, drugs, dyes, etc.	free	.....	13,527,002	.....	7,592,821
	dut	.....	8,673,268	.....	3,794,447
Total chemicals, drugs, dyes, and medicines	free	.....	145,585,995	.....	66,767,678
	dut	.....	65,942,104	.....	28,836,234
Fertilizers—					
Ammonia, sulphate of	tons. free	1,994	247,495	4,677	260,390
Calcium cyanamid or lime nitrogen	tons. free	71,305	4,541,870	16,589	970,719
Guano	tons. free	53,790	4,583,313	1,751	89,527
Kainite	tons. free	374,732	8,268,031	69,076	1,453,854
Manure salts	tons. free	317,911	10,730,274	38,648	792,601
Potash—					
Muriate of	tons. free	121,602	12,703,858	71,109	4,777,726
Sulphate of	tons. free	15,184	2,343,431	11,124	719,183
Total fertilizers	tons	1,116,505	51,153,989	310,009	12,450,361

TABLE IV—EXPORTS OF CHEMICAL PRODUCTS, BY PRINCIPAL COMMODITIES, 1920 AND 1921

		1920		1921	
Chemicals, drugs, dyes, and medicines:		Quantity	Value	Quantity	Value
Acids—					
Carbolic	lb	2,151,475	$388,047	249,658	$35,994
Nitric	lb	716,914	96,109	177,80	26,176
Picric	lb	9,480	4,022	1,742	927
Sulphu ic	lb	28,987,342	738,188	12,814,344	317,720
All other		.....	5,521,818	.....	1,171,992
Total acids		.....	6,748,184	.....	1,552,809
Alcohol, wood	gal	703,064	1,244,197	412,110	454,584
Calcium carbide	lb	23,369,534	1,111,587	11,808,252	606,999
Coal-tar dis illates, n.e.s.—					
Benzene	lb	13,174,268	927,940	71,850,400	3,007,086
All other		.....	6,952,249	.....	509,508
Copper, sulphate of	lb	3,783,409	306,899	3,582,933	217,491
Dyes and dyestuffs—					
Aniline dyes		.....	22,450,480	.....	5,067,000
Logwood extract		.....	2,605,060	.....	589,756
All other		.....	7,373,111	.....	1,203,139
Total dyes and dyestuffs		.....	32,428,651	.....	6,859,895
Formaldehyde		.....	2,640,225	.....	349,087
Glycerin		1,742,708	429,116	2,394,714	361,509
Lime—					
Acetate of	lb	23,309,469	647,284	18,239,740	404,538
Chloride of, or bleaching powder	lb	48,826,348	1,480,142	18,447,579	483,752
Potash—					
Chlorate	lb	2,819,459	445,243	375,401	49,709
All other	lb	2,819,459	445,243	375,401	49,709
All other		.....	3,116,772	.....	286,284
Soda—					
Bicarbonate of	lb	20,642,201	616,261	11,703,183	307,138
Borax	lb	14,325,037	1,206,936	4,063,683	270,127
Caustic	lb	224,137,406	10,944,017	49,865,219	2,041,236
Sal soda	lb	12,030,193	220,487	10,354,513	204,616
Silicate of	lb	34,095,542	450,770	20,789,095	247,761
Soda ash	lb	166,761,603	4,689,591	35,042,691	850,369
All other salts		.....	7,161,784	.....	3,584,953
Total soda		.....	25,289,846	.....	6,506,200
Sulphur or brimstone	tons	447,450	8,994,350	285,762	4,524,78
Total chemicals, etc		.....	168,999,706	.....	61,111,293
Fertilizers—					
Phosphate rock, ground or unground—					
High-grade hard rock	tons	344,896	4,496,457	182,594	2,637,541
Land pebble	tons	693,355	5,593,814	544,425	4,627,875
All other	tons	31,461	479,904	6,714	117,989
Superphosphates	tons	80,993	2,949,629	4,296	98,343
Ammonia, sulphate of	tons	59,566	7,433,350	102,614	6,098,406
All other fertilizers	tons	205,666	15,602,658	54,800	2,581,969
Total fertilizers	tons	1,415,937	36,555,812	895,443	16,162,123

decreased in about the same proportion. The total exports of chemicals were valued at approximately $169,000,000 in 1920 and at $61,000,000 in 1921.

Perhaps the most significant feature of the incoming trade was the continued importation of large quantities of coal-tar products. Although of slightly smaller volume than in 1920, there were many noticeable increases. Phenol, benzene, creosote oil and coal-tar pitch were received in larger amounts than in the preceding year. Colors and dyes fell off only about 10 per cent in quantity. A rather unusual circumstance was that potassium-cyanide imports fell from 14,450,000 lb. to 3,775,000 lb., while sodium cyanide increased from 7,590,000 lb. to 8,707,000 lb.

The total exports of chemicals were valued at only about one-third those of the preceding year, and with the exception of two products, every article in Table IV showed a decrease. The two exceptions are in the case of benzene and ammonium sulphate. The former increased from 13,000,000 lb. to 71,850,000 lb.

A Record Production of Petroleum

The petroleum output of the United States in 1921 was the largest ever recorded and exceeds that of 1920 by over 26,000,000 bbl. of 42 gal. each. The U.S. Geological Survey announced that the total production was 469,639,000 bbl., which is more than double the amount produced in 1912.

It is estimated that the world's production will probably be in the neighborhood of 750,000,000 bbl., as compared with 695,000,000 bbl. produced in 1920.

The estimated consumption—i.e., deliveries to consumers—of domestic and imported crude oil during 1921 amounted to 525,407,000 bbl., as contrasted with 530,474,000 bbl. in 1920. Consumption for the year just ended, therefore, amounted to 55,768,000 bbl. more than the country produced.

Estimates of Daily Production

The American Petroleum Institute estimates that the daily average gross crude oil production in the United States for the week ended Jan. 28 was 1,415,950 bbl., as compared with 1,418,200 bbl. for the preceding week, a decrease of 2,250 bbl.

The following are estimates of daily average gross production for the weeks ended Jan. 28, Jan. 21, 1922, and Jan. 29, 1921:

DAILY AVERAGE PRODUCTION

(Figures in Barrels)

	1922		1921
	Jan. 28	Jan. 21	Jan. 29
Oklahoma	325,350	325,900	273,370
Kansas	83,100	83,350	85,075
North Texas	60,350	60,900	74,020
Central Texas	216,350	214,250	137,160
North Louisiana and Arkansas	129,150	131,400	82,225
Gulf Coast	107,450	107,400	116,920
Eastern	115,800	115,500	121,000
Wyoming and Montana	53,400	54,500	52,646
California	325,000	325,000	325,000
*Total	1,415,950	1,418,200	1,267,415

*Daily average gross production.

American Potash in 1921

The U. S. Potash Producers' Association, on the basis of statistics submitted by members of the association, has estimated that the total production of potash in the United States during 1921 was less than 25,000 tons of crude salts containing less than 9,000 tons of K_2O. This production is the lowest for any year since 1916.

The association points out that this was due to the almost complete failure of the market. Most of the Nebraska plants were closed down in January, 1921. One or two continued producing a small amount through the spring months, but in April the last of them quit and no potash has been produced in the Nebraska field since that date. In Utah the last production came in February, while the last primary producer in California closed its plant in June.

During the last 6 months of the year the only plants still operating, so far as known, were two or three of the cement mills and two alcohol distilleries. These turned out a relatively small tonnage, and in default of a market made no effort to produce to capacity.

January Business Failures Set New High Record

The total number of business failures reported to Bradstreet's for the month of January was 2,705, or approximately 11.5 per cent above the former record total reported in December, 1921.

The liabilities for January were $115,301,371, an increase of 42 per cent over those for December and 76 per cent more than for January a year ago. This is the largest total of liabilities ever recorded in January and second only to the monthly total of $172,675,890 reported in October, 1908.

The Rise in Foreign Exchange

Conditions in Europe have improved materially if we are willing to accept foreign exchange as an index. Since the review published in our issue of Jan. 25, the British pound has reached $4.33, which is higher than at any time during the past year. French francs at 8.39 cents as compared with 8.15 on Jan. 18 is also a marked gain. During the same period the Italian lire increased in value from 4.35 to 4.69 cents.

The underlying factors which are thought to be responsible for the stronger exchanges are the successful conclusion of the Arms Conference, the passage of the foreign debt and refunding bill, and the promising possibilities of the coming economic conference at Genoa.

Soap Makers Cited by Trade Commission

Two Chicago soap manufacturers have been cited by the Federal Trade Commission in complaints of unfair competition. These charges are based on preliminary investigations of the Commission and, as is usual in such cases, 30 days is allowed for the companies to file their answers. Thereafter the cases are set down for trial.

The complaints charge that the Crofts & Reed Co. and the Polonia Soap Co. used false brands on certain of their soaps. Thus, it is charged that "Olive Bouquet" and "Olive Castille" were used on soaps containing no olive oil, and "Medicinal Toilet Soaps" applied to soaps said to contain no medicine or drug.

The Break in the Crude Rubber Market

One of the outstanding developments of the last 2 weeks has been the phenomenal break in the crude rubber market. The price of spot smoked sheets dropped from 21c. a lb. to less than 16c. This is only 6c. above the record low price of 1920 and is the lowest price quoted since last summer. Those familiar with the trade attribute the break to the forced selling by the large London interests. Furthermore the imports increased considerably toward the end of the year.

On Feb. 2 plantation first latex crêpe was quoted at 15½c. and smoked rib sheets at 15¾c.

New York Market

NEW YORK, Feb. 6, 1922.

The market for general chemicals during the week was somewhat irregular, with a tendency to limit puchases to immediate necessities. Large consumers are practically the only buyers interested in round-lot quantities, but the producers are getting most of this business. Factors in chemical circles were elated over the report that one of the largest textile concerns contracted for 1,000,000 lb. of bichromate of soda for delivery this year. This is the largest domestic order recorded for this item in the past 12 months. The price said to be paid for the quantity was in the neighborhood of 7c. per lb. Resale bichromate was generally quoted at 7¼c. per lb. with reports current that odd lots could be purchased down to 7½c. Actual spot offerings are not very liberal and the general tone of the market is quite steady.

The outstanding feature of the week's activities was the remarkable rise in red prussiate of potash. There seems to be no relief from the acute shortage and it is doubtful if any stocks can be purchased in any direction. In one quarter it was announced that a bid of 55c. per lb. for a small quantity was turned down. The shortage is apparently as pronounced in the foreign markets as in local quarters. Sales of yellow prussiate of potash were reported at 25c. per lb. The demand has continued quite active for small lots from the consuming trades. Business in caustic potash, 88-92 per cent, was very quiet, with imported prices ranging from $5.80@$6 per 100 lb. There were occasional odd-lot sales recorded at a fraction below quoted prices. Shipment figures range from $5.70@$5.75 per 100 lb. Leading importers of carbonate of potash, 80-85 per cent, report sales at 4½c. per lb. It is possible that round-lot orders would bring about some price concessions. Material for shipment was offered at 4¼c. per lb. c.i.f. New York. Although transactions have been mostly for small quantities, a good consuming demand has been noted in this item during the past week. Sales of solid caustic soda were reported by leading makers at $3.50 per 100 lb. f.a.s. Some are inclined to believe that large quantity orders could be purchased at $3.45. Producers are quoting contracts at $2.45 per 100 lb., basis 60 per cent, for carload lots, f.o.b. works. Domestic producers of cyanide of soda are finding a steady market at the revised prices of 26@28c. per lb. for the 96-98 per cent grade. Imported material is offered at prices ranging from 22½@26c. per lb. depending upon the test. The American producers have recently filed a brief with the Senate Finance Committee asking for a 33⅓ per cent ad valorem duty on cyanides, but it is doubtful whether any such rate will be agreed upon by the committee.

Spot soda ash has continued to be quiet, and the market has not shown any appreciable change. Carload quantities have gone through as low as $1.70 per 100 lb., while smaller lots commanded as high as $2. Spot quotations on barium chloride have advanced sharply during the week and sales have been reported at $54 per ton for fair-sized orders. Domestic producers quote contracts at $52 per ton, while imported material is held at $54@$58 per ton on spot, depending upon the quantity. First-hand sales of bleaching powder at the works were reported at 2c. per lb., but it is intimated that a firm offer for a large-quantity shipment might bring shading. The consuming inquiry for additional lots is not as active as at the beginning of the year. The decrease in price and demand is probably due to the fact that paper mills contracted heavily for shipment prior to the close of last year. Producers of fluoride of soda have reduced prices to a level competing with foreign sellers. Material can now be obtained from domestic sources at prices ranging from 8@9c. per lb., depending upon the quantity. Citric acid was reduced 2c. per lb. by leading manufacturers. This is the first price cut recorded in about 9 months. First-hand quotations ranged from 45@46c. per lb., with resale material held around 42½@43c. per lb. The demand was moderate.

COAL-TAR PRODUCTS

The coal-tar products market during the past week remained inactive. Producers in many instances were revising prices to attract what little business might be obtained. The call for phenol has remained quite active both for domestic and foreign consumption and the market showed a steadier tone. The recent reductions in cresylic acid and other tar acids have brought out an improved inquiry from the consuming industries and indications in this direction are more encouraging. Benzene is still in limited supply on spot and makers are booking a good volume of business for shipment. Large producers offer cresylic acid, 95 per cent, dark, at 45@47c. per gal. and the 97-99 per cent, straw color, at 50@52c. per gal. First-hand sales of dip oil, 25 per cent, are going through at 26c. per gal. Smaller quantities command a slight advance. A moderate inquiry is reported. The benzaldehyde market appears quite steady with consumers calling for contract deliveries. First hands quote the U.S.P. at $1.30@$1.35 per lb. and state that the technical is moving on the basis of 45@50c. per lb. There has been no added interest in the market on beta naphthol and prices have been weaker in some directions at 29c. per lb. The general range is from 29@32c. per lb. Prices on dimethylaniline in the resale market have been as low as 38c. per lb. Makers are quoting 40c. but the keen competition for passing business has caused price concessions.

The Iron and Steel Market

PITTSBURGH, Feb. 3, 1922.

Taking the steel market as a whole there has probably been a slight increase in demand on the mills in the past week, but the condition remains disappointing from the viewpoint of late December. Then it was expected that there would be a quick revival after Jan. 1 to the stage of activity witnessed in October and November. The demand is not yet up to the level of that period.

Probabilities now are that it will require the approach of spring to bring the steel market up, in point of tonnage, to the stage of activity previously witnessed. In other words, the lull of December was not a pre-inventory lull but a winter lull. This is the natural explanation of what is observed. There is no reason for assuming that the fundamental conditions that make for steel demand have changed for the worse, for rather the basis for activity is more substantial. Nor can the buyers' attitude toward prices be used as an explanation for light demand. Buyers have been holding off for many months from making purchases that could be postponed and at no time have done more than buy to meet pressing requirements. They cannot become more conservative than they have been.

Operations at individual plants change so much, almost from day to day, that a close estimate of the average rate of operation of the industry is impossible, and even an approximation is not easy. In general it may be said that while the production of steel ingots was at a rate of 23,000,000 tons a year in October and November and at 20,000,000 tons in December, the production of January may not have been as heavy as that of December, while it is somewhat doubtful whether even February will show a return to the October-November rate.

Price Competition Strenuous

The much more strenuous competition that appeared early in January shows no abatement. It is not so much that new low prices are being made on large orders as that relatively small orders are being taken at prices that formerly ruled only on large lots. The mills are making concessions from the regular or open prices for smaller and smaller orders, until in some commodities the regular prices rule only on carloads, and in some cases less than carload lots go at the regular prices.

The regular or open prices for the principal steel mill products have not changed in the past 6 weeks, or since the formal reduction in wire products made by the leading interest, Dec. 21, but on account of concessions having extended to smaller orders the average price of the entire tonnage sold has been steadily declining.

Shading is of course not equal for the different products. Sheets are held quite steadily. Until a week or two ago they were held very rigidly, but now it appears there are occasional instances of small concessions being given, particularly on galvanized sheets. In wire products the regular prices are held on ordinary orders, while to large jobbers, in nails at least, a concession of 10 cents a keg from the $2.50 price is given. In bars, shapes and plates concessions are quite common on lots of over 100 tons, the regular price for all three commodities being 1.5c.

Demand for fabricated steel, while far from large, is perhaps above the expectations recently entertained. Demand for tin plate is quite good and a heavy tonnage year is assured. Standard steel pipe is doing fairly well. Oil country goods are out of season and whether demand will return in the spring to the 1921 rate depends largely on prices bid for oil by the refiners.

Pig Iron and Coke

The pig iron markets continue quiet and prices are not overly firm. Prices in the valley market are unchanged since the declines reported a week ago, standing at $19.50 for bessemer, $18 for basic and $19 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

Connellsville coke continues in poor demand, with prices decidedly weak. One large operator has allowed two monthly adjustment contracts for furnace coke to lapse, being unwilling to meet prices (said to be below $3) quoted by others on February delivery. Foundry coke is doing about as well as formerly. The spot market remains quotable at $2.75@$2.90 for furnace and $3.75@$4.25 for foundry, according to brand.

The St. Louis Market

ST. LOUIS, Feb. 2, 1922.

The actual volume of business transacted during January of this year in the St. Louis district was far better than for the corresponding month of last year, and it is hoped that this increase will continue. Reports from some quarters are not so favorable. There have been very few price changes during the last period, which is due to the healthier condition of the market; furthermore, this condition indicates that there is more confidence.

Alkalis

The market on caustic soda has eased up somewhat, showing a decrease in price of from 40c. to 60c. per 100 lb. The 76 per cent solid in carlots can be had as low as $3.40 per 100 lb., f.o.b. point of production. Spot goods in less than carlot quantities are $4.25 per 100 lb., in 1- to 10-drum lots. Carload price of the 76 per cent flake caustic is $3.75 f.o.b. point of production. Drum lot prices range from $4.40 to $4.85, and in one or two instances the price quoted is $5. Spot goods are in fair demand, but little is being done in the way of purchases for future delivery. Along with caustic soda, soda ash has declined quite appreciably, with the 58 per cent now selling in spot market for $2.40@$2.75 in 1- to 10-bbl. lots. Carlots can be purchased for about $1.85 in bags f.o.b. point of production. Bicarbonate of soda continues stable at around $2.75 in 5-bbl. lots, delivered to buyers' order. Salsoda in single barrels stands at $2.15 per 100 lb.

General and Special Chemicals

Manufacturers of heavy commercial mineral acids report good business. Acid citric is still on the inactive list, with further reduction in price taking place yesterday. The demand for gallic acid and pyrogallic acid has been much better for the last few weeks than for some time past. Phosphoric acid continues to move in a lively way. Ammonia water, 26 deg., U.S.P., is in fair demand. Inquiries for ammonium sulphate are more numerous. Carbon bisulphide is very firm with a normal demand. Producers of sugar copperas report that the demand is far greater than the production, with the price ranging from $18 to $20 per ton, f.o.b. works. Cream of tartar continues to move through regular channels, while tartaric acid has shown an appreciable increase. Glycerine is holding firm at 16½c. in drums, with a steady demand. Further advances on this item would not be surprising. Hydrogen peroxide is moving in a routine way. A further reduction in the prices of strychnine alkaloid and sulphate took place last week. The demand is light. Sulphur commercial is moving slowly. Louisiana producers quote $15 per ton for crude sulphur, f.o.b. works; freight rate to the St. Louis market is $9.60. There has been no change in the zinc sulphate market, and a fair amount of business is being transacted, the price ranging from 3c. to 3½c. per lb., f.o.b. point of production.

Vegetable Oils and Naval Stores

The linseed oil market is completely in producers' hands. Contracts for future delivery are being ignored today, and spot goods are being held at 82c. basis raw oil. Turpentine continues firm, fluctuating from 93c. to 98c. for pure gum spirits. Some material has been sold on the market for the pure gum spirits at a figure within 1c. of Savannah market price. Castor oil is in good demand and the price is firm at 13c. in drums, 14½c. in cans and 12c. in quantities of 200 gal. or over.

Paint Material

The St. Louis lithopone market continues in a slump. With three lithopone manufacturing plants in this district, imported goods fill most of the orders. Barytes are moving fairly well at $23.50 per ton. Whiting, all grades at all prices, is being offered here, prices varying from $12 to $18 per ton in carlots.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.42
Acetone	lb.	$0.12½ – $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.60	2.65 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9.50	9.75 – 10.00
Boric, crystals	lb.	.12¼ – .12¾	.13 – .13½
Boric, powder	lb.	.12¼ – .13	.13½ – .14
Citric	lb.	..... –	.42½ – .43
Hydrochloric	100 lb.	1.25 – 1.30	1.35 – 1.85
Hydrofluoric, 52 per cent	lb.	.11½ – .12	.12½ – 13
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06¼ – .06½	.06½ – 07
Nitric, 42 deg.	lb.	.06½ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.14 – .14½	.14½ – .15½
Phosphoric, 50 per cent solution	lb.	.09 – .09½	.09½ – .11
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 – 11.00	..... – .....
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16.00 – 16.50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.65 – .75
Tannic (tech.)	lb.	.45 – .50	51 – .55
Tartaric, imported crystals	lb.	..... –	25 – .25½
Tartaric acid, imported, powdered	lb.	..... –	.25½ – .26
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof	gal.	..... –	.41 – .42
Alcohol, denatured, 190 proof	gal.	..... –	.43 – .44
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¾ – .04	.04¼ – .04½
Alum, chrome lump	lb.	.07½ – .08	.08¼ – .08½
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02¼ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07¼ – .07½
Amylacetate tech	gal.	..... –	2.00 – 2.40
Arsenic, white, powdered	lb.	.07½ – 07¾	.07⅞ – .08½
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – .13
Barium chloride	ton	54.00 – 55.00	55.50 – 70.00
Barium dioxide (peroxide)	lb.	.21 – .21½	.22 – .23
Barium nitrate	lb.	.06½ – .07	.07½ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	2.25 – 2.35	2.40 – 3.25
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .06	.06¼ – .07
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.20 – .21	.21½ – .26
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	23.00 – 24.00	24.50 – 28.00
Calcium chloride, granulated	lb.	.01¾ – .02	.02¼ – .02½
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.92 – .95
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10¾	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04¼ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.37 – .40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 20.00
Copper carbonate, green precipitate	lb.	.20 – .20½	.21 – .21½
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.60 – 5.65	5.70 – 6.25
Cream of tartar	lb.	..... –	.24 – .25½
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.58 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – .....
Formaldehyde, 40 per cent	lb.	.10 – .10½	.10¾ – .11¼
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth–imported powdered–net ton		30.00 – 32.00	..... – .....
Fusel oil, ref	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.40 – 1.75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16½ – .17
Iodine, resublimed	lb.	..... –	3.80 – 3.90
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.10⅝ – .12½
Lead arsenate, powd	lb.	.15 – .15½	.15¾ – .16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2.75 – 3.00
Magnesium sulphate, technical	100 lb.	..... –	1.05 – 1.80
Methanol, 95%	gal.	..... –	.60 – .62
Methanol, 97%	gal.	..... –	.63 – .64
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	10 – 10½	.10½ – 11
Potassium bromide, granular	lb.	..... –	.13 – .17
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.05½ – .05¾	.06 – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	lb.	.05¾ – .06	.06½ – .06½
Potassium iodide	lb.	..... –	2.90 – 3.00
Potassium nitrate	lb.	.07⅜ – .07½	.08 – .09
Potassium permanganate	lb.	.14 – .15	.16 – .22
Potassium prussiate, red	lb.	.38 – .39	.40 – .50
Potassium prussiate, yellow	lb.	.25 – .25½	.25¾ – .26½
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.06½ – .07	.07¼ – .07¾
Salammoniac, gray, granular	lb.	.06½ – .06¾	.07 – .07½
Salsoda	100 lb.	1.60 – 1.70	1.75 – 2.00
Salt cake (bulk)	ton	17.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.70 – 1.95	2.00 – 2.40
Soda ash, dense	100 lb.	1.85 – 1.90	1.95 – 2.40
Sodium acetate	lb.	.04 – .04¼	.04½ – .05
Sodium bicarbonate	100 lb.	2.20 – 2.25	2.30 – 2.75
Sodium bichromate	lb.	.07½ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04¾	.05 – .05½
Sodium chlorate	lb.	.06¼ – .06¾	.07 – .07½
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.26 – .26½	.26¾ – .27
Sodium fluoride	lb.	.08 – .08½	.08¾ – .09½
Sodium hydroxide (caustic soda)	100 lb.	3.50 – 3.60	3.65 – 4.20
Sodium hyposulphite	lb.	.03½ – .03½	.03¾ – .04
Sodium nitrite	lb.	.06½ – .06¾	.07 – .07½
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04 – .04¼	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.17 – .17½	.17½ – .17½
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.25 – 1.30	1.35 – 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04½ – .04⅞	.04¾ – .05
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, red	lb.	.05 – .05½	.05¾ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.15 – .15¼	.15½ – .16
Zinc chloride, gran	lb.	.08 – .08½	.08¾ – .09
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.08 – .08¼	.08½ – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.15 — 1.20
Alpha-naphthylamine	lb.	.27 — .30
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.30 — 1.35
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.65 — .67
Beta-naphthol, tech	lb.	.29 — .32
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.20 — .22
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.95 — 1.05
Dimethylaniline	lb.	.40 — .45
Dinitrobenzene	lb.	.21 — .25
Dinitroclorbenzene	lb.	.25 — .27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, car lots, in drums	gal.	.28 — 30
Diphenylamine	lb.	.60 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	1.00 — 1.05
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.15 — 1.20
Naphthalene crushed, in bbls.	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — .08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.30 — 1.35
Para-amidophenol, HCl	lb.	1.40 — 1.50
Para-dichlorbenzene	lb.	.17 — 18
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.60 — 1.65
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.37 — .40
Phenol, U. S. P., drums	lb.	.12 — .16

Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.85 —	2.00
Salicylic acid, tech., in bbls.	lb.	.20 —	.21
Salicylic acid, U. S. P.	lb.	.23 —	.24
Salol	lb.	.75 —	.77
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.26 —	.28
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices remain quotably unchanged.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.45 —	5.50
Rosin E-I	280 lb.	5.55 —	5.60
Rosin K-N	280 lb.	6.20 —	6.95
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.93 —	....
Wood turpentine, steam dist.	gal.	.91 —	....
Wood turpentine, dest. dist.	gal.	.90 —	....
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	$2.50 —	2.60
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.37 —	2.40
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	37.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0.20¾ —	.20¾
Upriver coarse	lb.	.13 —	.13½
Upriver caucho ball	lb.	.12 —	.12½
Plantation—First latex crepe	lb.	.17 —	.17¼
Ribbed smoked sheets	lb.	.17 —	.17¼
Brown crepe, thin, clean	lb.	.14 —	....
Amber crepe No. 1	lb.	.16 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13⅛ —	.13⅜
Coconut oil, Ceylon grade, in bbls.	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls.	lb.	.09¾ —	.10
Corn oil, crude, in bbls.	lb.	.08½ —	.08¾
Cottonseed oil, crude (f. o. b. mill)	lb.	.08 —	.08¼
Cottonseed oil, summer yellow	lb.	.09⅝ —	.09¾
Cottonseed oil, winter yellow	lb.	.10¼ —	.10½
Linseed oil, raw, car lots (domestic)	gal.	.76 —	.76½
Linseed oil, raw, tank cars (domestic)	gal.	.71 —	.72
Linseed oil, in 5-bbl lots (domestic)	gal.	.79 —	.80
Olive oil, denatured	gal.	$1.12 —	$1.15
Palm, Lagos	lb.	.07¾ —	.08
Palm, Niger	lb.	.06⅛ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08 —	.08¼
Peanut oil, refined, in bbls.	lb.	.10¾ —	.11
Rapeseed oil, refined in bbls.	gal.	.84 —	.85
Rapeseed oil, blown, in bbls.	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 —	....

FISH

Light pressed menhaden	gal.	$0.45 —	....
Yellow bleached menhaden	gal.	.48 —	....
White bleached menhaden	gal.	.47 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$1,000 00	$1,200.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	80 00 —	125 00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	12 50 —	17 50
Barytes, ground, white, f.o.b. mills	net ton	23 00 —	23.50
Barytes, ground, off color, f.o.b. mills	net ton	17 00 —	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24 00
Barytes, crude f.o.b. mines	net ton	6.00 —	7.00
Casein	lb.	.15 —	.16
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00 —	8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	14.00 —	20.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, No. 1 pottery grade	long ton	6.50 —	6.75
Feldspar, No. 2 pottery grade	long ton	5.75 —	5.90
Feldspar, No. 1 soap grade	long ton	7.25 —	7.50
Feldspar, No. 1 Canadian, for mill	long ton	22.00 —	22.50
Graphite, Ceylon lump, first quality	lb.	.04½ —	.06½
Graphite, Ceylon chip	b.	.03½ —	.05
Graphite, high grade amorphous crude	lb.	.00¾ —	.02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00 —	....
Kieselguhr, f.o.b. N. Y.	per ton	55.00 —	60.00
Magnesite, calcined (crude)	per ton	12.00 —	15.00
Pumice stone, imported	lb.	.03 —	.40
Pumice stone, domestic, lump	lb.	.05 —	.05½
Pumice stone, domestic, ground	lb.	.06 —	.07
Shellac, orange fine	lb.	.68 —	.70
Shellac, orange superfine	lb.	.71 —	.72
Shellac, A. C. garnet	lb.	.58 —	.60
Shellac, T. N.	lb.	.65 —	66
Silica, glass sand, f.o.b. Indiana	per ton	1.25 —	1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25 —	4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	14.00 —	14.50
Silica, building sand, f.o b. Pa.	per ton	2.25 —	3.00
Soapstone	ton	12.00 —	15.00
Talc, 200 mesh, .o.b. Vermont	ton	7.00 —	12.00
Talc, 200 mesh, f.o.b. Georgia	ton	8.25 —	13.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00 —	20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00	
Carborundum refractory brick, 9-in.	less than carlot	1,000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44	
Chrome cement, 40-50% Cr_2O_3	net ton	30–32	
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30	
Magnesite brick, 9-in. straight (f.o b. works)	net ton	53–55	
Magnesite brick, 9-in. arches, wedges and keys	net ton	70	
Magnesite brick, soaps and splits	net ton	90	
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37	
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30	

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.50
Aluminum, 98 to 99 per cent.	19.00
Antimony, wholesale lots, Chinese and Japanese	4.45
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	32.00
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375–4.40
Zinc, spot, New York	4.90–4.95
Zinc, spot, E. St. Louis	4.45–4.50

OTHER METALS

Silver (commercial)	oz.	$0.66⅝
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.90@2.00
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	100.00@105.00
Iridium	oz.	170.00@190.00
Palladium	oz.	60.00
Mercury	75 lb.	47.00–49.00

Ferro-Alloys

Ferro-manganese—78-82 per cent Mn—foreign—c.i.f. Atlantic seaport—gross ton—$57—58.35. All other prices remain the same as Feb. 1 report.

Ores and Semi-finished Products

Market remains unchanged.

Structural Material

Prices are the same as Feb. 1 report.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—The Arkansas Platinum Development Co., P. O. Box 815, C. C. Williams, secretary, has tentative plans under consideration for the erection of a new ore-reduction plant for platinum and gold production. The company has extensive mining properties in this section.

EL DORADO—Fire, Jan. 18, destroyed a portion of the oil refinery of the El Dorado Oil & Pipe Line Co., with loss estimated at about $32,000. It will be rebuilt.

Connecticut

STAMFORD—The Segal Metal Products Co., Springdale, near Stamford, has awarded a contract to Tucker & Lewis, 103 Park Ave., New York, N. Y., for the erection of a new 1-story foundry, 45 x 81 ft., to replace its plant building recently destroyed by fire. Lockwood, Greene & Co., 101 Park Ave., New York, are architects. R. H. Schoell is general manager.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. has filed plans for the erection of the first unit of its new plant in the South Wilmington section, consisting of a 5-story building, 125 x 150 ft., estimated to cost close to $750,000. Foundation work for this and other plant units is well under way, and plans for the other buildings will be filed early in the spring. W. J. Wayte, Inc., 125 East Forty-Sixth St., New York, N. Y., is engineer.

Florida

CLERMONT—The Board of Trade is considering the establishment of a local plant for the manufacture of glass bottles and kindred products. A company will be organized to operate the property.

Illinois

EAST ST. LOUIS—The Obear-Nestor Glass Co., 25 North Second St., St. Louis, Mo., has awarded a contract to the Fred Gauschmetz Co., 501 North 18th St., East St. Louis, for the erection of a 1-story addition to its East St. Louis plant at Broadway and Belt St., to be used for the manufacture of bottles, etc., estimated to cost about $75,000. Joseph Nestor is president.

Indiana

CARBON—The Carbon Firebrick & Coal Co., 345 Lemcke Annex Bldg., Indianapolis, Ind., is considering plans for the erection of a new plant in the vicinity of Carbon, for the manufacture of firebrick and other refractory products, estimated to cost about $150,000, including machinery. E. E. Dean is president.

MARION—The Mileage Oil Co., Kokomo, Ind., is negotiating for the purchase of the property and business of the Service Oil Co., Marion, and upon acquisition, plans for extensive operations. The Service company has been operating under a receivership; the receiver will dispose of the property.

BLOOMINGTON — The Bloomington Brick & Tile Co., A. W. Beecher, president, is considering the erection of a new plant, on site about 12 miles north of the city. The plant will consist of a number of one-story buildings, and is estimated to cost about $200,000, including equipment. Preliminary surveys for the buildings are under way.

Kansas

WICHITA—The Western Art Glass Co., 331 North Market St., is considering the construction of a new 3-story works building, 75 x 140 ft., estimated to cost about $60,000. It is planned to cemmence work early in March.

Kentucky

PAINTSVILLE—The Big Sandy Oil & Refining Co. is perfecting plans for the construction of a new oil-topping plant, with initial capacity of about 100 bbl. A number of tanks for storage service will also be constructed. Ralph Stafford heads the company; M. B. Westcott is engineer.

Maine

GREENVILLE — The Great Northern Paper Co. is completing the construction of a new mechanical building at its plant, 116 x 225 ft., estimated to cost about $230,000. A portion of the structure will be used as a machine and repair shop.

Maryland

BALTIMORE—The American Oil Co., American Bldg., is planning for the erection of a new plant to cost about $200,000. A large steel tankage department will be installed. Plans will be drawn at an early date. Louis Blaustein is manager.

BALTIMORE — The Virginia-Carolina Chemical Co., Richmond Va., will hold in temporary abeyance the erection of its proposed new plant at Baltimore to be occupied by its affiliated organization, the Rasin-Monument Co., National Marine Bank Bldg., Baltimore, for the manufacture of fertilizer products. The latter company now operates a plant in the Curtis Bay section of the city. The building contract for the new plant was awarded recently to Huggar Brothers, Montgomery, Ala.

BALTIMORE — The Atlas Chemical Laboratories, Inc., Mosher and Bruce Sts., is planning for enlargements in its plant. J. E. Auld, Jr., is president.

BALTIMORE—The Prudential Oil Co., Keyser Bldg., has completed plans for the construction of a new tankage plant at Third St. and Fourth Ave., consisting of a number of steel tanks, estimated to cost about $80,000.

BALTIMORE—The Maryland Steel Rolling Co., 1410 Fidelity Bldg., recently organized with a capital of $1,000,000, will soon commence the erection of its proposed new plant at Dundalk, consisting of a main works, 65 x 330 ft., with electrically driven mills and oil-fired heating furnaces. It is proposed to develop an annual production of about 30,000 tons of bar steel per annum. R. S. Baldwin is general manager.

Michigan

MANISTEE—The Filer Fibre Co., has tentative plans under consideration for the erection of a new local plant for the manufacture of fine paper, to utilize the output of the fiber mills. The plant will cost in excess of $250,000, and is expected to give employment to about 150 men. P. P. Schnorback, manager of the company is in charge.

GRAND RAPIDS—The Wolverine Soap Co., Portland, Mich., has acquired property at Grand Rapids for the erection of a new 2-story plant, 50 x 70 ft., to be ready for occupancy in June. The present works will be removed to the new location. A. A. Meeth heads the company.

Minnesota

MORRIS—The Board of City Trustees, Dr. George W. Ceenty, president, has rejected bids for the erection of a new filtration plant for the municipal waterworks, and will call for new bids at a later date. C. F. Tweed, 1353 University Ave., St. Paul, Minn., is engineer.

Missouri

WEBB CITY—The Rock Hill Paint & Cloth Co., Ray Porter, president, is planning for the erection of a new local plant for the manufacture of paints, oils, etc., estimated to cost about $50,000.

Montana

MILES CITY—The Glengarry Mining Co., has acquired property at Laurel, Mont., as a site for the erection of a new smelting plant for treating the ores from its properties near Cooke City. It is estimated to cost close to $500,000, including machinery.

New Jersey

PATERSON—Fire, Jan. 27, destroyed a large portion of the plant of the Colrin Chemical Co., River Rd., East Paterson, specializing in the production of nitrate of iron and kindred products, with loss estimated at close to $200,000. The main building, 100 x 100 ft., was entirely destroyed. Frederick Colrin is head.

New York

NEW YORK—The Fleischmann Co., 701 Washington St., manufacturer of yeast, has completed plans and will commence the immediate erection of a new 3-story laboratory building, 52 x 165 ft., on Mott Ave. near 157th St., estimated to cost $150,000. Arthur B. Heaton, 52 Vanderbilt Ave., is architect.

BUFFALO—Fire, Jan. 25, destroyed a portion of the plant of the F. F. Dalley Co., 271-81 Military Rd., manufacturer of polishes, with loss estimated at about $75,000.

NIAGARA FALLS—The chemical laboratory in the local high school was destroyed by fire, Jan. 25, with entire loss of building and other departments estimated at over $250,000. The Board of Education plans to rebuild the structure.

North Carolina

CHARLOTTE—A complete chemical and biological laboratory will be installed in the new high school to be erected by the local Board of Education at Cecil St. and Elizabeth Ave., estimated to cost in excess of $300,000. H. P. Harding is secretary.

Oregon

PORTLAND—The Colby Compression Tube Co. has acquired property at East Third and Burnside Sts., for the erection of a new plant for the manufacture of rubber tubes and other rubber products.

Pennsylvania

PHILADELPHIA — The Pennsylvania Sugar Co., 1037 North Delaware Ave., has construction under way on a new 2-story plant, 70 x 175 ft., at Delaware Ave., and South Laurel St., estimated to cost $50,000.

STROUDSBURG — The Scott-Warman Glass Co., East Stroudsburg, is considering the rebuilding of the portion of its plant, destroyed by fire, Jan. 31, with loss estimated at close to $150,000.

SCRANTON—Fire, Jan. 27, destroyed a section of the plant of the Wickham-Branning Cut Glass Co., Gibson St., with loss estimated at about $50,000.

SPRING GROVE—The P. H. Glatfelter Co. has awarded a contract to the Aberthaw Construction Co., for the erection of a 1-story addition to its paper mill, 100 x 500 ft., and will commence work at once. J. A. Dempwolf, York, Pa., is architect.

Rhode Island

PROVIDENCE—The Davol Rubber Co., Eddy and Point Sts., manufacturer of rubber goods, has awarded a contract to Carl E. Carlson, 142 Atlantic Ave., for the erection of a two-story addition to its plant.

Texas

ROTAN—The Patton Cement Plaster Co., recently formed with a capital of $350,000, has completed plans and will soon break ground for the erection of its proposed new local plant, on property about 1 mile from the city. It will be equipped for a capacity of 400 tons of material a day and is estimated to cost in excess of $200,000. J. W. Patton is president, and E. W. Maben, secretary.

Virginia

SHAWSVILLE—The Kimbalton Lime Co., Shawsville, Va., operating a plant at Kimbalton, Va., is planning for the erection of two additions, with two new kilns, and auxiliary operating equipment. Richard K. Meade & Co., 11 East Fayette St., Baltimore, Md., engineers, will take bids at once.

WINCHESTER—The Cumberland Valley Fruit Products Co., recently organized with a capital of $100,000, is planning for the erection of a new local plant for the manufacture of vinegar and affiliated products. It is estimated to cost about $60,000. Boyd Richards is president, and Allen Bond, secretary.

Washington

SUNNYSIDE—The Big Y Fruit Growers' Association, C. H. Swigart general manager, is planning for the establishment of a local plant for the manufacture of lime and sulphur spray products for agricultural service.

Wisconsin

PARK FALLS—The Flambeau Paper Co. is having plans prepared and will take bids early in the spring for the erection of a new 2-story pulp mill to cost about $100,000, with equipment. A portion of the structure will be used for office service. Thomas W. Orbison, 812 College Ave., Appleton, Wis., is engineer. Guy Waldo is general manager.

New Companies

THE CARROLL MFG. CO., Boston, Mass., has been incorporated with a capital of $15,000, to manufacture fiber board products, leather specialties, etc. Carl H. Carroll, Arlington, Mass., is president.

THE SOLIDIFIED NAPHTHA CORP., 1209 Conway Bldg., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture naphtha products, vegetable oils and affiliated specialties. The incorporators are Otto E. Reitzman, Albert Emerson and Edsen Manierre.

THE D. P. CASE CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, colors, etc. The incorporators are L. S. Hirsch, E. Dreyfus and J. C. Guggenheimer. The company is represented by Guggenheimer, Strasser & Meyer, 27 William St., N. Y.

THE NATIONAL BRICK CO., Washington, D. C., has been incorporated with a capital of $75,000, to manufacture brick and other burned clay products. The incorporators are J. E. and Clyde C. Daley; and Alan S. Wolfe, 1612 Longfellow St., Washington, D. C.

THE RUBBER ACE CO. OF NEW ENGLAND, INC, Providence, R. I., has been incorporated with a capital of $100,000, to manufacture rubber products. The incorporators are George C. Clinton, James O. McManus and John J. Dillon, 192 Lockwood St., Providence.

THE BEAVER ENAMELING CO., Ellwood City, Pa., has been incorporated with a capital of $33,000, to manufacture enameled products. A. Largue May, Beaver Falls, Pa., is treasurer.

LEAS & MCVITTY, INC., 303 Vine St., Philadelphia, Pa., has been incorporated with a capital of $3,400,000 under Delaware laws, to manufacture leather products.

THE HIGHLAND LAKE PAPER CO., Framingham, Mass., has been incorporated with a capital of 6,000 shares of stock, no par value, to manufacture paper products. Daniel A. Donnelly is president; and James P. Welch, treasurer, both of Framingham.

THE LION OIL & REFINING CO., El Dorado, Ark., has been incorporated under Delaware laws with capital of $450,000, to manufacture refined petroleum products. The incorporators are George A. Todd, El Dorado; F. H. Thwing and E. D. Ellison, Kansas City, Mo. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ODORLESS BYPRODUCTS & REDUCTION CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture fertilizers and affiliated products. The incorporators are T. E. Halle, J. L. Watson and F. H. Butehorn, New York. The company is represented by F. J. Knorr, Albany, N. Y., attorney.

THE MAL-ZEMA CHEMICAL CO., 1021 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are William I. Russell, John H. Zink, and Cornelius J. Hamilton.

THE GLOBE VARNISH CO., 1503 City Hall Sq. Bldg., Chicago, Ill., has been incorporated with a capital of $100,000, to manufacture varnishes, paints, oils, etc. The incorporators are Frank C. Wilkinson, F. A. Willenbrink and Herman Sander.

THE SUNOCO SERVICE CORP., Trenton, N. J., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are Henry J. Baker, Clark L. Dickson and Frank M. Brown, Pear St. and New York Avenue, Trenton.

THE STROH PROCESS STEEL CO., Pittsburgh, Pa., has been incorporated with a capital of $5,000, to manufacture steel products. A. R. Bassett, Westinghouse Bldg., Pittsburgh, is treasurer.

THE METAL-DURO PAINT CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture metal-protective paints, etc. The incorporators are G. H. McMillin, H. C. V. Christensen and E. L. Smith. The company is represented by J. L. Rosenberg, 15 Park Row, New York.

SIEGEL'S STOVE POLISH CO., 38-40 Sherman Ave., Newark, N. J., has filed notice of organization to manufacture polishes and kindred products. The company is headed by Fred Siegel, 483 Stuyvesant Ave., Irvington, Newark.

THE GULF PRODUCTS CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $100,000, to manufacture sugar products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

GARLINGER & CO., INC., 207 West Franklin St., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture soaps, flavoring extracts and kindred products. The incorporators are Isaac T. Parks, Jr., Frank F. Ramsey and William H. Garlinger.

THE MICHIGAN-ILLINOIS PETROLEUM CORP., Room 1303, 5 North Wabash Ave., Chicago, Ill., has been incorporated with a capital of $500,000, to manufacture refined petroleum products. The incorporators are Glen H. Downes, F. W. Graham and Colfax Gibbs.

THE KLEANSTONE CO., Buffalo, N. Y., has been incorporated with a capital of $10,000, to manufacture cleaning compounds and other chemical products. The incorporators are C. T. and F. T. McCarthy, and G. F. Smith. The company is represented by John J. Brown, Ellicott Sq., Buffalo.

THE FAIRMOUNT LEATHER MFG. CO., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture leather products. The incorporators are S. Fogel, I. Ehrich and H. Friedman. The company is represented by Leo Schafran, 51 Chambers St., New York.

THE HULL & COWAN CO., Jacksonville, Fla., has been incorporated with a capital of $100,000, to manufacture brick and other burned clay products. Henry H. Hull is president; Hugh B. Cowan, vice-president; and W. N. Mason, Jr., secretary and treasurer, all of Jacksonville.

THE HILLTOP OIL CO., Eureka, Ark., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are H. D. Hever, W. R. Heekey and C. N. Stambaugh, all of Eureka.

THE STANDARD DRUG & CHEMICAL CO., 24 South Charles St., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals and affiliated products. The incorporators are Arthur W. Smith, Jules D. Fritz, and Herbert Gordon.

THE MOORE LEATHER CO., Boston, Mass., has been incorporated with a capital of $10,000, to manufacture leather products. C. T. Moore is president; William S. Liggett, vice-president; and Frederick N. Moore, Peabody, Mass., treasurer.

THE EMMERT MFG. CO., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture gummed papers and kindred products. The incorporators are S. B. and E. Emmert, and L. Nissen. The company is represented by J. A. Morison, 41 Park Row, New York.

ULMAN BROTHERS, INC., 30 West Baltimore St., Baltimore, Md., has been incorporated with a capital of $10,000, to manufacture chemicals, chemical compounds, etc. The incorporators are Marx, Ferdinand L., and Joseph N. Ulman.

THE ALUNITE CHEMICAL PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with capital of $500,000, to manufacture chemicals and chemical byproducts. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE MYZO MFG. CO., Pittsburgh, Pa., is being organized by Joseph A. and George T. McCleary, and James H. Corbin, to manufacture chemicals, chemical compounds, etc. Application for a state charter will be made at once. James P. Herron, 86 St. Nicholas Bldg., represents the company.

THE MARTIN OIL REFINING CO., Rooms 619-21, 608 South Dearborn St., Chicago, Ill., has been organized under state laws as a subsidiary of the Aluminum Chemical Co., address noted, to manufacture refined oil products. The incorporators are Clinton D. Martin, John A. Rowe and J. J. Cruews.

THE SOILAMIES PRODUCTS CORP., Allentown, Pa., has been incorporated under Delaware laws, with capital of $100,000, to manufacture cement products and affiliated specialties. The incorporators are Harvey H. Steckel, W. C. Senger and C. B. Roberts, Allentown. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE LIBERTY SPARK PLUG CORP., Boston, Mass., has been incorporated with a capital of $75,000, to manufacture porcelain spark plugs. James E. Rich is president; and Richard J. Burton, Brookline, Mass., treasurer.

THE BIG SANDY OIL & REFINING CO., Paintsville, Ky., has been incorporated with a capital of $24,000, to manufacture petroleum products. The incorporators are Ralph Stafford and H. B. Stambaugh, of Paintsville; and H. B. Stafford, Ashland, Ky.

THE ROYAL BRASS FOUNDRY CO., 39-45 New York Ave., Newark, N. J., has filed notice of organization to manufacture brass, bronze and other metal castings. Lothar Elsner, 20 Beach St., Newark, heads the company.

Capital Increases, Etc.

THE LUTTER BRICK CO., 1445 Diversey Parkway, Chicago, Ill., has filed notice of increase in capital from $50,000 to $200,000.

THE SEIBERLING RUBBER CO., Akron, O., manufacturer of tires and other rubber products, has arranged for preferred and common stock issues to total $1,500,000, for additional working capital, general operations, etc. F. A. Seiberling is president and general manager.

THE GRAND RAPIDS VARNISH CO., Grand Rapids, Mich., has filed notice of increase in capital from $100,000 to $300,000.

THE SHASTA ZINC & COPPER CO., 25 Broad St., New York, N. Y., has filed notice of increase in capital from $25,000,000 to $30,000,000.

VALENTINE & CO., 456 Fourth Ave., New York, manufacturers of varnishes, colors, etc., have filed notice of increase in capital from $2,250,000 to $3,000,000.

THE MONTROSE REFINING CO., Shreveport, La., manufacturer of refined petroleum products, has filed notice of increase in capital from $1,000,000 to $3,000,000.

A petition in bankruptcy has been filed against the SPEARE CHEMICAL PRODUCTS CO., INC., 30 Cliff St., New York, N. Y., by a number of creditors.

THE DEFORD CO., Luray, Va., manufacturer of sole leather and other leather products, has arranged for a bond issue to total $600,000, the proceeds to be used for general operations, financing, etc. Robert B. Deford is vice-president.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN SOCIETY FOR STEEL TREATING, will hold a sectional meeting, Friday, March 3, at the Hotel McAlpin, New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

NORTHWEST MINING ASSOCIATION will hold a convention in the Chamber of Commerce Bldg., Spokane, Wash., Feb. 14 to 18.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting: June 9—American Chemical Society, regular meeting.

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A consolidation of
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A British View Of the Dye Industry

IT IS REFRESHING to observe the wholesome respect with which the policies of leaders in industry are being received. An industrial program based on strict observance of the principles of sound economics which a short time ago was a voice crying in the wilderness is now hailed as a master stroke in the "return to normalcy." Fable has it that it took the fall of an apple to demonstrate to NEWTON the truth of the law of gravitation. Evidently it has taken the collapse of the bubble of post-war prosperity to bring home to our industries the existence and operation of economic laws which had been lost sight of in the period of speculation and overexpansion during and immediately after the war.

Some industrial problems are local and some are worldwide. Those confronting Great Britain are similar to our own, although perhaps more serious in many cases. Railroad and freight rates are higher than they should be. The coal production is uncertain and prices for home consumption are variable. The labor situation is unsettled. The dye and chemical industries are threatened, but they have an able champion.

"Chemicals and dyestuffs form the two most important and valuable key industries that a nation can possess. They ought to be vigorously developed and closely guarded." Thus spoke Sir WILLIAM ALEXANDER, chairman of the British Dyestuffs Corporation, Ltd., in a statement given to *Chemical Age* (London), after an extended tour of the United States and Canada in the interests of the future of the British dye industry. He points out that Great Britain has facilities in modern equipment for supplying at least the requirements of the British Empire. These new and extended installations should not be permitted to become derelict, for they stand for national security as well as commercial prosperity. They can be maintained in operation if British consumers will support British industries, if British chemists and engineers will concentrate on obtaining maximum efficiency in their plants, if labor will recognize that maximum production is its best security for good wages, if the British Government will continue to assist the industries to fight against depreciated currencies and other handicaps to fair trading and if the government will send commercially competent consuls and trade commissioners to pioneer and assist in the development of British trade. The reconstruction of Europe is all-important to Great Britain as an exporting nation and Sir WILLIAM advocates the rendering of aid by solvent countries to assist in reconstruction on sound lines, but warns against trade with nations on hazardous credit.

Such a reconstruction policy is sound economics and applies equally well to the United States. The depreciated currency and phantom credit of insolvent nations should turn the body of trade of exporting countries within their own boundaries, thus insuring maintenance of production facilities and a circulation of money within the country—a condition which stimulates production and employment. Nations whose currencies have fallen so low as to have little or no purchasing power must suffer until they have reorganized their internal economies and industries by production so that exports may balance imports. Production is their salvation, and the sooner such reorganization is accomplished the sooner will those countries reach a stable economic condition. But for countries like Great Britain and the United States, which have balanced budgets and fairly stable business conditions, the great desideratum is the maintenance of those key industries like dyes and chemicals which have been built up at great cost under arduous conditions. We wish political leaders could see the light as clearly as business men.

In Full For Services Rendered

OUR comment last week on the soldier bonus has brought some friendly protest from subscribers who are members of the American Legion and favorable to bonus legislation. We did not expect that our opposition would meet with unqualified universal approval, but we felt that it was in the best interest of business and industry to sound a warning against increasing taxes at a time when the nation is already heavily in debt and its citizens are struggling under a burden of unprecedented magnitude.

There is no doubt in our mind that the country, as a whole, does not want bonus legislation. It is noteworthy that no public voice other than that of politicians and American Legion officers has been raised in its support. As far as we are aware, every newspaper of importance has expressed itself editorially against the proposal. The all-important question is, Where is the money coming from? We think it not unfair to call upon the American Legion to make some constructive suggestions in the solution of this problem. It is unfair to sidestep it. In trying to solve it, Congress is in the most desperate dilemma with which it has yet been confronted. Will the Legion openly sponsor additional taxes in any form: a sales tax, a stamp tax, a motor tax, a gasoline tax, new taxes on tobacco, postage and theater tickets? Will it advocate these things or any of them to the farmer, the small merchant or the salaried man? If it will undertake something definite of this kind, we believe it will soon discover just how unpopular the bonus measure is.

Elsewhere we publish a few letters inspired by our editorial comment of last week. One of our correspondents unfortunately argues for the bonus on the basis of "paying a debt to those who 'took a chance' against the German" and "sufficient recompense for the time

spent on military duty." The argument does not appeal to us, nor do we think it is the best that can be advanced. Will the American Legion, or any member of it, or our correspondent give a receipt to the United States "in full for services rendered," and acknowledge that he has been fully compensated by the payment of a sum ranging from $500 to $625? We think not. We hope not. No cash value can be placed upon the service rendered by those who wore the uniform in the late war, whether they helped build Muscle Shoals or fought their way through the Argonne.

It may be just as well to mention the fact that in opposing the soldier bonus we are not expressing the opinions of theorists. We speak as those having experience, if not authority. Five men on CHEM. & MET.'S staff served overseas and in this country. They came out of the war poorer than they went in. In no case did their war-time compensation amount to enough to take care of themselves and families and they were obliged to draw upon savings or to incur debt. But none of them is in favor of the bonus. They all realize that legislation for it would be an economic blunder.

Mysticism Among Men of Science

IT WAS NOT so very many years ago when most men of science were in open conflict with all that is mystic in life. We older fellows called it the conflict between Science and Religion—and so did Dr. DRAPER and so did Dr. WHITE of Cornell. It was a lively and rather bitter quarrel in which nearly everybody took side. The fight was hot and anger was rife, so that very few of the parties of either part could see that the dispute was not between science and religion, but rather between science and dogma.

It appears to us that a turn in the habits of thought of many men of science is coming about. They are not seeking the mourners' bench or weeping over their sins or singing revival hymns or even growing orthodox from the standpoint of dogma; but there appears to be coming over a considerable number of leading men of science an enlivened reverence for that which is beyond human knowledge. It shows itself in various ways. Sir WILLIAM CROOKES did, and Sir OLIVER LODGE does, believe in ghosts. They have not many followers among their colleagues. The tendency is rather toward a less definite quality of mysticism; toward a belief in a greater illumination than is ours. It is not organized and it does not follow creeds or catechisms or articles that were drawn and recorded when, according to the best human understanding, the earth was flat like a cake, when it was the center of the universe, when the sun was a great lamp that was raised in the morning and lowered at night, and the lesser lights, the moon and stars, were little incidents to mitigate the darkness.

Earlier generations accepted orthodoxy. Sir ISAAC NEWTON was a man of unusual piety. MICHAEL FARADAY was a sound churchman. LOUIS PASTEUR was among the last of the great men of science to whom the "requirements of faith" were welcome.

The present tendency is independent of dogma. It does not insist on any particulars. It does not condemn. It seeks the Greater Illumination and finds hope and comfort in the quest.

On January 8 last Professor MICHAEL I. PUPIN of Columbia made a memorial address at St. Paul's Chapel on the campus in honor of those who in their lifetime had advanced the honor of Columbia University. Now to such persons as know him casually, the genial professor of electromechanics would be about the last one they would expect to see in a pulpit preaching a sermon. But his beautiful "Herdsman's View of Human Life" was indeed a sermon. He harked back to the time when, 50 years ago, he had helped the village herdsman to guard the grazing oxen through the night on the hills of Serbia. The mystic thoughts of ancient reverence that inspired the watching boy have not been killed by the study of science. It was beautiful and reverent and sincere, and it did not offend the understanding. Many will remember the plea for spiritual vision made by Professor BASKERVILLE in his address at the Great Hall of City College during the September joint meeting of the chemical societies. It was his last public utterance, this urgent appeal for the search after light to come from beyond our ken. Dr. CHARLES P. STEINMETZ in his illuminating contribution to the current number of *Harper's Magazine* has approached close to the boundaries of mysticism.

It is an excellent thing to "get down to brass tacks" in our discussions of particular things and in the consideration of principles and processes. But the world is not made up of brass tacks alone. There are vague shapes in the minds of men and women that are potent to build up or to destroy. As men of science we are beginning to see that our obligations extend far and away beyond the laboratory, and that, among other things, the duty is ours to guide the vague shapes into the paths that lead to human welfare and betterment. We, too, are our brother's keepers.

X-Ray for Routine Testing

EVEN the best modern testing laboratories seldom possess X-ray apparatus, and it is still more rarely seen in use for the routine examination of chemical and metallurgical materials. But for that matter, only a few years ago a microscope was nothing but an instrument for advanced specialists, and the old ones among us can even remember the introduction of the analytical balances. So it is somewhat unsafe to prophesy the future utility of recently discovered and adapted implements of research when applied to the multifarious needs of present-day industry.

But based on past performances, some of which are well known, and on recent developments, not so widely advertised, the X-ray seems likely to become very useful in three major directions: First, for revealing sizable internal defects; second, for studies in crystallography; third, for spectrum analysis.

The first kind of work is an extension of the methods and equipment commonly used by dentists and medical men when they make shadowgraphs to aid in their diagnoses. A pencil of rays is passed through the body to be examined; the denser portions absorb or scatter a greater proportion, and cast a "shadow" on a fluorescent screen or photographic film placed beyond. In this way internal defects in solid material, improper material covered by veneer or contained in solid packages, and poor fits at joints can be easily determined in suspected articles, without destroying or even disturbing them in the investigation.

Notwithstanding the fact that such methods are thoroughly practicable for organic substances, they will require much development before they will be extensively used for testing metal. As a piece of steel becomes greater than 1 in. thick, the time of exposure

increases rapidly and the indications rapidly become less distinct. Of course, it is easily possible that the sensitivity of the fiber may be increased, some method of filtering out the confused beams scattered by the metal itself may be devised, and Coolidge tubes of very high power might be constructed. But even so, the physical danger attending the use of such penetrating rays and the enormous difficulties to be overcome at present seem to limit the use of pure radiography to moderate sections of metals of low atomic weight. Exposures of such castings, for instance, should show the presence or absence of dangerous blowholes or slag inclusions quite clearly. Unfortunately their cracks cannot be found unless placed "edge on" to the rays.

Crystallography is a subject which the ordinary testing engineer would associate with geology or mineralogy, and therefore quite anterior to the testing of materials in process. However, X-ray crystal analysis may easily become of great value in working with graphite, clay and various other substances entering largely into present-day industry but about whose chemistry and physics we are so relatively ignorant. A compact machine has recently been described in these columns for crystal analysis, and Dr. BAIN has shown how it has already yielded results of the greatest importance to theoretical metallurgy. Briefly, the method consists of passing a monochromatic ray through a sample of powder or fine-grained solid. The ray is photographed after reflection from the variously oriented crystalline planes. This reflection occurs in certain dominant directions which depend upon the atomic arrangement and which can be computed for the various crystal systems. Since no two substances have the same crystal structure, here is a new method of analysis. Unfortunately, it is not yet capable of showing small traces of adulterants. However, many substances of identical chemical composition exhibit isomerism and allotropy. Such a substance will exhibit many puzzling variations in its properties and action when in process, and yet the reason will of course be undiscoverable by chemistry and often elude other physical investigations.

True X-ray spectrum analysis may become more popular than the older visible spectrum analysis, because the number of X-ray waves characteristic of each element are very small and can be easily recognized. Furthermore, the intensity of the lines is strictly proportional to the amount of the element present. When practicable, the material to be investigated is rubbed into the face of the target in a Coolidge tube. X-rays emitted from this target are then analyzed by the X-ray crystal spectrometer, and the result compared with the radiations from the standard material—where only a comparative test is to be made—or to the characteristic waves for the various chemical elements, when an ultimate analysis is desired. Much the same results may be had by passing a pencil of X-rays from a tungsten target through a sample, and analyzing the emergent rays for absorption bands. This practice is particularly sensitive in detecting very small traces of heavy elements occurring in materials of low atomic weight.

Enough has been said in the above brief outline, however, to indicate that unquestionably the X-ray is a powerful tool, whose ultimate development and application cannot now be foreseen. Enthusiastic men in many laboratories will doubtless seize upon it now that the equipment has become available in compact and simple form, and adapt it to their own uses. What they will be able to do will be awaited with great interest.

Profits and Losses In the Steel Industry

THE "prince or pauper" industry experiences great vicissitudes in the matter of profits and losses, not simply because the demand for its product varies widely but also because it is subject to heavy overhead or fixed expense. The capital invested in facilities, excluding transportation facilities but including ore mines, coke works, blast furnaces, steel mills and finishing departments, is not far from $100 per gross ton of annual output in finished steel when there is substantially a capacity operation, so that there is an interest charge alone of something like $10 per ton on a 50 per cent operation. Then there are general administrative and selling expenses as well as a heavy expense in those employees at manufacturing plants who are naturally carried on annual salaries and whose employment does not vary according to tonnage output. Another fixed expense is taxes. This item cannot be estimated closely, but it is a matter of record that the United States Steel Corporation's taxes in 1920, exclusive of federal taxes, amounted to $38,724,289, the output of steel products for sale being 14,228,502 tons, representing an operation at 88.3 per cent of capacity. Allowing that part of the taxes accrued on transportation and other properties not engaged directly in steel manufacture, the direct taxes would be close to $2 a ton on a full operation, or twice as much per ton on a 50 per cent operation.

Given competitive conditions in the steel market, the free play of the law of supply and demand, with a demand less than 50 per cent of capacity, it is easy to see how the steel industry can quickly develop a condition of selling its product at a loss. The cost per ton mounts and it would require a high selling price to enable all producers merely to break even.

There were very few independent steel companies that did not report losses in 1921 and some of the losses appeared very large. The United States Steel Corporation reported earnings in both the third and fourth quarters of the year sufficient to pay all charges together with the preferred dividend, but with scarcely anything left for the common shares, on which the dividend at the modest rate of 5 per cent a year was maintained chiefly by drafts upon surplus.

A common view is that the Steel Corporation has such refinements and economies in operation that it can make profits when independent companies have losses, given similar conditions as to selling prices and rate of operation. This may be true, but the financial reports published do not prove the point, because conditions as to selling prices and rates of operation were not identical.

Even the Steel Corporation, however, is in a tight place as regards earnings. Superficially, the corporation seems to have done well when it reported earnings at $18,918,058 for the third quarter of 1921 and $19,612,033 for the fourth quarter, representing an increase of 3.7 per cent; but the showing is not as good as appears, since the earnings per ton greatly decreased, there having been an increase of 50 or 60 per cent in shipments from the third to the fourth quarter. Furthermore, the December shipments were at approximately the average rate for the quarter, while the December earnings were only $4,967,237, or at the rate of less than $15,000,000 for a quarter, instead of $19,612,033. Realized prices are probably running a trifle lower now than in December, while production is improved but little if any.

Readers' Views and Comments

Does Business Want the Soldier Bonus?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am not in the habit of writing with reference to editorials but I do wish to say that I feel a large percentage of the thinking men of the country are heartily in accord with the attitude which you have taken on the soldiers' bonus. I wish to extend to you my congratulations that you have the nerve to publish an article of this character.

At present I have in my department a few men who have been overseas, one of whom has suffered the loss of one arm. I think I am safe in saying that every one of these men who has seen actual service takes essentially the same attitude that you have in your editorial. I am speaking advisedly in this matter, because one of the strongest men in our school happens to be my personal assistant, an overseas man, who feels very strongly as you do, and knows the attitude of the other overseas men who are worth while.

Chemical Engineering Dept.,
Bucknell University,
Lewisburg, Pa. GLENN V. BROWN.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am always glad to recognize the courage of those who express their opinions at a time when such a statement may detract from their popularity and add nothing to their bank account; however, I wish to express an opinion contrary to the stand you have taken regarding the soldier's bonus.

It is my belief that not all the opponents to this legislation are as sincere in the cry for economy and their fear of national bankruptcy as you are.

The ex-service men of your acquaintance may be possessed of a super-patriotism that is not evident in western Pennsylvania, for I have not met a man who thought he had received sufficient recompense for the time spent on military duty.

Some of our self-styled economists have pointed out the advantage of paying still larger amounts to the railroads and the cancellation of the foreign debt; but the paying of a debt to those who "took a chance" against the German goes against their theory of economics and their morals.

We ask no favors, no courtesy, no preference; but only fair pay for a job which others have said was well done.

G. W. PAULIN.
Leechburg, Pa.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was greatly disappointed with your editorial in the current issue on the soldiers' bonus. I am proud to be a member of the American Legion and do not appreciate the implied slur on it, for it is an organization actuated by the highest ideals and one which is pledged to promote the best interests of the country as a whole. At the present time it appears that it is only just that those who spent time in the service of the nation should have some form of compensation to place them on a financial par with those who for one reason or another did not go. Most of the influential members of the American Legion are agreed that the cash settlement plan will be chosen by only a small proportion of the total number of eligibles and by even a smaller ratio of our members. However, you should know that we are undertaking a census to determine that matter accurately.

Bonuses were given freely to those who might otherwise have lost by cancellation of war contracts, to the railroads and to the civilian employees of the government. We do not say that these were not necessary and just, but we do claim that compensation for the veterans is not only just but will be a good investment for the future economic welfare of the nation as a whole, for it is so designed as to throw by far the larger part of the amount allowed into the purchase of homes and farms, the two types of investment which do most to promote stability and industry in society.

As a chemical engineer and an old subscriber, I hated to see you misled on this very important question and hope that you will get in touch with our national officers and get a definite and accurate line on the Legion aspirations before writing your next article on this subject.

Kansas City, Mo. R. H. BAXTER.

Human Relations in Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the subject of "Human Relations in Industry," considered by Dean Kimball in the Jan. 18 issue of your journal, may I offer the following suggestions?

Nothing more timely in the consideration of what should be included in "the content" of the courses given by our educational institutions can be suggested than that our educators dig hard and deep to find a permanent foundation for and build thereupon a constructive course in what I would term a Science of Human Relations. The subject is the very cornerstone among all the educational materials out of which the world's most helpful leaders among men should be technically, morally and spiritually constructed.

As Dean Kimball says, a sound philosophy of what human relations in industry should be has not as yet been formulated, but may it not also be said much, very much, more effort to do so than has been heretofore undertaken may be with correspondingly better understanding? As old as history are the records of man's efforts to find a system of moral direction suitable for all mankind, yet to this day unity of formula seems as far off as before; still such teachers are by their patience and conscientious zeal a great directing force in our civilization.

As engineers many of us are today more than ever impressed by such sayings as "Obligations and duties take precedence over rights and privileges," and again, "His kindliness, wisdom and humanity made him a natural leader." Great harm is too often done by sneering at this moral or ethical basis of any association as the aspiration of overpious and impractical minds, and it is an inspiration for those of us who believe otherwise to read Dean Kimball when he says, "A new industrial day has dawned . . . we are more interested in men than in machines."

These and many similar enunciations of principles

and policies surely are not fully amplified by a general advocacy of the Golden Rule. They are keys and by the synthetic investigation and study of the substance they represent, the first lines are found for a codification of a class of practical knowledge to which our schools and colleges might give more special attention, if not a curriculum status in their courses.

EDWARD F. WHITE,
Middleport, N. Y. Mechanical Engineer.

The Field for University Patents

To the Editor of Chemical & Metallurgical Engineering

SIR:—Dr. Hale's vigorous contribution to the discussion of university patents in your issue of Nov. 16, 1921, is convincing. One cannot disagree, granting his premises. But Dr. Hale has missed the point entirely. I am sure that Mr. Hoskins and Mr. Wiles were not thinking of the location of the eye in a needle as a "basic patent"; nor would it ever have occurred to them that a clutch release could possibly be the object of a university research. Admittedly, these are basic matters for the industries concerned, but from the scientific point of view the only proper results from university researches must be far more basic.

Roentgen's discovery of the X-ray was patentable. That is the sort of thing that universities are giving to the industries with no recompense. Faraday's fundamental work on electric current, Schömbein's discovery of ozone, Daguerre's application of the photo-sensitiveness of silver salts in photography, Millikan's determination of the properties of the electron—these are instances of what pure science has done for industry. And seldom has the scientist or his institution drawn any monetary reward.

Soon a university man will discover how atoms may be broken down into their constituent parts, and will release incalculable energy for human use. This is the sort of work the reward for which should go to the universities, and not to industry, nor primarily to the man who succeeds in it; and if such matters as these are considered instead of the instances which Dr. Hale gives, his arguments are pointless. Such discoveries should not be given outright to industries; neither could they be licensed to any one manufacturer, and no single professor could remain a research man if the administration of the patents were to be in his hands. The only solution which will endow research, reward the inventor, compensate the universities and place the tax where it is due and gladly payable is that suggested by Messrs. Hoskins and Wiles.

Finally, Dr. Hale's chief point is that no matter what the invention, the professor himself should maintain and defend the patent. Messrs. Hoskins and Wiles grant that the inventor has every right to do this, but they realize that the large majority of pure research men are what they are because they have no time for business and could not administer a patent if they would. Hence they suggest that the university provide a repository which will secure all previous benefits and in addition would prevent the scientist from interference by business detail with which he has no concern.

Chicago, Ill. GERALD L. WENDT.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In commenting upon my contribution in your issue of Nov. 16, 1921, Dr. Wendt would have us believe that foundation researches are really patentable. We all agree at the outset that universities should in some way be able to reap rewards for the discoveries of those broader principles, so many of which in the past have fallen to the credit of university investigators. But have these discoveries been patentable in themselves alone? Certainly not. Were Dr. Wendt to apply for a patent on some such general discovery as he has mentioned, he would become painfully cognizant of the necessity of setting forth clearly and pointedly the actual claims in no vague terms, nor could his claims cover the entire field of human endeavor.

If Dr. Wendt will pursue the history of scientific theory, he will find that the possibility of obtaining patents in the name of the leading discoverers was practically reduced to nil in the face of diversified applications so speedily come upon by any number of enthusiasts. When the patent application does not embrace all of the possible claims known at the time, the patent carries little of actual value.

Let us take, for example, a case illustrative of this development from earliest record to final utility. The discovery by Maxwell, the theorist, in 1873, that light is an electric phenomenon could not have been patented, nor also his inference that there are other electromagnetic waves, non-illuminant in effect. Hertz, the research physicist, who in 1886 actually proved the existence of these other electromagnetic waves and described their properties of penetrability as regards solid walls, etc., had little to patent. But Marconi, who in 1896 was able to collect these waves by antennæ and record impulses therein by the flow of current through a coherer, actually hit upon the wireless telegraph, which cannot be construed otherwise than of a basic patentable nature. Now, Hertz deserves greatest praise for his researches, university researches as they were, but everyone knows that he did not have enough to make up a basic patent. Marconi's discoveries, therefore, will ever be regarded as of the basic patent class.

Those discoveries cited by Dr. Wendt were for the most part non-patentable, although they are of general import and certainly give credit to the universities where they were announced. After all, we must not overlook the fact that universities owe much to the industries for their lease on life and certainly these general contributions by universities to science will do much to stimulate further investigations for the good both of the universities and of the industries.

Patents should be obtained upon university researches as well as upon others. The chances for early patents, however, are more likely to fall to industrial research laboratories, where intensive work under high pressure may be instantly inaugurated. My contention has been and still is that the university is not organized to take over the ownership or control of patents and patent rights. In this I feel that university men are thoroughly in agreement, as vouchsafed by over fifty letters recently received by me in commenting upon the contribution of Nov. 16. Not one single case opposing the views therein set forth has come to my attention, save of course these comments of Dr. Wendt.

Let us not forget that university faculties are made up of intelligent men. Were I ever again to be holding a place of honor in a chemical faculty, I certainly would no more consent to have my prerogative as chemist interfered with than I would consent to the university's taking up and handling a case of divorce, assuming thereby that my duties and responsibility to the university as a chemist precluded the possibility of my being able to look after my own affairs.

Midland, Mich. WILLIAM J. HALE.

An Outline of the Uses of Lime*

Chemical Uses: Raw Material in the Manufacturing Industries; Sanitation; Purification of Materials; Food; Catalytic Processes; Utilization of Byproducts; General Utility; Miscellaneous—Construction Uses—Agricultural Uses—Chart Showing Some of the Many Functions and Uses of Lime

By M. E. HOLMES, Ph.D.
Manager, Chemical Department, National Lime Association

THE use of lime in mortar and plaster was, in past ages, its only important use. Coincident with our modern industrial development along technical lines, the lime industry has expanded enormously in the number of its technical uses and thereby has offered a fertile field for the activities of the investigator and writer. The "Uses of Lime" is the subject of a paper read in 1904 by S. V. Peppel[1] before the convention of the National Lime Manufacturers Association. Since then a number of publications have appeared. In 1913 the United States Geological Survey issued a publication on the "Sources, Manufacture and Use of Lime."[2] R. K. Meade[3] in 1914 wrote a paper on the "Composition, Manufacture, Properties and Uses of Lime" and at a later date[4] contributed an article on the "Valuation of Lime for Various Purposes." In 1920 the Bureau of Standards issued a publication[5] under the title "Lime, Its Properties and Uses."

In the present article the author has approached the subject primarily from the point of view of a systematic arrangement in outline form of the uses of lime, grouping the various uses under headings indicating functions performed by the lime. In order to show the unusually large number of functions that lime can perform, we have included not only the well-known uses that represent large tonnage but all the uses of which we have authentic records.

In order to give a proper perspective of the relative importance of the various uses, the latest available data compiled by the United States Geological Survey are rearranged and presented in Table I to show the tonnage distribution of lime by uses. These data are supplied to the Survey by lime manufacturers, who specify the uses for which their lime is sold. The data show that the largest single use of lime is for construction purposes, 1,305,412 tons being reported for 1920. This use is followed by paper mills, with 365,897 tons, agriculture with 351,851 tons, metallurgy with 344,921 tons and refractories with 316,293 tons. At this point there is a large drop to the next important use, which is that for making alkalis, which consumes 104,250 tons. Then follows a gradual decreasing series of figures for the lime consumption in the seventy itemized uses which follow. The item of "unspecified," representing 178,904 tons, accounts for the many other uses for which lime can be and is used. Although it is impracticable to include tonnage figures for the numerous small uses, yet they are important in considering possible future tonnage and in a study of the functional capacity of lime.

In industrial technology it is convenient to divide the uses of lime into three major groups—viz., construction uses, agricultural uses and chemical uses. The construction uses include those involved in building operations, the agricultural uses are limited to the uses on the farm, and the chemical uses include the very large number involved in manufacturing and technical processes. Although the allocation of certain uses is somewhat arbitrary, yet it serves to divide the field in accordance with the duties of the engineer, agronomist and chemist.

The Chemical Uses of Lime

Until recent years the use of lime in chemical engineering processes has been of negligible importance. The rise of the science of chemistry has been attended, however, by disclosures of numerous technical uses for lime which has opened up a new outlet for the industry of such magnitude that it may safely be stated that the chemical uses of lime are now the most numerous and most important in point of tonnage. Calculations from

TABLE I—DISTRIBUTION OF LIME BY USES

	1919	1920
Construction	1,191,434	1,305,412
Paper mills	335,813	365,897
Agriculture	438,632	351,851
Metallurgy	295,622	344,921
Refractories	222,036	316,293
Unspecified	119,770	178,904
Alkalis	136,896	104,250
Water purification	.....	90,533
Sanitation	82,522	(a)
Calcium carbide	140,165	88,465
Tanneries	59,978	61,162
Glass works	44,618	54,747
Acids	8,178	48,361
Bleaching works	27,804	24,030
Calcium acetate	(a)	22,241
Silica brick	16,552	20,371
Sand-lime brick	5,096	19,521
Soap manufacture	.....	18,607
Undistributed (f)	30,742	17,347
Coke and gas manufacture	17,207	.....
Sugar factories	13,111	14,145
Ammonia works	5,323	10,041
Coke-oven byproducts	.....	8,740
Explosives	7,196	(a)
Spraying	.....	6,141
Glue manufacture	4,499	5,641
Cyaniding	5,206	4,295
Oil, fat and soap manufacture	29,205	3,238
Corn products	(a)	2,428
Paint manufacture	2,275	1,954
Wood distillation	(a)	1,474
Sewage purification	.....	1,361
Gas plant byproducts	.....	1,207
Dairy products	(a)	1,207
Gelatine manufacture	.....	1,183
Coal and water gas purification	.....	1,164
Salt refining	(a)	921
Flour mills	350	313
Dininfectant	.....	205
Candles	.....	114

(a) Included under "Undistributed."
(f) Included in 1919: Lime used in the manufacture of calcium acetate, alcohol, phenol, salt, oxygen, corn products, rubber, textiles, baking powder, belting, lime pencils, dairy products, polishing and buffing compounds, distillation of wood; in 1920: Lime used in the manufacture of gypsum products, rubber, lubricating grease, polishing and buffing compounds, cyanide, pottery, textiles, explosives, cyanamide, phenol, barium products, basic magnesium carbonate, nitrates, alcohol, oxygen, dyes, for correcting the acidity of soils, for kalsomine,wire coating, purification of blast furnace gases, and for sanitation.

*Paper read at the fourteenth annual meeting of the American Institute of Chemical Engineers, Baltimore, Md., Dec. 9, 1921.

[1] *Lime Light*, pp. 106-113 (1904).

[2] E. F. Burchard and W. E. Emley, U. S. G. S., Mineral Resources, 1913, Part II, pp. 1509-1593.

[3] *Concrete Cement*, vol. 5, pp. 20-22 (July, 1914).

[4] *J. Ind. Eng. Chem.*, vol. 10, pp. 214-219 (March, 1918).

[5] Bureau of Standards Circular 30, Second Edition.

data published by the U. S. Geological Survey indicate that lime producers in 1918 sold about 1,900,000 tons for chemical uses, representing roughly 60 per cent of their total. In 1919 this percentage dropped to about 51 per cent, but rose in 1920 to more than 53 per cent. The war undoubtedly had its effect in making the 1918 figure somewhat abnormal, but the indications are that the chemical uses will continue to be the major outlet for our lime production.

The chemical uses of lime may be grouped under nine main heads, which are sanitation, purification of materials, food, catalytic processes, medicine, general utility, byproducts utilization, raw material in the manufacturing industries and miscellaneous.

Raw Material in the Manufacturing Industries

As a raw material in the manufacturing industries, lime functions in processes of saponification, dehydration, hydrolysis, causticization, distillation, high-pressure processes, absorption of gases, coagulation, precipitation, solution, high temperature processes and neutralization of acids.

In high temperature processes lime is used as a fluxing agent in the open-hearth process of steel purification and in the recovery of zinc in the roasting of zinc ore. It finds use as a fluxing agent also in the ceramic and porcelain industries. Lime in the form of very fine quicklime is used as a lubricating agent for dies in drawing steel wire. In electrothermic operations lime is used in the refining of steel, nickel and copper. There is evidence that lime may function as a solute in fused melts whereby alkaline earth metals are produced by electrolysis. Lime functions as an oxidizing agent for carbon under the conditions existing in the manufacture of calcium carbide, cyanamide and silicide and metallic magnesium in the fertilizer and metallurgical industries. Lime is used in fusions such as with silicates to form glass, with alkali hydroxides in making soda-lime and alkali peroxides, with chromite in making chromates, and with clay in the manufacture of aluminum and barium compounds. The manufacture of dead-burned dolomite is possible with the use of lime by a high-temperature calcination process. The manufacture of pottery, decolorizing carbon and silica brick can be accomplished by a baking process in which lime is used with clay, tarry material and kieselguhr, respectively.

In saponification processes, lime functions as a saponification agent for oils in making lubricating greases and various other tar products in the petroleum industry. Organic salts may be saponified with lime in making hyroxides in the dye and organic chemical industry. The action of lime as a saponifying agent for fats, waxes or greases is involved in the cleansing of textiles and also in the manufacture of soap, glue, glycerine, lubricating greases and paints in the animal products industry.

As a dehydrating agent, lime is used in the manufacture of industrial alcohol. It also finds a place in the petroleum industry for the dehydration of petroleum and greases.

Lime is used as a hydrolyzing agent in the manufacture of hydrolyzed glue for use in the prevulcanization treatment of rubber. It can also be used as such in the manufacture of ammonia from aluminum nitride and in the manufacture of pulp cloth from cellulose.

Causticization with lime is involved in the manufacture of alkali hydroxides from sulphates, carbonates and phosphates. Such processes are used extensively in the paper industry for making soda and sulphate pulp, in the inorganic chemical industry for making alkali salts, in the textile industry for mercerizing cloth and for the manufacture of hypochlorites for bleaching purposes, and in the animal products industry for making alkali soaps.

The use of lime as a coagulating agent is extensive in the purification of turbid water for use in making artificial ice and for general municipal purposes. It functions similarly in the settling of ore slimes for the recovery of precious metals in the mining industry, and in the defecation of sugar juices both by the carbonation and sulphitation processes in the cane and beet sugar industry. In the clarification of sorghum juice, for making molasses and in the flocculation of clay in making compounding ingredients for the rubber industry, lime functions as a coagulating agent.

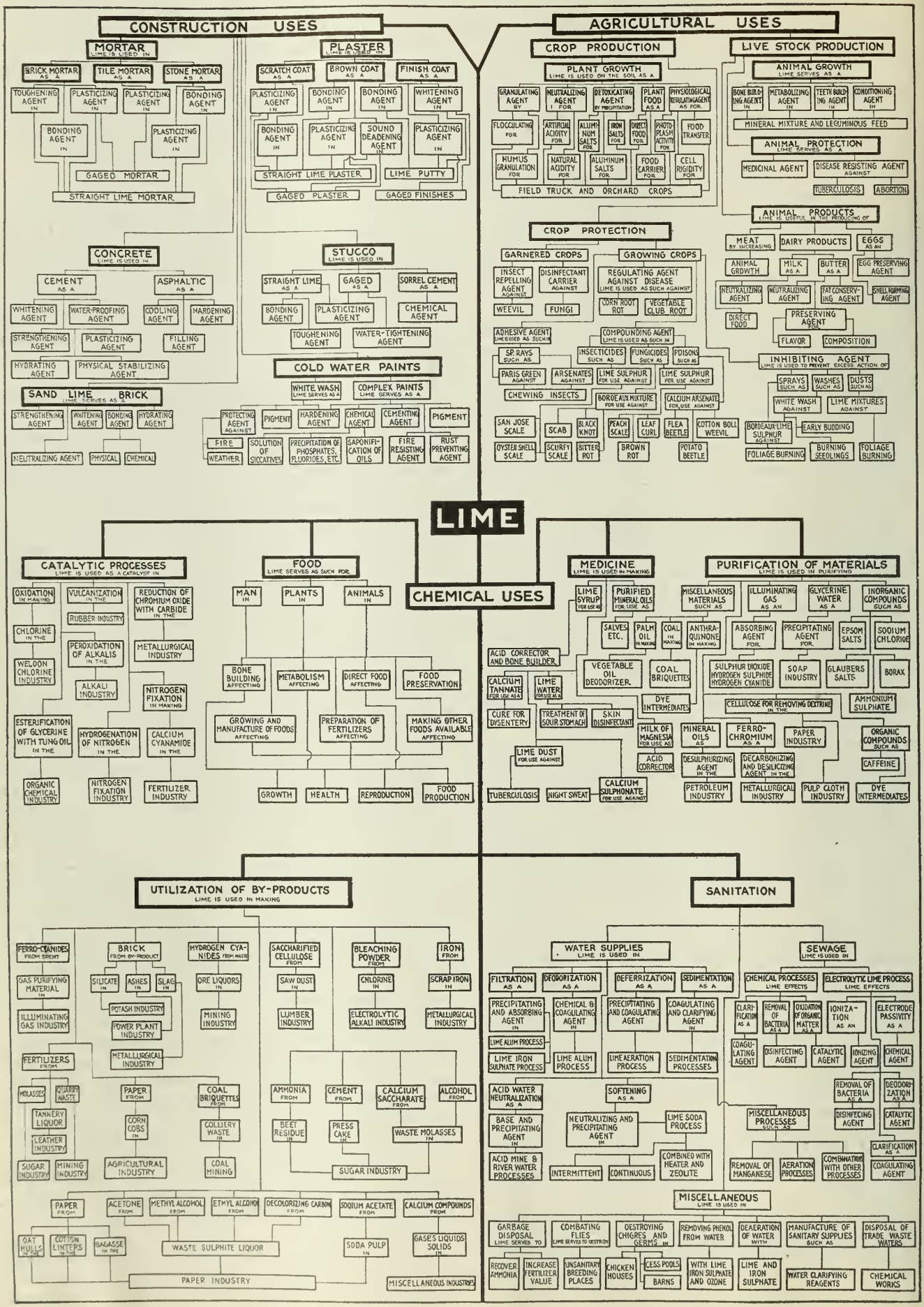
The action of lime as an absorption agent for gases is made use of in the manufacture of acetic acid and acetate of lime in the wood-distillation industry, in the manufacture of bleaching powder and alkali hypochlorites which involve the absorption of chlorine, and also in the manufacture of lime nitrogen salts and nitric acid by the absorption of oxides of nitrogen. The absorption of carbon dioxide by lime is involved in the manufacture of precipitated calcium carbonate, phenol and magnesia insulating material. The absorption of sulphur dioxide, hydrogen sulphide and hydrogen cyanide by lime is involved in the purification of illuminating gases.

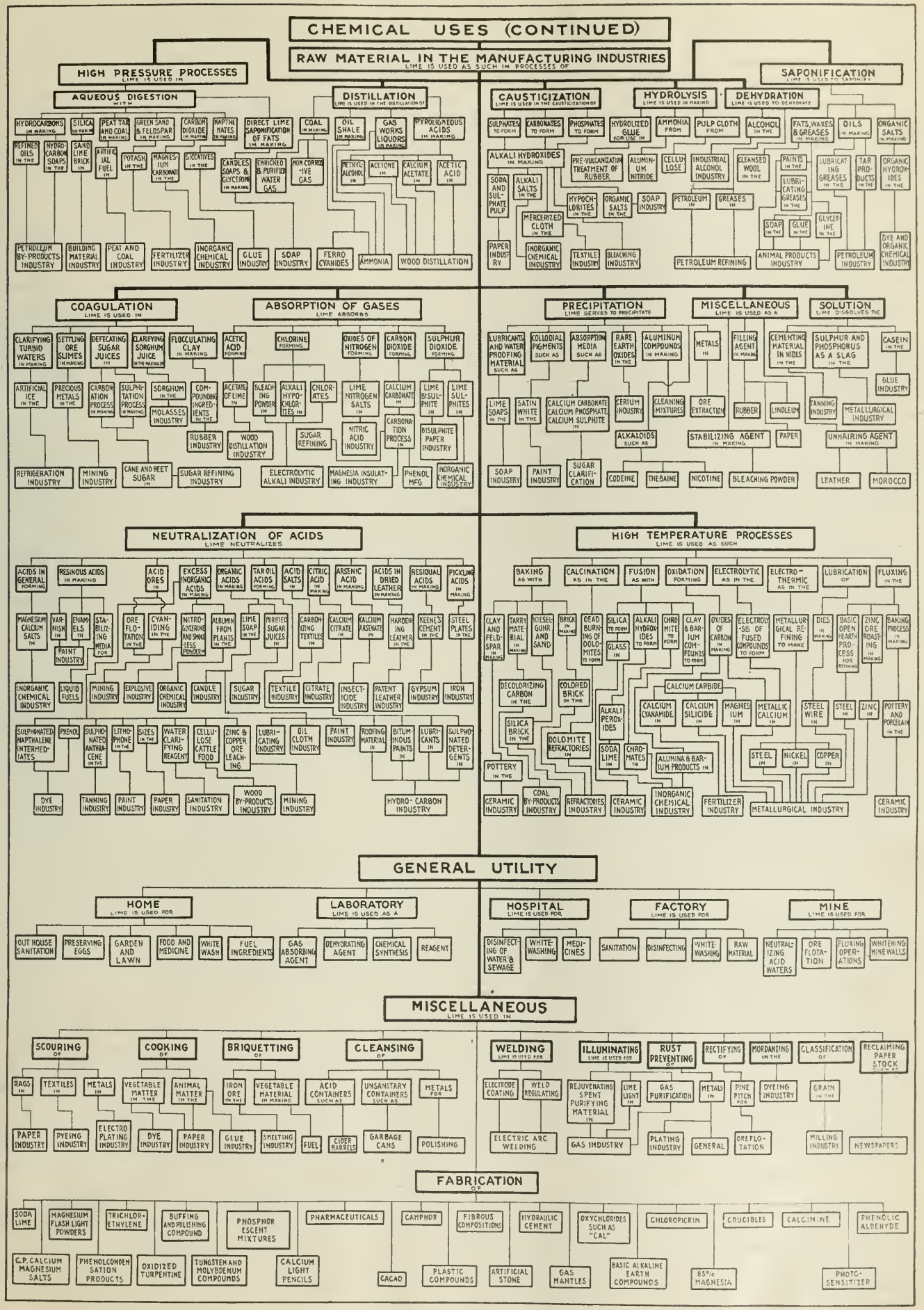
In high-pressure processes, lime is used in the direct saponification of fats, in making candles, soap and glycerine. The manufacture of refined oils and calcium soaps from hydrocarbons, the manufacture of sand-lime brick from silica and the manufacture of artificial fuel from peat, tar and coal can be accomplished with the use of lime under pressure. Potash is extracted from greensand and feldspar by aqueous digestion under pressure with lime. This process is also used in the glue industry in the making of siccatives from naphthanates.

Processes of distillation with lime are involved in the manufacture of enriched and purified water gas, ferrocyanides and ammonia. Coal, oil shale and gas works liquors may be distilled with lime for the recovery of ammonia. In the wood-distillation industry, lime is used in the distillation of pyroligneous acid in making methanol, acetone, calcium acetate and acetic acid.

As a precipitating agent, lime is used in the soap industry for making lime soaps which are used as lubricants and waterproofing material. In the paint industry lime is used for precipitating colloidal pigments such as satin white. The sugar industry employs lime for precipitating carbonates, phosphates and sulphites which function as absorption media for impurities in the juice. Cleaning mixtures are made by the precipitation of aluminum compounds with lime. Lime is used also as a precipitating agent for the rare earth oxides in the manufacture of cerium for the gas mantle industry.

The neutralization of acids with lime has an unusually large number of applications in the technical industries. In the paint industry lime is involved in the neutralization of resinous acids for the manufacture of


LIME
CHEMICAL USES
CONSTRUCTION USES
MORTAR
LIME IS USED IN
BRICK MORTAR AS A
TILE MORTAR AS A
STONE MORTAR AS A
TOUGHENING AGENT IN
PLASTICIZING AGENT IN
PLASTICIZING AGENT IN
BONDING AGENT IN
BONDING AGENT IN
PLASTICIZING AGENT IN
GAGED MORTAR
STRAIGHT LIME MORTAR
PLASTER
LIME IS USED IN
SCRATCH COAT AS A
BROWN COAT AS A
FINISH COAT AS A
PLASTICIZING AGENT IN
BONDING AGENT IN
BONDING AGENT IN
WHITENING AGENT IN
BONDING AGENT IN
PLASTICIZING AGENT IN
SOUND DEADENING AGENT IN
PLASTICIZING AGENT IN
STRAIGHT LIME PLASTER
LIME PUTTY
GAGED PLASTER
GAGED FINISHES
CONCRETE
LIME IS USED IN
CEMENT AS A
ASPHALTIC AS A
WHITENING AGENT
WATER-PROOFING AGENT
CODLING AGENT
HARDENING AGENT
STRENGTHENING AGENT
PLASTICIZING AGENT
FILLING AGENT
HYDRATING AGENT
PHYSICAL STABILIZING AGENT
SAND LIME BRICK
LIME SERVES AS A
STRENGTHENING AGENT
WHITENING AGENT
BONDING AGENT
HYDRATING AGENT
NEUTRALIZING AGENT
PHYSICAL
CHEMICAL
STUCCO
LIME IS USED IN
STRAIGHT LIME AS A
GAGED AS A
SORREL CEMENT AS A
BONDING AGENT
PLASTICIZING AGENT
CHEMICAL AGENT
TOUGHENING AGENT
WATER-TIGHTENING AGENT
COLD WATER PAINTS
WHITE WASH LIME SERVES AS A
COMPLEX PAINTS LIME SERVES AS A
PROTECTING AGENT AGAINST
PIGMENT
HARDENING AGENT
CHEMICAL AGENT
CEMENTING AGENT
PIGMENT
FIRE
WEATHER
SOLUTION OF SICCATIVES
PRECIPITATION OF PHOSPHATES, FLUORIDES, ETC.
SAPONIFICATION OF OILS
FIRE RESISTING AGENT
RUST PREVENTING AGENT
AGRICULTURAL USES
CROP PRODUCTION
PLANT GROWTH
LIME IS USED ON THE SOIL AS A
GRANULATING AGENT BY
NEUTRALIZING AGENT FOR
DETOXICATING AGENT BY PRECIPITATION
PLANT FOOD AS A
PHYSIOLOGICAL REGULATING AGENT AS FOR
FLOCCULATING FOR
ARTIFICIAL ACIDITY FOR
ALUMINUM SALTS FOR
IRON SALTS FOR
DIRECT FOOD FOR
PHOTOPLASM ACTIVITY FOR
FOOD TRANSFER
NUMUS GRANULATION FOR
NATURAL ACIDITY FOR
ALUMINUM SALTS FOR
FOOD CARRIER FOR
CELL RIGIDITY FOR
FIELD TRUCK AND ORCHARD CROPS
CROP PROTECTION
GARNERED CROPS
GROWING CROPS
INSECT REPELLING AGENT AGAINST
DISINFECTANT CARRIER AGAINST
REGULATING AGENT AGAINST DISEASE
LIME IS USED AS SUCH AGAINST
WEEVIL
FUNGI
CORN ROOT ROT
VEGETABLE CLUB ROOT
ADHESIVE AGENT LIME IS USED AS SUCH IN
COMPOUNDING AGENT LIME IS USED AS SUCH IN
SP. RAYS SUCH AS
INSECTICIDES SUCH AS
FUNGICIDES SUCH AS
PDISONS SUCH AS
PARIS GREEN AGAINST
ARSENATES AGAINST
LIME SULPHUR FOR USE AGAINST
LIME SULPHUR FOR USE AGAINST
CHEWING INSECTS
BORDEAUX MIXTURE FOR USE AGAINST
CALCIUM ARSENATE FOR USE AGAINST
SAN JOSE SCALE
SCAB
BLACK KNOT
PEACH SCALE
LEAF CURL
FLEA BEETLE
COTTON BOLL WEEVIL
OYSTER SHELL SCALE
SCURFY SCALE
BITTER POT
BROWN ROT
POTATO BEETLE
LIVE STOCK PRODUCTION
ANIMAL GROWTH
LIME SERVES AS A
BONE BUILDING AGENT IN
METABOLIZING AGENT IN
TEETH BUILDING AGENT IN
CONDITIONING AGENT IN
MINERAL MIXTURE AND LEGUMINOUS FEED
ANIMAL PROTECTION
LIME SERVES AS A
MEDICINAL AGENT
DISEASE RESISTING AGENT AGAINST
TUBERCULOSIS
ABORTION
ANIMAL PRODUCTS
LIME IS USEFUL IN THE PRODUCING OF
MEAT BY INCREASING
DAIRY PRODUCTS
EGGS AS AN
ANIMAL GROWTH
MILK AS A
BUTTER AS A
EGG PRESERVING AGENT
NEUTRALIZING AGENT
NEUTRALIZING AGENT
FAT CONSERVING AGENT
SHELL FORMING AGENT
DIRECT FOOD
PRESERVING AGENT FOR
FLAVOR
COMPOSITION
INHIBITING AGENT
LIME IS USED TO PREVENT EXCESS ACTION OF
SPRAYS SUCH AS
WASHES SUCH AS
DUSTS SUCH AS
WHITE WASH AGAINST
LIME MIXTURES AGAINST
BORDEAUX-LIME SULPHUR AGAINST
EARLY BUDDING
FOLIAGE BURNING
BURNING SEEDLINGS
FOLIAGE BURNING
CATALYTIC PROCESSES
LIME IS USED AS A CATALYST IN
OXIDATION IN MAKING
VULCANIZATION IN THE
RUBBER INDUSTRY
REDUCTION OF CHROMIUM OXIDE WITH CARBIDE IN THE
CHLORINE IN THE
PEROXIDATION OF ALKALIS IN THE
METALLURGICAL INDUSTRY
WELDON CHLORINE INDUSTRY
ALKALI INDUSTRY
NITROGEN FIXATION IN MAKING
ESTERIFICATION OF GLYCERINE WITH TUNG OIL IN THE
HYDROGENATION OF NITROGEN IN THE
CALCIUM CYANAMIDE IN THE
ORGANIC CHEMICAL INDUSTRY
NITROGEN FIXATION INDUSTRY
FERTILIZER INDUSTRY
FOOD
LIME SERVES AS SUCH FOR
MAN IN
PLANTS IN
ANIMALS IN
BONE BUILDING AFFECTING
METABOLISM AFFECTING
DIRECT FOOD AFFECTING
FOOD PRESERVATION
GROWING AND MANUFACTURE OF FOODS AFFECTING
PREPARATION OF FERTILIZERS AFFECTING
MAKING OTHER FOODS AVAILABLE AFFECTING
GROWTH
HEALTH
REPRODUCTION
FOOD PRODUCTION
MEDICINE
LIME IS USED IN MAKING
LIME SYRUP FOR USE AS
PURIFIED MINERAL OILS FOR USE AS
SALVES ETC.
PALM OIL IN MAKING
COAL IN MAKING
ANTHRAQUINONE IN MAKING
ACID CORRECTOR AND BONE BUILDER
VEGETABLE OIL DEODORIZER
COAL BRIQUETTES
CALCIUM TANNATE FOR USE AS A
LIME WATER FOR USE AS A
DYE INTERMEDIATES
CURE FOR DYSENTERY
TREATMENT OF SOUR STOMACH
SKIN DISINFECTANT
MILK OF MAGNESIA FOR USE AS
ACID CORRECTOR
LIME DUST FOR USE AGAINST
CALCIUM SULPHONATE FOR USE AGAINST
TUBERCULOSIS
NIGHT SWEAT
PURIFICATION OF MATERIALS
LIME IS USED IN PURIFYING
MISCELLANEOUS MATERIALS SUCH AS
ILLUMINATING GAS AS AN
GLYCERINE WATER AS A
INORGANIC COMPOUNDS SUCH AS
ABSORBING AGENT FOR
PRECIPITATING AGENT FOR
EPSOM SALTS
SODIUM CHLORIDE
SULPHUR DIOXIDE HYDROGEN SULPHIDE HYDROGEN CYANIDE
SOAP INDUSTRY
GLAUBERS SALTS
BORAX
CELLULOSE FOR REMOVING DEXTRINE IN THE
AMMONIUM SULPHATE
MINERAL OILS AS
FERRO-CHROMIUM AS A
PAPER INDUSTRY
ORGANIC COMPOUNDS SUCH AS
CAFFEINE
DESULPHURIZING AGENT IN THE
DECARBONIZING AND DESILICIZING AGENT IN THE
PETROLEUM INDUSTRY
METALLURGICAL INDUSTRY
PULP CLOTH INDUSTRY
DYE INTERMEDIATES
UTILIZATION OF BY-PRODUCTS
LIME IS USED IN MAKING
FERRO-CYANIDES FROM SPENT
GAS PURIFYING MATERIAL IN
ILLUMINATING GAS INDUSTRY
FERTILIZERS FROM
MOLASSES
YEAST WASTE
TANNERY LIQUOR
LEATHER INDUSTRY
SUGAR INDUSTRY
MINING INDUSTRY
BRICK FROM BY-PRODUCT
SILICATE IN
ASHES IN
SLAG IN
POTASH INDUSTRY
POWER PLANT INDUSTRY
METALLURGICAL INDUSTRY
PAPER FROM
CORN COBS IN
AGRICULTURAL INDUSTRY
HYDROGEN CYANIDES FROM WASTE
ORE LIQUORS IN
MINING INDUSTRY
COAL BRIQUETTES FROM
COLLIERY WASTE IN
COAL MINING
SACCHARIFIED CELLULOSE FROM
SAW DUST IN
LUMBER INDUSTRY
BLEACHING POWDER FROM
CHLORINE IN
ELECTROLYTIC ALKALI INDUSTRY
IRON FROM
SCRAP IRON IN
METALLURGICAL INDUSTRY
AMMONIA FROM
BEET RESIDUE IN
CEMENT FROM
PRESS CAKE IN
CALCIUM SACCHARATE FROM
WASTE MOLASSES IN
ALCOHOL FROM
SUGAR INDUSTRY
PAPER FROM
OAT HULLS IN THE
COTTON LINTERS IN THE
BAGASSE IN THE
ACETONE FROM
METHYL ALCOHOL FROM
ETHYL ALCOHOL FROM
DECOLORIZING CARBON FROM
SODIUM ACETATE FROM
CALCIUM COMPOUNDS FROM
WASTE SULPHITE LIQUOR
SODA PULP IN
GASES LIQUIDS SOLIDS IN
PAPER INDUSTRY
MISCELLANEOUS INDUSTRIES
SANITATION
WATER SUPPLIES
LIME IS USED IN
FILTRATION AS A
DEODORIZATION AS A
DEFERRIZATION AS A
SEDIMENTATION AS A
PRECIPITATING AND ABSORBING AGENT IN
CHEMICAL & COAGULATING AGENT IN
PRECIPITATING AND COAGULATING AGENT
COAGULATING AND CLARIFYING AGENT IN
LIME ALUM PROCESS
LIME IRON SULPHATE PROCESS
LIME ALUM PROCESS
LIME AERATION PROCESS
SEDIMENTATION PROCESSES
ACID WATER NEUTRALIZATION AS A
SOFTENING AS A
BASE AND PRECIPITATING AGENT IN
NEUTRALIZING AND PRECIPITATING AGENT IN
LIME SODA PROCESS
ACID MINE & RIVER WATER PROCESSES
INTERMITTENT
CONTINUOUS
COMBINED WITH HEATER AND ZEOLITE
SEWAGE
LIME IS USED IN
CHEMICAL PROCESSES LIME EFFECTS
ELECTROLYTIC LIME PROCESS LIME EFFECTS
CLARIFICATION AS A
REMOVAL OF BACTERIA AS A
OXIDATION OF ORGANIC MATTER AS A
IONIZATION AS AN
ELECTRODE PASSIVITY AS A
COAGULATING AGENT
DISINFECTING AGENT
CATALYTIC AGENT
IONIZING AGENT
CHEMICAL AGENT
REMOVAL OF BACTERIA AS A
DEODORIZATION AS A
DISINFECTING AGENT
CATALYTIC AGENT
MISCELLANEOUS PROCESSES SUCH AS
CLARIFICATION AS A
COAGULATING AGENT
REMOVAL OF MANGANESE
AERATION PROCESSES
COMBINATION WITH OTHER PROCESSES
MISCELLANEOUS
LIME IS USED IN
GARBAGE DISPOSAL LIME SERVES TO
COMBATING FLIES LIME SERVES TO DESTROY
DESTROYING CHIGRES AND GERMS IN
REMOVING PHENOL FROM WATER
DEAERATION OF WATER WITH
MANUFACTURE OF SANITARY SUPPLIES SUCH AS
DISPOSAL OF TRADE WASTE WATERS
RECOVER AMMONIA
INCREASE FERTILIZER VALUE
UNSANITARY BREEDING PLACES
CHICKEN HOUSES
CESS POOLS
BARNS
WITH LIME IRON SULPHATE AND OZONE
LIME AND IRON SULPHATE
WATER CLARIFYING REAGENTS
CHEMICAL WORKS


CHEMICAL USES (CONTINUED)
RAW MATERIAL IN THE MANUFACTURING INDUSTRIES
LIME IS USED AS SUCH IN PROCESSES OF
HIGH PRESSURE PROCESSES
LIME IS USED IN
AQUEOUS DIGESTION
WITH
HYDROCARBONS IN MAKING
SILICA IN MAKING
PEAT TAR AND COAL IN MAKING
GREEN SAND & FELDSPAR IN MAKING
CARBON DIOXIDE IN MAKING
NAPTHENATES IN MAKING
DIRECT LIME SAPONIFICATION OF FATS IN MAKING
REFINED OILS IN THE
HYDRO-CARBON SOAPS IN THE
SAND LIME BRICK IN
ARTIFICIAL FUEL IN
POTASH IN THE
MAGNESIUM CARBONATE IN THE
SICCATIVES IN THE
CANDLES SOAPS & GLYCERINE IN MAKING
ENRICHED & PURIFIED WATER GAS
PETROLEUM BY-PRODUCTS INDUSTRY
BUILDING MATERIAL INDUSTRY
PEAT AND COAL INDUSTRY
FERTILIZER INDUSTRY
INORGANIC CHEMICAL INDUSTRY
GLUE INDUSTRY
SOAP INDUSTRY
DISTILLATION
LIME IS USED IN THE DISTILLATION OF
COAL IN MAKING
OIL SHALE IN MAKING
GAS WORKS LIQUORS IN MAKING
PYROLIGNEOUS ACIDS IN MAKING
MON CORROSIVE GAS
METHYL ALCOHOL IN
ACETONE IN
CALCIUM ACETATE IN
ACETIC ACID IN
FERRO CYANIDES
AMMONIA
WOOD DISTILLATION
CAUSTICIZATION
LIME IS USED IN THE CAUSTICIZATION OF
HYDROLYSIS
LIME IS USED IN MAKING
DEHYDRATION
LIME IS USED TO DEHYDRATE
SAPONIFICATION
LIME IS USED TO SAPONIFY
SULPHATES TO FORM
CARBONATES TO FORM
PHOSPHATES TO FORM
HYDROLIZED GLUE FOR USE IN
AMMONIA FROM
PULP CLOTH FROM
ALCOHOL IN THE
FATS, WAXES & GREASES IN MAKING
OILS IN MAKING
ORGANIC SALTS IN MAKING
ALKALI HYDROXIDES IN MAKING
PRE-VULCANIZATION TREATMENT OF RUBBER
ALUMINUM NITRIDE
CELLULOSE
INDUSTRIAL ALCOHOL INDUSTRY
CLEANSED WOOL IN THE
PAINTS IN THE
LUBRICATING GREASES IN THE
TAR PRODUCTS IN THE
ORGANIC HYDROXIDES IN THE
SODA AND SULPHATE PULP
ALKALI SALTS IN THE
HYPOCHLORITES IN THE
ORGANIC SALTS IN THE
SOAP INDUSTRY
PETROLEUM IN
GREASES IN
MERCERIZED CLOTH IN THE
SOAP IN THE
GLUE IN THE
GLYCERINE IN THE
PAPER INDUSTRY
INORGANIC CHEMICAL INDUSTRY
TEXTILE INDUSTRY
BLEACHING INDUSTRY
PETROLEUM REFINING
ANIMAL PRODUCTS INDUSTRY
PETROLEUM INDUSTRY
DYE AND ORGANIC CHEMICAL INDUSTRY
COAGULATION
LIME IS USED IN
ABSORPTION OF GASES
LIME ABSORBS
CLARIFYING TURBID WATERS IN MAKING
SETTLING ORE SLIMES IN MAKING
DEFECATING SUGAR JUICES IN
CLARIFYING SORGHUM JUICE IN THE MAKING OF
FLOCCULATING CLAY IN MAKING
ACETIC ACID FORMING
CHLORINE FORMING
OXIDES OF NITROGEN FORMING
CARBON DIOXIDE FORMING
SULPHUR DIOXIDE FORMING
ARTIFICIAL ICE IN THE
PRECIOUS METALS IN THE
CARBONATION PROCESS IN MAKING
SULPHITATION PROCESS IN MAKING
SORGHUM IN THE
MOLASSES INDUSTRY
COMPOUNDING INGREDIENTS IN THE
ACETATE OF LIME IN
BLEACHING POWDER IN
ALKALI HYPOCHLORITES IN
CHLORATES
LIME NITROGEN SALTS IN
CALCIUM CARBONATE IN
LIME BISULPHITE IN
LIME SULPHITES IN
RUBBER INDUSTRY
WOOD DISTILLATION INDUSTRY
SUGAR REFINING
NITRIC ACID INDUSTRY
CARBONATION PROCESS IN
BISULPHITE PAPER INDUSTRY
REFRIGERATION INDUSTRY
MINING INDUSTRY
CANE AND BEET SUGAR IN
SUGAR REFINING INDUSTRY
ELECTROLYTIC ALKALI INDUSTRY
MAGNESIA INSULATING INDUSTRY
PHENOL MFG
INORGANIC CHEMICAL INDUSTRY
PRECIPITATION
LIME SERVES TO PRECIPITATE
MISCELLANEOUS
LIME IS USED AS A
SOLUTION
LIME DISSOLVES THE
LUBRICANTS AND WATERPROOFING MATERIAL SUCH AS
COLLODIAL PIGMENTS SUCH AS
ABSORPTION MEDIA SUCH AS
RARE EARTH OXIDES IN THE
ALUMINUM COMPOUNDS IN MAKING
METALS IN
FILLING AGENT IN MAKING
CEMENTING MATERIAL IN NIDES IN THE
SULPHUR AND PHOSPHORUS AS A SLAG IN THE
CASEIN IN THE
GLUE INDUSTRY
LIME SOAPS IN THE
SATIN WHITE IN THE
CALCIUM CARBONATE
CALCIUM PHOSPHATE
CALCIUM SULPHITE IN
CERIUM INDUSTRY
CLEANING MIXTURES
ORE EXTRACTION
RUBBER
LINOLEUM
TANNING INDUSTRY
METALLURGICAL INDUSTRY
ALKALOIDS SUCH AS
STABILIZING AGENT IN MAKING
PAPER
UNHAIRING AGENT IN MAKING
SOAP INDUSTRY
PAINT INDUSTRY
SUGAR CLARIFICATION
CODEINE
THEBAINE
NICOTINE
BLEACHING POWDER
LEATHER
MOROCCO
NEUTRALIZATION OF ACIDS
LIME NEUTRALIZES
HIGH TEMPERATURE PROCESSES
LIME IS USED AS SUCH
ACIDS IN GENERAL FORMING
RESINOUS ACIDS IN MAKING
ACID ORES IN
EXCESS INORGANIC ACIDS IN MAKING
ORGANIC ACIDS IN MAKING
TAR OIL ACIDS FORMING
ACID SALTS IN
CITRIC ACID IN MAKING
ARSENIC ACID IN MAKING
ACIDS IN DRIED LEATHER IN MAKING
RESIDUAL ACIDS IN MAKING
PICKLING ACIDS IN MAKING
MAGNESIUM CALCIUM SALTS IN
VARNISH IN
ENAMELS IN
STABILIZING MEDIA FOR
PAINT INDUSTRY
ORE FLOTATION IN THE
CYANIDING IN THE
NITROGLYCERINE AND SMOKELESS POWDER
ALBUMIN FROM PLANTS IN THE
LIME SOAP IN THE
PURIFIED SUGAR JUICES IN
CARBONIZING TEXTILES IN
CALCIUM CITRATE IN
CALCIUM ARSENATE IN
HARDENING LEATHER IN THE
KEENE'S CEMENT IN THE
STEEL PLATES IN THE
INORGANIC CHEMICAL INDUSTRY
LIQUID FUELS
MINING INDUSTRY
EXPLOSIVE INDUSTRY
ORGANIC CHEMICAL INDUSTRY
CANDLE INDUSTRY
SUGAR INDUSTRY
TEXTILE INDUSTRY
CITRATE INDUSTRY
INSECTICIDE INDUSTRY
PATENT LEATHER INDUSTRY
GYPSUM INDUSTRY
IRON INDUSTRY
SULPHONATED NAPTHALENE INTERMEDIATES
PHENOL
SULPHONATED ANTHRACENE IN THE
LITHOPHONE IN THE
SIZES IN THE
WATER CLARIFYING REAGENT
CELLULOSE CATTLE FOOD
ZINC & COPPER ORE LEACHING
LUBRICATING INDUSTRY
OIL CLOTH INDUSTRY
PAINT INDUSTRY
ROOFING MATERIAL IN
BITUMINOUS PAINTS IN
LUBRICANTS IN
SULPHONATED DETERGENTS IN
DYE INDUSTRY
TANNING INDUSTRY
PAINT INDUSTRY
PAPER INDUSTRY
SANITATION INDUSTRY
WOOD BY-PRODUCTS INDUSTRY
MINING INDUSTRY
HYDRO-CARBON INDUSTRY
BAKING AS WITH
CALCINATION AS IN THE
FUSION AS WITH
OXIDATION FORMING
ELECTROLYTIC AS IN THE
ELECTRO-THERMIC AS IN THE
LUBRICATION OF
FLUXING IN THE
CLAY AND FELDSPAR IN MAKING
TARRY MATERIAL IN MAKING
KIESELGUHR AND SAND
BRICK IN MAKING
DEAD BURNING OF DOLOMITES TO FORM
SILICA TO FORM
GLASS IN
ALKALI HYDROXIDES TO FORM
CHROMITE TO FORM
CLAY & BARIUM COMPOUNDS TO FORM
OXIDES OF CARBON IN MAKING
ELECTROLYSIS OF FUSED COMPOUNDS TO FORM
METALLURGICAL REFINING TO MAKE
DIES IN MAKING
BASIC OPEN HEARTH PROCESS FOR REFINING
ZINC ORE ROASTING IN MAKING
BAKING PROCESS IN MAKING
DECOLORIZING CARBON IN THE
COLORED BRICK IN THE
CALCIUM CARBIDE
SILICA BRICK IN THE
DOLOMITE REFRACTORIES IN
ALKALI PEROXIDES
CALCIUM CYANAMIDE IN
CALCIUM SILICIDE IN
MAGNESIUM IN
METALLIC CALCIUM IN
STEEL WIRE IN
STEEL IN
ZINC IN
POTTERY AND PORCELAIN IN THE
SODA LIME IN
CHROMATES IN
ALUMINA & BARIUM PRODUCTS IN
STEEL IN
NICKEL IN
COPPER IN
POTTERY IN THE
CERAMIC INDUSTRY
COAL BY-PRODUCTS INDUSTRY
REFRACTORIES INDUSTRY
CERAMIC INDUSTRY
INORGANIC CHEMICAL INDUSTRY
FERTILIZER INDUSTRY
METALLURGICAL INDUSTRY
CERAMIC INDUSTRY
GENERAL UTILITY
HOME
LIME IS USED FOR
LABORATORY
LIME IS USED AS A
HOSPITAL
LIME IS USED FOR
FACTORY
LIME IS USED FOR
MINE
LIME IS USED FOR
OUT HOUSE SANITATION
PRESERVING EGGS
GARDEN AND LAWN
FOOD AND MEDICINE
WHITE WASH
FUEL INGREDIENTS
GAS ABSORBING AGENT
DEHYDRATING AGENT
CHEMICAL SYNTHESIS
REAGENT
DISINFECTING OF WATER & SEWAGE
WHITE-WASHING
MEDICINES
SANITATION
DISINFECTING
WHITE-WASHING
RAW MATERIAL
NEUTRALIZING ACID WATERS
ORE FLOTATION
FLUXING OPERATIONS
WHITENING MINE WALLS
MISCELLANEOUS
LIME IS USED IN
SCOURING OF
COOKING OF
BRIQUETTING OF
CLEANSING OF
WELDING
LIME IS USED FOR
ILLUMINATING
LIME IS USED FOR
RUST PREVENTING
RECTIFYING OF
MORDANTING IN THE
GLASSIFICATION OF
RECLAIMING PAPER STOCK FROM
RAGS IN
TEXTILES IN
METALS IN
VEGETABLE MATTER IN THE
ANIMAL MATTER IN THE
IRON ORE IN THE
VEGETABLE MATERIAL IN MAKING
ACID CONTAINERS SUCH AS
UNSANITARY CONTAINERS SUCH AS
METALS FOR
ELECTRODE COATING
WELD REGULATING
REJUVENATING SPENT PURIFYING MATERIAL IN
LIME LIGHT IN
GAS PURIFICATION
METALS IN
PINE PITCH FOR
DYEING INDUSTRY
GRAIN IN THE
PAPER INDUSTRY
PYEING INDUSTRY
ELECTRO PLATING INDUSTRY
DYE INDUSTRY
PAPER INDUSTRY
GLUE INDUSTRY
SMELTING INDUSTRY
FUEL
CIDER BARRELS
GARBAGE CANS
POLISHING
ELECTRIC ARC WELDING
GAS INDUSTRY
PLATING INDUSTRY
GENERAL
OREFLOTATION
MILLING INDUSTRY
NEWSPAPERS
FABRICATION OF
SODA LIME
MAGNESIUM FLASH LIGHT POWDERS
TRICHLORETHYLENE
BUFFING AND POLISHING COMPOUND
PHOSPHORESCENT MIXTURES
PHARMACEUTICALS
CAMPHOR
FIBROUS COMPOSITIONS
HYDRAULIC CEMENT
OXYCHLORIDES SUCH AS "CAL"
CHLOROPICRIN
CRUCIBLES
CALCIMINE
PHENOLIC ALDEHYDE
C.P. CALCIUM MAGNESIUM SALTS
PHENOLCONDENSATION PRODUCTS
OXIDIZED TURPENTINE
TUNGSTEN AND MOLYBDENUM COMPOUNDS
CALCIUM LIGHT PENCILS
CACAO
PLASTIC COMPOUNDS
ARTIFICIAL STONE
GAS MANTLES
BASIC ALKALINE EARTH COMPOUNDS
85% MAGNESIA
PHOTOSENSITIZER

varnishes and enamels. Certain liquid fuels are stabilized with products made by the neutralization of resinous acids with lime. In the mining industry lime is used for the neutralization of acid ores both in the process of ore flotation and cyaniding and in neutralizing excess leaching acids. Pickling acids in the steel industry are neutralized with lime, as is also residual acid in the manufacture of Keene's cement. The manufacture of patent leather involves a hardening process which may require the neutralization of acids in the dried leather with lime. The insecticide calcium arsenate is made commercially by neutralizing arsenic acid with lime. Lime is used as a neutralizing agent in the manufacture of calcium citrate and citric acid. The neutralization of tar acids with lime is involved in the manufacture of certain kinds of roofing material, bituminous paints, lubricants and sulphonated detergents. Organic acids are commercially neutralized with lime in purifying sugar juices and in making lime soaps, the latter being used in making candles, lubricants, oilcloth and paint. The practice of using lime to neutralize excess acids enters into a large number of industrial processes, of which may be mentioned the making of phenol and sulphonated naphthalene intermediates in the dye industry, synthetic tanning materials in the tanning industry, lithopone in the paint industry, sizes in the paper industry, water-clarifying agents for use in sanitation, cellulose cattle food in the wood byproducts industry, zinc and copper ore leaching in the mining industry, the extraction of nicotine from tobacco, the manufacture of albumen from plants and the manufacture of nitroglycerine and smokeless powder from cellulose.

Sanitation

The uses of lime in sanitation may be grouped under three main heads—viz., the treatment of water supplies, the treatment of sewage and miscellaneous sanitary uses. Treatment of sewage may be either the direct chemical process or the electrolytic-lime process. In the direct chemical process the action of the lime is chiefly that of clarification, the removal of bacteria and possibly the oxidation of organic matter. In the electrolytic-lime process lime effects ionization, electrode passivity, deodorization, clarification and indirectly the removal of bacteria. In the treatment of water supplies lime is used as a precipitating and absorbing agent in deferrization processes and processes of ordinary filtration. It is used also as a precipitating, coagulating and neutralizing agent in water-softening processes. The treatment of the water supplies with lime also includes the neutralization of acid waters and such other miscellaneous processes as the aëration process and the ordinary sedimentation process. The miscellaneous sanitary uses of lime include its use in the disposal of trade waste waters, the manufacture of water-clarifying agents, the destroying of chigres and germs such as in chicken houses, the combating of the fly nuisance by destroying unsanitary breeding places, and the disposal of garbage by processes which provide for the recovery of ammonia.

Purification of Materials

Certain inorganic compounds such as epsom salts, sodium chloride, glaubers salts, borax and ammonium sulphate may be purified by the use of lime. In the soap industry, glycerine water is purified by the use of lime as a precipitating agent. In the purification of illuminating gas, lime functions as an absorbing agent for such materials as sulphur dioxide, hydrogen sulphide and hydrogen cyanide. Caffeine and dye intermediates are examples of organic compounds which may be purified with the use of lime. In the metallurgical industry lime is used as a purifying agent for ferrochromium, the lime functioning as a decarbonating and desilicizing agent. The basic open-hearth process for steel involves the use of lime as a purifying agent. In the petroleum industry lime may be used for the desulphurizing of mineral oils. In the purification of palm oil lime functions as a deodorizing agent. The treatment of coal with lime in the manufacture of coal briquets may be considered a process of purification.

Food

Lime functions as a food for man, plants and animals, affecting growth, health, reproduction and food production. It functions in the growing and manufacture of food, in the manufacture of fertilizers, in preserving food, in making other foods available, in bone and teeth building and in metabolism in general.

Catalytic Processes

Lime enters into certain chemical processes which may be considered catalytic. In the vulcanization of rubber lime serves as a carrier of sulphur. Lime may be used in the contact mass which is used in the hydrogenation of nitrogen in the nitrogen fixation industry. In the reduction of chromium oxide with carbide lime catalytically affects the reaction. In the manufacture of calcium cyanamide from carbide an excess of lime facilitates the reaction. The peroxidation of alkalis is catalyzed with lime.

Utilization of Byproducts

The metallurgical industry makes use of lime as a fluxing agent in the recovery of scrap iron. This industry also makes use of lime in the disposal of byproduct slag in making building brick. In the electrolytic alkali industry byproduct chlorine is recovered by absorption with lime, forming bleaching powder. In the lumber industry byproduct sawdust is saccharified with acids in making cattle feed and lime is used in the neutralization of the excess acid. In the mining industry waste ore liquors may be treated with lime for the recovery of hydrogen cyanide. Potash feldspar quarry waste may be used with lime in the manufacture of fertilizers. In the coal-mining industry, colliery waste is admixed with lime and made into coal briquets. In the manufacture of potash from greensand the byproduct silicates are utilized with lime in making building brick. Brick may also be made by the use of lime and coal ashes or blast-furnace slag. In the manufacture of illuminating gas the waste gas-purifying material may be treated with lime in the recovery of ferrocyanide. The sugar industry makes use of lime in the recovery of ammonia from beet residue, in the manufacture of cement from press cake and in the manufacture of calcium saccharate, alcohol and fertilizers from waste molasses. Waste tannery liquor is utilized with lime in making fertilizers. Corncobs are utilized in the manufacture of paper which involves the use of lime for neutralizing excess acids. In the paper industry the use of lime is involved in the recovery of acetone, methanol, ethyl alcohol and decolorizing carbon from waste sulphite liquor and sodium acetate from waste soda pulp liquor.

The general utility of lime extends to the home,

laboratory, hospital, factory and mine. In the mine, lime is used for the neutralization of acid mine waters, for the neutralization of ores in flotation processes, in fluxing operations and for the whitening of mine walls. In the factory, lime is used as a raw manufacturing material, as a cold water paint and for disinfecting and general sanitary purposes. In the laboratory, lime finds use in a large number of ways, including its use as a chemical reagent, as a dehydrating agent and as a gas-absorbing agent. Around the home, lime is used in whitewash and cold-water paints, it is used on the field, garden and lawn, for preserving eggs, for outhouse sanitation, as a fuel ingredient and as a food and medicine. In the hospital, lime finds use for general sanitary purposes.

Miscellaneous

Lime acts as a scouring agent in several industries, including the scouring of rags in the paper industry, the scouring of textiles in the dyeing industry and of metals in electroplating processes. Lime is used in the cooking of certain materials such as animal matter in the manufacture of glue and of vegetable matter in the manufacture of paper and dyes. The briquetting of iron ore in the smelting industry involves the use of lime, as does also the briquetting of such vegetable matter as lignite in making fuel. Lime is used as a cleansing agent for wooden containers such as cider and oil barrels, for metals of various kinds as a preliminary to the polishing process and it serves as a cleanser for unsanitary containers such as garbage cans. In electric welding, lime serves as a weld regulator and coating for the electrodes. In illumination, lime is used directly in the limelight and as a gas-purifying material in the gas industry. Lime serves to retard rusting of metals such as iron under certain conditions. In ore flotation pine oil may be rectified with lime. Lime is sometimes used in the dye industry for mordanting, particularly in logwood and turkey red dyeing. The milling industry makes use of lime to remove smut spores and thereby improve the grade of the grain.

The miscellaneous uses of lime include the fabrication of a large number of products, some of the more important of which are phenolic aldehyde, photosensitizers, calcimine, crucibles, 85 per cent magnesia, chlorpicrin, basic alkaline earth compounds, alkaline earth oxychlorides, gas mantles, hydraulic cement, artificial stone, fibrous composition, camphor, cacao, pharmaceuticals, calcium light pencils, phosphorescent mixtures, tungsten and molybdenum compounds, buffing and polishing compounds, oxidized turpentine, trichlorethylene, magnesium flashlight powder, soda-lime, calcium and magnesium salts, antiseptics, quick drying varnishes, and carbonizers for metals.

Construction Uses

The lime industry had its birth in its construction uses. The most ancient record of the use of lime is as a mortar and plaster. The development of the art of lime manufacture and of its use in construction was well on its way before our technical manufacturing industries began to develop. As a result of this time element we find the art of the construction uses of lime in a relatively advanced state compared with the other uses. Although the construction uses of lime are not numerous, yet the tonnage is very important. In 1918, about 28½ per cent of the lime manufacturers' tonnage was for construction uses. In recent years this percentage has increased somewhat. With the improvements in the quality of material, the standardization of the product and the development of new construction materials, this use of lime bids fair to thrive, especially in the next few years.

Mortar

The use of lime in mortar is the most impotrant one in the construction field. It is used in brick mortar, tile mortar and stone mortar, both in the form of gaged and straight lime mortar. In these materials, lime performs functions which have been explained in various ways. Lime serves as a bonding agent by taking on a stone-like set through the process of recarbonation and thereby, with the intermixed sand, not only binds the main elements of the structure but also fills the larger voids. Limes of various kinds perform varying degress of plasticizing action in the wet mortar, affecting the ease with which it is spread. Characteristic also of lime mortar is a certain resiliency or elasticity which has been expressed by attributing to lime the function of a toughening agent.

Plaster

Lime is used in the scratch coat, brown coat and finish coat of plaster. These may either be straight lime or gaged plaster in which lime serves as a bonding agent, whitening agent, plasticizing agent and as a sound-deadening agent.

Concrete

Lime is used in both cement and asphaltic concrete. In asphaltic concrete lime serves as a hardening agent, filling agent and cooling agent. In cement concrete, lime serves as a hydrating agent, plasticizing agent, strengthening agent, water-tightening agent and whitening agent, and as a physical stabilizing agent to prevent segregation.

Stucco

There are three kinds of stucco—viz., straight lime and gaged stucco and sorrel cement. In the first two, lime serves as a bonding agent, plasticizing agent, toughening agent and water-tightening agent. In sorrel cement the action of lime is primarily chemical instead of physical.

Sand-Lime Brick

The function of lime in the manufacture of sand-lime brick is much the same as that of the other construction uses—viz., bonding (both physical and chemical), strengthening, whitening, hydration and neutralization.

Cold-Water Paints

Cold-water paints are conveniently divided into whitewash and complex paints. In these products lime serves as a protecting agent against wind and weather, as a pigment, as a hardening agent, as a cementing agent and as a rust-preventing agent. In certain of the complex paints it enters into chemical reactions such as the saponification of oils, the precipitation of phosphates, fluorides, etc., and in the solution of siccatives.

Agricultural Uses

The agricultural uses of lime may be divided into two main divisions—viz., crop production and livestock production. In crop production, lime is made use of both in connection with plant growth and with crop protection. In livestock production lime is made use

of in connection with animal growth, animal protection and animal products.

Crop Production

Plant growth is affected by lime through its use on the soil. This use extends to field, truck and orchard crops, in connection with which it performs a number of functions. It corrects active free acid and thereby a chain of effects results, including the promotion of organic decay, nitrogen fixation and nitrification by organisms. It serves as a granulating agent by flocculation of colloids, both inorganic and organic, thereby improving the soil tilth with the long chain of physical benefits that result from such a change. It serves as a detoxicating agent by its action in precipitating aluminum and iron salts. Inside of the plant it serves as a direct plant food and as a physical regulating agent by its effect on food transfer, cell rigidity and protoplasm activity.

Crop protection with the use of lime extends to both the growing crop and the garnered crop. The use of lime in the protection of garnered crops involves its action as a disinfectant carrier against fungi and as an insect-repelling agent against weevil.

The protection of growing crops by lime enters into a number of ramifications in which it performs four important and distinct functions. Lime serves as an adhesive agent in sprays, such as paris green and the arsenates for use against chewing insects. Lime is used directly as a regulating agent against such diseases as corn root rot and vegetable clubfoot. Lime performs the function of an inhibiting agent against excess action of such sprays, washes and dusts, as whitewash, lime mixtures and bordeaux lime-sulphur, which are used in preventing foliage burning, seedling burning and early budding.

The most important use of lime, however, in crop protection is as a compounding ingredient for insecticides, fungicides and poisons such as lime sulphur, bordeaux mixture and calcium arsenate respectively. These materials are used in combating the San José scale, oystershell scale, scurfy scale, scab, black-knot, bitter-root, peach scale, brown rot, leaf curl, flea-beetle, potato-beetle and cotton-boll weevil.

Livestock Production

Animal growth is affected by lime through its use in feed both leguminous food and mineral mixtures wherein lime functions as an agency for bone building, conditioning, metabolism and teeth building. It affects animal protection both as a medical agent and as a disease-resisting agent against tuberculosis and abortion. The animal products that are affected by the use of lime are dairy products and eggs. Lime is a shell-forming agent and thereby affects the production of eggs. In the form of lime water it is a preservative for eggs. The manufacture of butter employs the use of lime as a milk food, and as a neutralizing agent for sour cream. It is also thought to function as a preserving agent for flavor and composition.

Closure

This review of the functions that lime performs in its numerous uses indicates that it is a most remarkable chemical. It is doubtful if there is any other chemical that is used in such a large number of diverse processes. In the construction uses of lime it performs at least seventeen different functions. In its agricultural uses it performs at least nineteen different functions. In its chemical uses it functions in a very much larger number of ways. Not only is lime as a chemical characterized by the large number of functions it performs but, what is more important, by the exceedingly diverse nature of its functional capacity. It is used as an oxidizing agent and as a reduction agent, it is used as a dissolving agent and a precipitating agent, it is used for the absorption of gases and for the expulsion of gases, in one form it acts as a dehydrating agent and in another form as a hydrolizing agent. Surely it is one of the most versatile of chemicals.

The nation is fortunately provided with an adequate supply of the raw materials for lime manufacture and with a lime industry adequately prepared to supply all demands with a high-grade standardized product. The industry can also produce various kinds of limes of widely varying chemical and physical properties. Lime is distinguished therefore not only by its versatility but by its cheapness, general availability and by its adaptability to the special requirements of its various uses.

What the industry needs is a larger tonnage outlet in the way of new and larger uses. It is the chemical engineer who can supply that tonnage. Fundamental research is needed on lime, its properties and uses under such headings as lime as a coagulating agent, lime as a dehydrating agent, etc. The field is a fertile one. The great potentiality of lime as a national asset has not been adequately realized.

Extent of Potash Deposits in Oil Fields

The discovery of potash in samples of salts recently received by the United States Geological Survey from new wells bored for oil at two additional localities in western Texas extends the area in which small amounts of potash salts are known to occur about 30 miles north and 50 miles east of the area of previous discoveries.

Starting from the Means well, which is close to the New Mexico-Texas line, in Loving County, about 20 miles west of the southeast corner of New Mexico, the boundary of the area in which potash in notable richness has been found in the red beds runs southward for 30 miles to well No. 1, or the river well of the Pitts Oil Co., about 8 miles east of Barstow, thence east by northeast 130 miles to the McDowell well in northern Glasscock County, and thence north by northwest 50 miles to the Burns well, in Dawson County, from which it returns in a west by southwest direction to the starting point. Indications have also been found in the Panhandle.

As all these wells were drilled for oil and the easily soluble salts were of secondary consequence to the drillers, the samples recently forwarded, like the samples previously received from this region and analyzed, were accompanied by scant data relative to the water in the wells, the length of time it had been in contact with the salts, the condition of casing, etc. So many unknown conditions must therefore be taken into consideration that it is impossible to say whether the potash-rich salts already analyzed represent beds several feet or only a few inches thick. Core-drilling will have to be done in order to answer these questions. However, those who are drilling for oil in this region are showing more interest in the possibility that potash may be found in their wells and are preserving better samples and furnishing fuller data.

Results Achieved by the Corrosion Committee British Institute of Metals

Failure of Brass Condenser Tubes in Marine Service Is Caused by Lodgment of Solids, Harmless in Themselves, but Which Trap Corrosive Substances Formed During the Inevitable Process of Slow General Thinning

By ERNEST E. THUM

IT IS rather difficult if not presumptuous to attempt to summarize the labors of the Corrosion Committee in a small space, since its investigations have been continuously under way for 10 years and its published reports cover 650 pages of the Institute's journal. The task is within reason only because but brief mention need be made of the early experiments, since they were much like groping in the dark. Current beliefs had first to be tested and discarded. Then a tremendous number of the ordinary "loss of weight" determinations were made before it became absolutely certain that this method was leading nowhere. Furthermore, some of the ideas strongly supported in the earlier reports have been greatly modified or even discredited by more precise work undertaken in later years.

Finally a carefully planned series of investigations disclosing the fundamental mechanism of the corrosion of brass was performed, and the information thus disclosed was used in interpreting the performance of new tubes in condensers operating under known circumstances.

In passing, it would be well to remark that the published results have been confined to that particular problem—that is, the corrosion of condenser tubes[1] in water. The searcher for information on corrosion should therefore consider the limitations of these publications, and translate their results to other situations with great circumspection.

In view of these circumstances, attention can be kept almost wholly upon the more recent reports. These confine themselves to the action of 70:30 brass condenser tubes in sea water and fresh water.

Organization of Research Activities

But first a word may be said about the organization. The founders of the Institute of Metals believed that its prime function would be to combine scientists, manufacturers and users in a joint quest for the reason why mysterious difficulties in the manufacture and use of alloys suddenly crop up, give no end of trouble and then as suddenly and mysteriously vanish. In view of the fact that many condenser tubes were apparently failing through corrosion after very short life, a committee was appointed and first met in May, 1910, under the chairmanship of Sir Gerard Muntz, to formulate ways and means to investigate that situation.

Mr. Bengough, then lecturer in metallurgy in the University of Liverpool, undertook to prepare a summary of the literature dealing with the corrosion of nonferrous alloys. He found that very few factors of the problem had been satisfactorily explained, and the first of his five reports—presented in September, 1911—was therefore confined to an exposition of the electrolytic theory of corrosion and a consideration of the possible causes of potential difference on the surface of an apparently uniform piece of metal.

Meanwhile the committee appealed for funds. Annual donations were made by the Institute, the Brass and Copper Tube Association, Lloyd's Register and various manufacturers, but with few exceptions the users of tubes refused to contribute on the ground that it was none of their affair, but that of the tube maker and the condenser manufacturer! An experimental plant, imitating carefully the details of a surface condenser on shipboard, was constructed at Liverpool University at a cost of about $1,000, but this was closed down after 9 months' running for the lack of operating funds. A figure between $3,000 and $4,000 financed the research up to 1917. Its investigations were then moved to London, enlarged under governmental auspices, and several problems connected with war work were submitted. The government donated £1,000 per year, and various manufacturers' associations more than duplicated that figure. With ampler funds, and the co-operation of many governmental and educational agencies, work has progressed along many lines, only a few of which can be mentioned here—indeed some of them are only indicated in the various reports.

Circumstances Surrounding Troublesome Condensers

One of the first requests made by the Corrosion Committee was for submission of defective tubes for examination, together with data on the service conditions. As a result many tubes were collected, but it was impossible to get more than a general idea of the problem in this manner, since the users could not define the surrounding circumstances with much clearness. To diagnose troubles, the consultant should know about the supply of cooling water—its chemical and mechanical analysis at seasonal variations and whether or not it is recirculated. He must know the metal comprising water mains, tubes and water ends; details of any attempted scheme of protection; the joint construction; whether tubes are often choked with sediment; the speed of cooling water and its temperature at outlet. Much information about the location of the trouble is needed: how soon did it occur; is it confined to a certain condition, to a few tubes in a certain part of one condenser, or to a localized part of a few tubes; is the steam properly deflected to all parts of the condenser; are the accessory parts also corroding? About the only way in which an investigator can be sure of getting this in-

[1] The following metals were used: Copper, zinc, aluminum, 70:30 brass, 61:39 brass (Muntz metal), 78:28:2 Pb special brass (Muntz "Nergandin"), 70:29:1 Sn Admiralty brass, 96:4 phosphor bronze and 92:8 copper-aluminum.

formation is to go to the plant himself, and this practice has lately been followed by the Corrosion Committee. In some cases fresh tubes have been placed and are under periodic inspection. At one power station an experimental condenser is in constant operation, and the Royal Navy has fitted half of a twin condenser with specially prepared tubes, under the committee's directions. From these commercial tests much reliable information will be forthcoming.

Study of Defective Tubes

Nearly all the brass tubes first submitted for examination had rapidly failed in service by corrosion at a few spots and in a manner which left behind more or less metallic copper, free of zinc. Depending upon past performance, a normal life to 50 per cent thinning was variously thought of as from 4 to 25 years, but it was common report that one shipment may show wide variations in durability (1 to 3). One 70:30 tube, taken from a trawler after 20 years' service, showed no trace of this apparent dezincification, and had lost not more than 0.05 mm. thickness. Such observations confirmed the general impression that localized attack was the culprit. Consequently it was essential to discover and remove the causes of pitting. The complexity of these causes may be inferred from the fact that if these same defective tubes were split, ground, polished and suspended in still sea water, they showed no localized dezincification. In 9 months the thickness had been uniformly reduced about 0.04 mm. and the pieces were covered by a film of dark brown copper oxide.

Despite the fact that concentrated attack was so early judged to be the damaging cause rather than general thinning (which indeed is always to be expected), it was not recognized until after the third report (1917) that repeated weighings of metallic samples would not answer the problem. Even when studying general thinning by non-selective attack, the actual amount of corrosion should be measured by the amount of metal disintegrated, which includes the metal passing into solution and remaining there, being redeposited as such, or being precipitated as an insoluble salt, the metal remaining on the sample in the form of oxide, and the metal lost by exfoliation. At present the total metal disintegrated is impossible to determine. A loss-of-weight experiment merely estimates the underlying metal plus the overlying scale. Successive weighings give no measure of the maximum penetration, the result becomes more inaccurate with time, and is subject to a great many uncertain factors. For instance, a table in the third report gives twelve duplicate experiments under conditions where only slow general corrosion at the rate of 0.05 mg. per sq.cm. per day was observed, but the average difference between pairs (supposedly identical) amounted to 19 per cent of the loss in weight. Determination of the minute amount of metal in the solutions and loose precipitate is difficult, and when used in calculations indicates only the weight of oxygen or other non-metallic products in the adherent scale. And finally the scale cannot be reduced or removed without affecting and destroying some of the underlying metal.

Those who still rely upon this kind of data may find a mine of information in the thousands of experiments on various kinds of condenser tubes published in the second and third reports.

Depth of pit is actually the most important consideration. Lacking some method of determining this, careful microscopic examination of the surface is the best method now known of attacking the problem of localized corrosion of 70:30 brass.

Protective Layers

Comparison of the 20-year old tube from the trawler with others which failed in less than that many months showed a very pronounced difference in the adhering scale. Early experiments also showed that the nature of the film first to form on the bright sample after immersion in sea water of various temperatures, aëration and dilution had a determining influence on the subsequent history of the experiment. In some cases this film will become darker with time, finally reaching a thickness of about 0.04 mm.; it is "glazed" in appearance and very tenacious. It does not seem to be wholly impervious to the corroding solution, since the metal in solution plus that in a loose precipitate gradually increases in amount. Yet it remains continuous and intact, and experiments extending nearly a year show the expected life of a tube with such a covering would be 15 to 20 years before 50 per cent thinning.

On the other hand, samples of metal of almost exactly the same composition, having no determinable differences in physical constitution or surface condition, when immersed in a companion beaker will first develop a film which cannot be distinguished from the other, but after a short lapse of time specks of adherent colored salt form here and there, grow and apparently perforate the original glaze. If removed, a red coppery area is seen. Localized corrosion has begun, and the tube is on the rapid road to failure. No reason can yet be given for these experimental results. Strangely enough, further work has shown that if a certain tube develops the resistant coating, all the tubes of that batch will also do so. Another batch, indistinguishable from the other, from the same reliable maker, will all develop the corrosive salt deposits!

Furthermore, when making brass cathodic to iron by an impressed current, under conditions similar to those obtaining in the electrolytic system of protection, the alloy remains bright after immersion in sea water, and at the end of, say, 3 weeks is found to have been covered with a thin, pinkish, translucent layer of calcium carbonate, quite hard, uniform and adherent. This layer does not entirely prevent corrosion, neither does the continual cathodic condition of the metal, for a thin layer of copper oxide gradually forms between the carbonate film and the metal, and general corrosion ensues—but at a very slow rate.

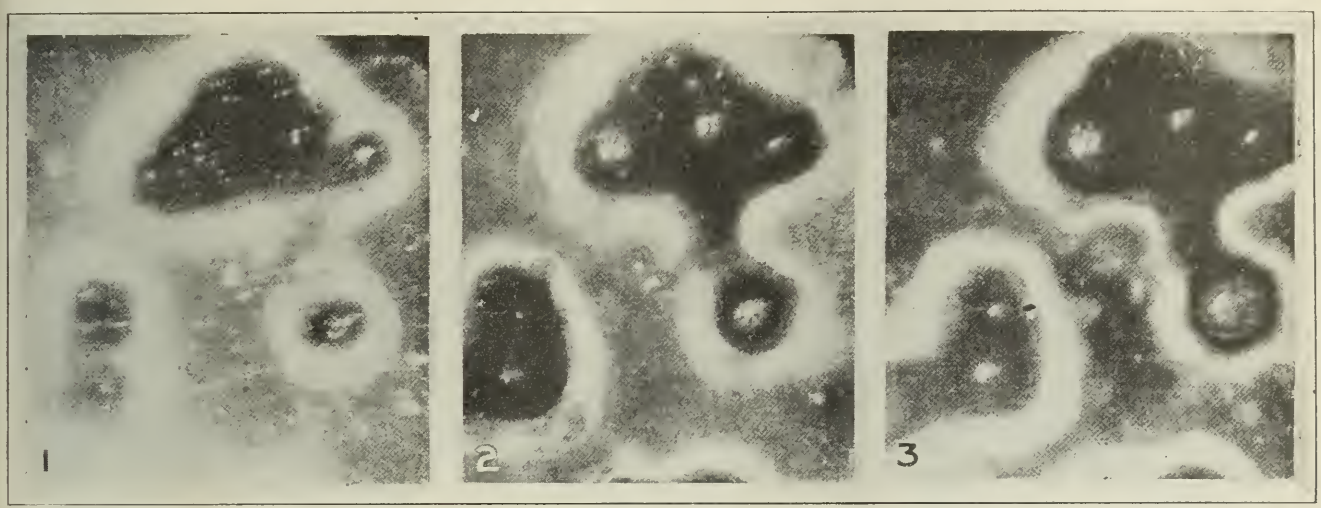
The Surface of a Tube

Such findings impressed Mr. Bengough and his associates with the fact that the surface layer—possessed by the original metal or built up upon it after immersion—had a determining influence on corrosion resistance to which nearly all other circumstances were secondary. Consequently great efforts have been made to determine the nature of these films.

A supporter of Beilby's amorphous theory would have no hesitation in accepting a statement that the surface of a tube, as received from the maker, is materially different from the underlying metal. For one thing, it is badly distorted from the cold work of the last draw. Previous annealings have doubtless volatilized some of the zinc and oxidized some of the copper. The actual surface should then comprise a thin sheath containing an unusual amount of amorphous metal, low in zinc and laminated with copper oxide.

A layer varying in thickness from 0.005 to 0.02 mm. can actually be removed from a section of 70:30 condenser tube. It flakes off, beginning at the edges, after a couple of weeks in 1 per cent NH_4Cl solution, and may often be recovered in sizable, coherent scales. Under the microscope it appears structureless; the outside surface still retains the draw lines, showing that the layer itself has resisted corrosion almost completely. The inside surface is more or less "pebbly." Analysis shows it to contain 73 per cent copper.

The underlying metal has been deeply attacked and its crystalline structure developed, thus exhibiting its essential difference from the resisting surface layer. Strangely enough, the reagent seems to attack the metal most readily along intercrystalline and intertwining plane material. It may be that the metal of the surface layer is different in some way from that which cements crystals and crystalline fragments. Or it may be that rapid corrosion on internal surfaces may be similar to that caused by mercurous nitrate in strained brass which eventually would fail by season cracking. These questions, and the differences between the surfaces which build up protective layers and those which do not, are problems yet to be solved.



FIGS. 1 TO 3—CAST ZINC SUSPENDED HORIZONTALLY IN DISTILLED WATER. OBLIQUE ILLUMINATION. × 70
Fig. 1—15 min. after immersion. Fig. 2—85 min. after immersion. Fig. 3—4 hours after immersion.

Corrosion of Zinc in Distilled Water

Zinc and copper were both closely observed, during the early stages of corrosion, hoping thereby to throw light upon the main problem—the rapid localized corrosion of 70:30 brass. A piece of smooth, clean, cast zinc (99.97 per cent pure) was immersed horizontally in distilled water[2] and observed under oblique illumination at 75 diameters. Figs. 1 to 6 from the fourth report are selected from a series given as typical.

Immediately upon immersion the surface showed numbers of small bright spots (minute holes) and scratches from the 00 emery paper used for final polish. Within 5 minutes curves ridges of bluish white material began to appear, which in 15 minutes had joined to form halos about portions of bare metal, bright and clear. (Fig. 1.) Outside the halos the metal gradually became covered with this gelatinous whitish material, shortly it became thick enough to obscure the scratches—however, there is little action in these regions, for when the precipitate is removed it is found that the scratches are not obliterated. It is an oxide or hydroxide of zinc, free of CO_2, and when dry exposes a somewhat nodular structure.

However, vigorous action proceeds inside the halos. Within 30 minutes definite pits seem to be forming as bright spots at the center of curvature of these ridges of zinc hydroxide. A definite convection is observed, upward and outward from the pits, building up the walls of the halo, toppling them over at times, whereupon the underlying corrosion will later be found to have advanced correspondingly. (Compare Figs. 2 and 6.) After 2 hours a secondary and inner halo forms around prominent pits. (Fig. 3.) This halo turns out to be an area of roughened surface, slowly and gradually spreading; it often is separated from the pit by a ring of unattacked metal; roughened surfaces sometimes occur in successive rings. (Fig. 4.) Despite appearances the pits are filled by a transparent gelatinous hydrated oxide. This is a fact of considerable importance, since it is often assumed that no corrosion exists in the absence of *visible* rust.

In about 4 hours feathery white crystals containing CO_2 appear at the outer surface and edges of the halos. Gradually all these details become obscured by the ever-increasing mass of corrosion products (Fig. 5), but a clear—sometimes tortuous—passage is always maintained from the pit to the outside solution. If after 72 hours the sheet is cleaned by dilute acetic acid, the corrosion is seen to have been almost entirely confined within the original hydroxide walls. (Fig. 6.)

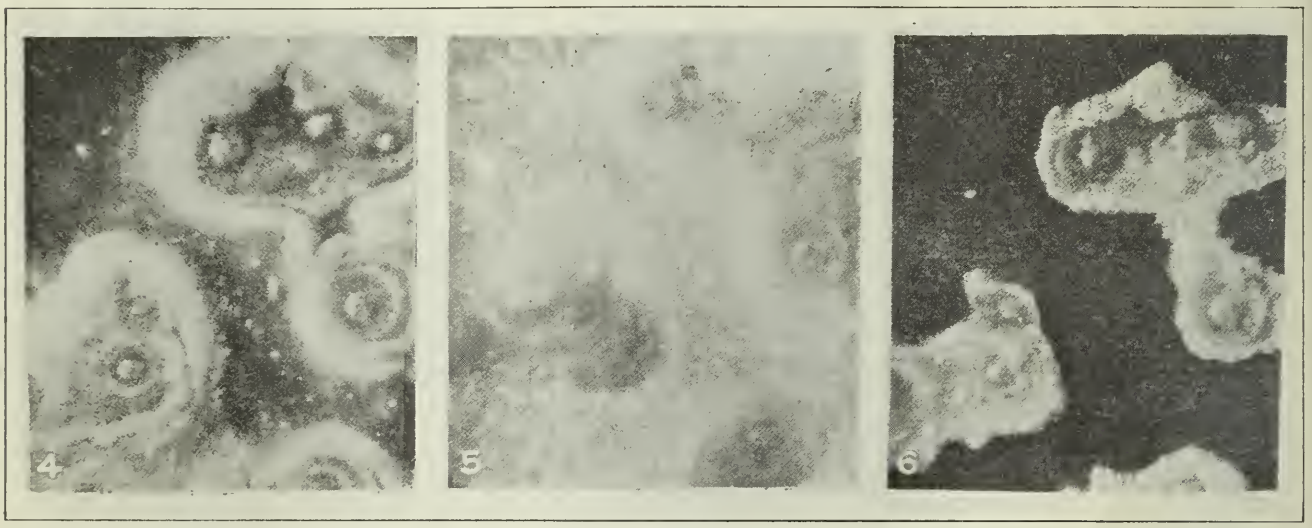
Contrary to the usual assumption that the location of the pits can be correlated with some definite property of the surface, Captain Bengough is positive in his statement that neither the original holes, artificial holes or scratches can be associated with these halos. That their location is dependent on factors external to the metal is demonstrated by Figs. 7, 8 and 9, which show the same piece of cast zinc after suspension in distilled water, lengthwise, sidewise and after having been immersed and spun horizontally. Corroded streaks of this sort have been observed microscopically during formation, and are caused by toppling halos of zinc hydrate moved in definite directions by gravity or water currents. Thus the arrangement of pits is determined mainly by the *distribution of the products* of earliest corrosion.

It has also often been stated that the corrosion of

[2]Distilled water was shown in the third report to attack zinc four times as fast as sea water.

metal by water is similar to acid attack—i.e., consists of hydrogen replacement. However, no evolution of hydrogen can be seen (under 400 magnifications) in distilled water, although 1:5000 acetic acid, which removes zinc at the same rate, produces very small hydrogen bubbles. In acids which pit, hydrogen appears to be evolved in the pit itself, and not at some distant cathode. Experiments with gas-free water seem to show that oxygen is an essential, and CO_2 is an accelerator of corrosion. It is inferred that oxygen does not act as a depolarizer of electrochemical action, since there is no water-line attack when zinc is partially immersed in distilled water, and from the fact that the addition of a powerful depolarizer like potassium bichromate actually retards corrosion of zinc.

Weighing all the evidence, the authors postulate that before immersion the zinc has had opportunity of acquiring a layer of oxide or basic carbonate, and its further history depends upon the action of the corroding solution on this coating. Dilute acids dissolve it, and zinc then may replace some hydrogen from the acid. Water with CO_2 in solution does dissolve the coating slowly, taking Zn into solution as bicarbonate and penetrating the surface layer at some points. Here an unknown oxide (peroxide?) is formed by the oxygen in solution reacting with the bare metal. This is highly transparent, gelatinous, non-adherent, and is an accelerator of corrosion. It is carried outward, is converted to ordinary hydroxide or basic carbonate slowly, in which condition it becomes more opaque, insoluble and protective to the metal upon which it lodges.



FIGS. 4 TO 6—CAST ZINC SUSPENDED HORIZONTALLY IN DISTILLED WATER. OBLIQUE ILLUMINATION. × 70
Fig. 4—24 hr. after immersion. Fig. 5—72 hr. after immersion. Fig. 6—After cleaning with acetic acid.

Oxidation of Copper in Water

Action of distilled water on electrolytic copper is much slower than on zinc, but many experiments led Dr. Bengough and his collaborators to the conclusion that here again the variations to be observed in corrosion experiments depend upon the differences in the resisting power of the first-acquired tarnish film rather than differences in the underlying metallic structure. Bright polished copper, as well as specimens annealed and cooled in hydrogen and immersed without coming in contact with air, remain bright for 2 months and lose weight at an almost vanishing rate, but when removed and dried show the acquisition of the same thin, adherent and uniform layer of tarnish which is acquired by specimens not specially prepared. Such a coating can apparently be formed only by direct oxidation of the copper.

After 3 months' immersion a clean piece of electrolytic copper will retain portions of its surface-tarnish intact, where the underlying metal has not corroded. But this gelatinous tarnish is soluble to a very slight extent in distilled water, and is converted slowly to a darker porous mass, overlying shallow pits where "autocorrosion" has started. The whole mass of oxide in this vicinity becomes very loose, and even flakes off. Later some of the oxide or metallic copper in solution is changed in nature and is precipitated as crystalline Cu_2O, which persists almost indefinitely. Eventually all oxides tend to blacken. If the loose secondary oxide is dissolved in HCl it is found to analyze 80 per cent Cu, and when this factor and determinations of copper in solution is applied to loss-of-weight experiments, remarkably consistent rates of corrosion are shown up to 160 days, as follows:

Cast copper in stagnant distilled water loses 1.7 mg. per sq.dm. per day.
Copper foil in stagnant distilled water loses 1.7 mg. per sq.dm. per day.
Arsenical copper in running distilled water loses 1.7 mg. per sq.dm. per day.
Cast copper in running distilled water loses 3.3 mg. per sq.dm. per day.

One piece of evidence that the oxidized film has determining influences lies in the fact that immersion in 1 per cent NH_4Cl (which has forty times the solubility for cuprous oxide as has distilled water, and also dissolves oxygen readily) causes rapid general corrosion of electrolytic copper without a trace of pitting. No tarnish film is formed, or it is dissolved as rapidly as formed, and the metal remains bright. Electrolytic action at anodic areas is an extremely rare occurrence. Indeed, the phenomena described above occur, but at a slower rate, when the copper is maintained cathodic by an applied e.m.f.

Stagnant and aërated sea water corrode copper in the same way, differing only in degree. The metal is first covered by a continuous film of cuprous oxide; in about 7 days a crystallized salt forms on the surface and then flakes off, often carrying the underlying

oxide with it. Bare metal thus exposed is apparently different from a polished surface, for it is a seat of rapid corrosion rather than a generator of a resistant membrane.

General Thinning of Brass

If a smooth piece of cast 70:30 brass be immersed in cold sea water, both the copper and zinc are oxidized immediately to form a superficial membranous tarnish. Constituents of this layer react slowly with the solution, forming basic carbonates and chlorides, mostly detached. This second reaction is slow, consequently the oxide layer gradually increases in thickness; it is also preferential, so that the oxide layers become rich in copper. However, the coating overlies yellow brass, so the corrosion is general, and eventual failure would be by general thinning, but very far distant in normal sea water.

Rapid thinning is essentially a fresh-water phenomenon, and is associated with the presence, at some time, of dilute solutions of free acid or alkalis. Thus, the

FIGS. 7 TO 9. CAST ZINC IMMERSED 24 HR. IN DISTILLED WATER. HALF SIZE

Fig. 7—Suspended lengthwise. Fig. 8—Suspended sidewise Fig. 9—Rotated horizontally

fifth report recounts experiments on twelve different kinds of tubes immersed in 30 parts HCl per million, renewed daily. Action started from the cut edges and at pin spots, undercutting the protective surface layers and peeling them off in large flakes by the formation of oxysalts *in situ,* laying the bare metal open to direct acid attack. All surface protection is thus rapidly lost, the brassy, crystalline surface appears slightly roughened and is covered with a thin reddish layer of copper and copper oxides. From 2 to 4 per cent of thickness may be lost in 6 weeks immersion in this weak acid, an amount which tubes in favorable sea water service may exhibit after 18 years.

Temporary acidity is only slightly less dangerous. A little acid entering the condenser would perforate the protective scale and surface layer at some point where it is thin or interrupted by slag or a "draw," and then, even if the water was neutral thereafter, the resulting depression would provide a lodgment for oxides, salt or other bodies, known to cause accelerated "deposit" attack—of which more later. It is therefore most important to prevent the entrance of acid by continually maintaining the circulating water alkaline with lime water or sodium carbonate solution to the extent of 10 to 15 parts per million.

Attack by Deposits

We have thus led up to a consideration of the principal cause of deterioration in brass condenser tubes: regional corrosion or pinhole pitting caused by accelerated attack underneath adhering deposits.

It has already been noted that brass condenser tubes of commerce possess a copper-rich surface layer, containing more or less oxide. Also that the first action of corrosion is upon a thin oxidized coating rather than upon the underlying metal. Now, if a piece of smooth copper be immersed in chloride solutions, the oxidized surface gradually changes into an almost insoluble cuprous chloride (CuCl), which ordinarily is swept away by gravity or by water currents, but which may adhere to the surface. In the latter case the cuprous chloride becomes oxidized according to the reaction

$$4CuCl + O \rightarrow Cu_2O + 2CuCl_2$$

into cuprite crystals and the very corrosive, soluble cupric chloride. Sometimes, instead of crystalline cuprite, colloidal green salt is formed,[3] which is very adherent and prevents the outward diffusion of cupric chloride. It is easily proved that cupric chloride is very corrosive to copper in a wide variety of concentrations, according to the reaction

$$Cu + CuCl_2 \rightarrow 2CuCl$$

and the end product is where we started from. Therefore these reactions recur in a cycle at spots underneath gelatinous salts permeable to oxygen in solution.

Brass in chloride solutions acts similarly. As noted before, the first attack gives a layer of copper oxide, plus a little zinc oxide, the zinc mainly going into solution as $ZnCl_2$. Reactions on the copper oxide then proceed as outlined just above; if the insoluble chlorides adhere to the surface cupric chloride is formed. Cupric chloride attacks zinc as well as copper,

$$CuCl_2 + Zn \rightarrow ZnCl_2 + Cu$$

with the formation of soluble zinc chloride and the deposition of crystalline or powdery copper.

Some zinc oxide is formed in the original membranous coating. It is slowly dissolved in salt solutions, and in the presence of carbonates may be precipitated as a white basic chloride or a green double salt with copper. If these materials adhere to the metal as crystalline plates they are distinctly protective; if they are flocculent they cause pitting by trapping the corrosive cupric chloride.

This is a general statement of the mechanism of all severe corrosion of brass in sea water. Pitting is seen to be due to a product of corrosion held in place by a deposit of some sort; the location of the pits is a matter of chance. Coke particles, clinkers, sand from various sources, pieces of glass, and even massive flakes of ferric hydrate or a piece of string all act in the same way. Electrochemical action is distinctly secondary; wherever these foreign matters find lodgment they form eddies in which cuprous chloride can lodge. Later, thick deposits of bright red cuprous oxide, ruby cuprite and greenish and white basic salts accumulate. These break away on reaching a certain size, often taking with them a tiny slab of underlying metal, exposing the crystalline structure underneath in a crater which speedily fills with corrosive substances.

Furthermore, water-line attack is only a special case of "deposit" attack, doubly dangerous since the deposit forms under especially favorable conditions. Contrary to common report, it occurs as severe irregular local action up to 2 cm. *above* the water line, where the above described salts have crystallized. These corroded spots are always connected with the water by a continuous moist band acting like a capillary tube.

[3]Hydrated basic cupric chloride, corresponding to atacamite, $CuCl_2.3CuO.4H_2O$. Ordinarily the sea water contains some CO_2 or bicarbonates, which enter atacamite, turning its color somewhat blue. This circumstance slows down the subsequent reaction, but does not change its nature.

Apparent Dezincification

A great deal of space in the fifth report is given to evidence that the so-called dezincification commonly observed in corroded tubes is never caused by preferential solution of the zinc, but always to redeposition of copper from cupric chloride solution by metallic zinc. Thus: if a piece of brass is made cathodic to iron in normal $CuCl_2$ solution for 14 days, it will be found on microscopic examination that the original metal has been reduced about 10 per cent, but the total thickness of the cathode has been increased 30 per cent. This difference is soft, coherent, ductile copper; whatever crystals are observed are of a different nature than the brass structure. The bulk of this copper must have been redeposited, but the outermost portions appear to be identical with the innermost, where any dezincification surely must have been proceeding, and where the residual copper should be powdery or pseudomorphic after brass crystals. Lacking any observable difference in appearance, and since the outer portion must have been deposited, the inner portion is also assumed to have been likewise deposited.

Prevention of Corrosion

Since rapid corrosion of brass in sea water is due to some phase of "deposit" attack, the obvious remedy is to prevent the adherence of deposits or the accumulation of sediments. This seems to be the principal virtue of the so-called electrolytic methods of protection—as mentioned earlier in this review, the current builds up and maintains a layer of $CaCO_3$ which is so smooth as to prevent lodgment effectually.[4] All foreign matter could evidently be kept out of the condenser water by adequate screening, or if it is suspected that solids have entered, the condenser should be thoroughly cleaned at the first opportunity. Eddies within the tubes themselves where air pockets form and induce "water line attack" can only be avoided by correct design.

Protective coatings of oxysalts, insoluble sulphide or lead are very interesting possibilities. Pre-oxidized tubes have been favored by many engineers. As a matter of fact an oxidized layer formed by low or high temperature annealing will only protect the underlying metal for a very moderate time—perhaps three months is required for the solution of these artificial layers. A premonition of what can eventually be done with certain protectors, however, was discovered when investigating so-called "plug dezincification." It was found that one lot of sea water which had been transported in galvanized iron barrels would not produce this type of action on specimens known to be susceptible, even after prolonged immersion at 50 deg. C. The water was found to contain 0.08 g. Zn per liter. Ordinary sea water to which a corresponding amount of zinc chloride had been added was also found impotent to cause "plug dezincification." Apparently a low concentration of zinc at the surface of the metal changes the physical character of the corrosion product, since this type of corrosion is set up by a colloidal precipitate of zinc oxychloride and carbonate, and since brasses containing more than 35 per cent zinc are immune (the precipitate being visibly crystalline, instead of a colloidal salt acting like a semi-permeable membrane).

[4] It is clear that if this method of protection is to be used, it should be in operation when the condenser first receives water —local action once started can be stopped with great difficulty.

Investigation of Effect of Sulphur in Steel Progressing

Tests to determine the effect of sulphur on rivet steel made at Watertown Arsenal and the U. S. Naval Experiment Station under the direction of the Joint Committee on Investigation of Effect of Phosphorus and Sulphur in Steel (American Society for Testing Materials) have been entirely completed.

The second group of residual sulphur material in this series comprises plate and structural steels, carbon 0.16–0.22 per cent, with sulphur ranging from 0.03 to 0.08 per cent. Four heats of basic open-hearth steel with sulphurs of 0.04, 0.05, 0.06 and 0.07 on ladle analysis have been made for the Joint Committee by the Cambria Steel Co. The heats run: C, 0.20–0.25; Mn, 0.42–0.46; P, 0.01–0.02. The complete history of each heat is known. After a suitable top discard, plates were rolled as follows from each heat:

Six pieces shear mill plate.....20 x 96 x ⅝ in.
Six pieces shear mill plate....15 x 96 x ⅝ in.
Three pieces universal mill plate 20 x 96 x ⅝ in.
Six pieces universal mill plate..15 x 96 x ⅝ in.

Similar material will be furnished the Committee from heats of this grade of steel containing 0.03 and 0.08 per cent sulphur.

The Bethlehem Steel Co. has recently completed the manufacture and fabrication of certain steel for this investigation. Three heats of basic open-hearth steel were manufactured having carbon contents of 0.18–0.22, 0.35–0.45 and 0.65–0.75, typifying plate, forging and rail steels respectively. The original sulphur content of each heat was 0.04 per cent or below. Iron sulphide was added during pouring, so that for each carbon content there were secured eight ingots with "added" sulphur contents from 0.04 to 0.15 per cent. Material from the 24 ingots has been furnished for test in the form of 1-in. rounds and in flats approximately 4 x 1 in. in dimension.

In order to compare the effects of "added" and "residual" sulphur, available scrap from three low-sulphur ingots of each heat was remelted, producing steel with "residual" sulphur of approximately 0.08 per cent; and three of the higher sulphur ingots from each heat were remelted, producing steel with residual sulphur of approximately 0.13 per cent. This material will also be fabricated in the form of rounds and flats for tests.

Regulations on Sale of Alcohol

The Internal Revenue Bureau has issued a warning that denatured alcohol offered for sale must be advertised and marked as denatured or completely denatured alcohol, with a poison label, and not simply as "alcohol."

It is charged that persons who sell denatured alcohol at retail frequently advertise that "alcohol" is for sale, without any qualifying words such as "denatured" or "completely denatured," in violation of section 17 of the national prohibition act and section 97 of regulations 60. It is charged that such retailers also frequently sell completely denatured alcohol without placing on the container thereof the cautionary "Poison" label required by article 108 of regulations 61.

Inasmuch as such illegal practices menace the health and lives of persons who might be misled into believing that the alcohol is pure, parties guilty of such practices are warned to discontinue them immediately. Violations will be reported to the United States Attorney for prosecution.

The German and American Synthetic-Ammonia Plants*—II

Comparison of the Methods of Manufacturing Hydrogen and Nitrogen at Oppau, Germany, and at Sheffield, Ala.—Differences in Processes for Supplying Nitrogen—Construction and Operation of the Carbon-Monoxide Converters

By R. S. TOUR

THERE are, in reality, four distinct types of gas produced at Oppau: (1) Water gas made from coke, as the main source of hydrogen for the synthesis of ammonia, (2) lean gas as the main source of nitrogen for the ammonia, (3) power gas (producer) as the main source of power throughout the plant, and (4) nitrogen from liquid air for adjustment of gas composition in the synthesis of ammonia. These gases and gas mixtures are generated according to standard methods and in standard equipment.

Water-Gas Production at Oppau

The water gas and lean gas are made in 12-ft. shell Pintsch type generators of which there are 15, 12 with, and 3 without, revolving grates. In addition there are two or three experimental generators where an attempt is being made to develop a lignite burning water-gas machine, and a slagging type producer. The fuel used is a high grade of coke normally to be delivered from byproduct coke ovens on the grounds. These ovens are to have a capacity of 700 tons of coke per day, the excess gas from which may be used for power purposes.

The water-gas machines deliver about 2,500,000 cu.ft. each per day (at 60 deg. F. and 30 in. Hg) with a fuel consumption of 40 to 42 lb. per thousand. The normal operating capacity of the water-gas machines is 25,000,000 to 30,000,000 cu.ft. per day, with a coke consumption of 550 to 650 tons. The generators are operated on one- to two-minute "blows" and three- to five-minute "runs," the latter being "up," "down," or "mixed," according to requirements. The steam used is 175 lb., 125 deg. F. superheat. The water-gas consumption is approximately: 4 per cent CO_2, 43 per cent CO, 49 per cent H_2 and 4 per cent N_2. Attention is called to the fact that a high nitrogen content is not objectionable here since there is to be a later admixture of high nitrogen gas. Any steps tending to decrease the loss of hydrogen in the stack, however, are desirable.

The lean gas (producer gas made from selected fuel) consists merely of water gas to which is added the blast gas of the blow period. This allows of continuous, rather than intermittent, operation of the machines producing this gas. In the water-gas machines the blast gas volume is nearly twice the water gas generated. Thus the capacity of the machine producing lean gas is about 7,000,000 cu.ft. per day, with a fuel consumption of about 15 lb. per thousand. The lean gas required is about half the water gas; hence two generators supply the necessary capacity and consume some 100 tons of coke per day, coke being used to produce a methane-free gas. The lean gas composition is approximately 5 per cent CO_2, 30 per cent CO, 15 per cent H_2 and 50 per cent N_2.

*For Part I see CHEM. & MET. ENG., vol. 26, No. 6, p. 245, Feb. 8, 1922.

The water gas and lean gas pass separately through standard wash-boxes and water scrubbers packed with Rauschig rings and on to two water-gas storage and relief holders of 500,000 cu.ft. capacity each, and one lean gas holder of like size. There are no purifiers for the gas and no waste-heat boilers on the machines.

Manufacture of Producer Gas

Producer gas (power gas) is made according to standard procedure in twenty-three B.A.M.A.G.[4] continuous producers with revolving grates. These are situated in the same building with, and in a row directly opposite, the water-gas machines mentioned above. The machines are of 16-ft. shell diameter and burn a fuel of part lignite briquets (cylindrical 2 in. by 4 in. in diameter) and part hard coal, the latter being advisable for maintaining good fuel bed conditions and producer capacity. The producers deliver about 2,500,000 cu.ft. per machine per day, with a fuel consumption of 20 to 22 lb. per thousand (at 60 deg. F. and 30 in. Hg). This gives a plant capacity of about 50,000,000 cu.ft. per day and a daily fuel consumption of about 500 tons.

In view of the high combustion rate for the type of fuel in the producers, a low steam proportion is used, a high fuel bed temperature is maintained and the gas made is high in nitrogen and of low heating value. A mean composition would be 4 per cent CO_2, 27 per cent CO, 4 per cent H_2, 2 per cent CH_4, and 63 per cent N_2. The purification of the producer gas is naturally more extensive than that of the water gas. First, a standard water scrubber is used, followed by a centrifugal water washer or tar extractor and a cyclone separator. The clean gas then passes to a

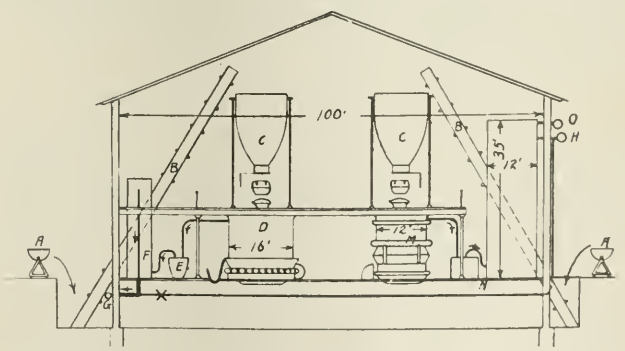


FIG. 2. PRODUCER AND WATER-GAS GENERATORS AT OPPAU

A. Cars for lignite and coke.
B. Conveyors.
C. Hoppers and charging buggies.
D. Power-gas producer.
E. Hydraulic main.
F. Water scrubbers.
G. Main to power-gas holder.
H. Main to lean-gas holder.
M. Water-gas generator.
N. Wash box and water scrubber.
O. Main to water-gas holders.

[4]Berlin Anhaltische Maschinen Aktien Gesellschaft.

2,000,000-cu.ft. holder feeding the gas engines throughout the plant.

Production of Pure Nitrogen

Free nitrogen is necessary for incidental purposes about the plant and large quantities are essential for continuous adjustment of the composition of the hydrogen-nitrogen mixture required for the synthesis. The mixing of the water gas, described above, with the lean gas yields a mixture somewhat low in nitrogen and purposely made so, since nitrogen in variable quantities in the form of air is to be later added for internal combustion and heat maintenance. The variation in this combustion air, as well as operating variations in gas compositions and in proportioning of lean gas to water gas, may lead to quite wide variation from the 3:1 hydrogen-nitrogen mixture finally required for ammonia synthesis. Since any slight excess of either constituent rapidly accumulates in the ammonia-synthesis circulating system where the ammonia removed represents exactly three parts hydrogen to one part nitrogen, it becomes necessary continuously to adjust the composition of the gases. It is obvious that this adjustment is more economically made by adding pure nitrogen rather than pure hydrogen, and hence the initial gas mixture is purposely maintained sufficiently low in nitrogen to allow for more than the subsequent operating variations.

The nitrogen plant at Oppau consists of 6 distillation columns of the Linde type and 7 air compressors direct-connected to gas engines. The installation was old and a new plant has been built similar to the above and having a capacity of about 1,800,000 cu.ft. of nitrogen per day. If half of this capacity is regularly used for adjustment of composition, it represents about 13 per cent of the nitrogen fixed and allows for an average nitrogen deficiency of 3 per cent of the total gas mixture entering the ammonia synthesis system.

The water gas, as a source of hydrogen, and lean gas, as a source of nitrogen, are delivered from their respective holders by turbo-exhausters equipped with water injectors for saturating the gas and followed by cyclone separators for removing excess water. The gases then pass through meters and to a mixing main equipped with turbo-blowers for mixing the gas and for feeding it to the converter system. The two gases are fed to the mixing main in such proportions as finally to yield a purified gas, which, as previously explained, is somewhat deficient in nitrogen.

Water-Gas Production at Sheffield

There was but one type of gas produced at Sheffield: viz., a water gas with varying nitrogen content—this gas being produced according to standard methods and in standard equipment. The latter consists of six 7½-ft. shell water-gas generators; the fuel used was a high grade of coke.

The capacity of each water-gas machine at Sheffield was about 0.7 million cu.ft. of water gas per day. The plant capacity was about 3,500,000, or about sufficient for the rated ammonia capacity. However, the contemplated operation called for a number of gas-fired furnaces in conjunction with the process and had their use not proved unnecessary, the gas plant would have been much under capacity. The water gas from the machines passed through standard wash boxes and water scrubbers and on to a storage and relief holder of 500,000 cu.ft. capacity. From this the gas was fed by holder pressure through iron-oxide purifying boxes on the way to the carbon-monoxide converters. The purifiers caused some trouble due to excessive friction and were soon found to be unnecessary. It will be noted that the Germans did not use any purification process.

Methods of Supplying Nitrogen

The plant had been designed to operate on a high-nitrogen water gas where all the nitrogen necessary for the later synthesis was injected as air into the generator during the gas-making period. This method, although generating a mixed gas, is not fundamentally different from the procedure used at Oppau, though the former may be more adaptable for small plant use. In either case, the nitrogen comes from blast gases and the air used has made available heat within the fuel bed. Where possible, it is naturally more desirable to operate one of the machines as a continuous producer and the other machines for straight water-gas production. The Sheffield plan of using only part of the blowing air in each machine simultaneously with steam during gas production involves many operating difficulties, the most important of which is the variable composition of the effluent gases. Although both the air and the steam can be measured, the proportion of steam

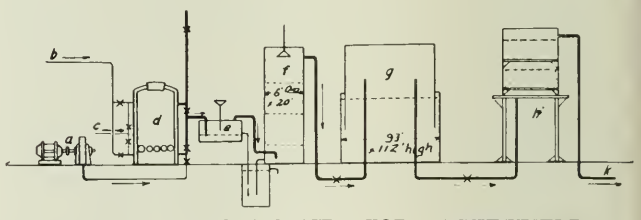


FIG. 3. WATER-GAS GENERATOR AT SHEFFIELD

a. Sirrocco blower, motor driven.
b. Auxiliary air inlet to gas generator.
c. Steam inlet to gas generator.
d. Water-gas generator.
e. Wash box.
f. Scrubber.
g. Holder.
h. Iron-oxide purifier.
k. Gas exit to CO converter.

decomposed, and therefore the resultant proportion of hydrogen, will be dependent upon the grade of fuel, upon the temperature and cleanliness of the fuel bed, and upon operating variables in general, and will also vary enormously from the beginning to the end of each "run."

It was found that later in the process very considerable air injection into the carbon-monoxide converters was required for internal combustion and maintenance of temperature, and this reduced the quantity of nitrogen the mixed gas might carry from the water-gas machines. In view, therefore, of the difficulties in operating the gas machines and the actual low nitrogen content desired, the final operation at Sheffield developed into straight water-gas manufacture with all of the nitrogen added later by air injection. The latter type of operation, although it may be necessary, is fundamentally inefficient, since air injection into the gas with combustion of the latter involves a definite loss of hydrogen or carbon monoxide (later yielding hydrogen), whereas the nitrogen available from the gas generator blast represents no loss of fuel. Complete nitrogen supply by air injection and combustion in the gas involves a loss of 25 per cent of the hydrogen obtainable from a given volume of water gas with

NITROGEN SUPPLY BY AIR INJECTION AND COMBUSTION

	Pure Water Gas (Cu.Ft.)	After Combustion of 333 Cu.Ft. of Air With CO (Cu.Ft.)	With H_2 (Cu.Ft.)	After CO Conversion (Cu.Ft.)	Analysis (Per Cent)
Carbon dioxide	40	177	40	449	29.2
Carbon monoxide	440	303	440	31	2.0
Hydrogen	520	520	383	792	51.6
Nitrogen	....	264	264	264	17.2
	1,000 Cu. Ft.			1,536 Cu.Ft.	100.0

NITROGEN SUPPLY BY BLAST-GAS ADDITION

	Pure Water Gas (Cu.Ft.)	After Adding 514 Cu.Ft. Blast Gas (Cu.Ft.)	After CO Conversion (Cu.Ft.)	Analysis (Per Cent)
Carbon dioxide	40	61	601	29.2
Carbon monoxide	440	581	41	2.0
Hydrogen	520	520	1,060	51.6
Nitrogen	...	352	352	17.2
	1,000 Cu. Ft.		2,054 Cu. Ft.	100.0

nitrogen added as blast gas, and thus increases the fuel consumption by 33 per cent.

The results given in the preceding tables have been calculated on the basis of identical operation and efficiency in each case. It is to be noted that it makes no difference whether carbon monoxide or hydrogen is burned by the air in the first case; values are, however, given for both.

During operation at Sheffield the blue water gas produced had the approximate composition: 4 per cent CO_2, 44 per cent CO, 50 per cent H_2, and 2 per cent N_2. The coke consumption was about 60 lb. per thousand cubic feet, and the labor charge high. A high fuel and labor charge is to be expected in view of the small size of the machines. After the close of plant operation, the Nitrate Division tried an improvement on the machines with great success. This consisted mainly of secondary blast within the fuel bed, allowing more rapid and uniform heating during the blow and improving the fuel efficiency by reducing carbon-monoxide losses in the blast gases. Test showed that the fuel consumption had been reduced to 40 lb. of coke, or equally as good as the German operation with their 12-ft. machines.

There was no pure nitrogen produced at Sheffield for adjustment of composition. Experience with the control of the nitrogen content, however, proved that had the plant produced any quantity of ammonia, adjustment of composition would have been necessary. Thus, had the hydrogen to nitrogen ratio been 3.3 to 1.0 (and that is not bad operation) rather than 3.0, capacity operation within three or four hours would have caused the ratio in the ammonia synthesis system to reach 5 to 1.

Carbon-Monoxide Conversion at Oppau

The mixture of lean gas and water gas after being proportioned properly has the approximate composition: 4 per cent CO_2, 39 per cent CO, 38 per cent H_2, and 19 per cent N_2. This mixed gas has added to it a large excess of steam and passes through heat interchangers to the converter where a catalyst aids the exothermic water-gas reaction: $CO + H_2O \leftrightarrows CO_2 + H_2$. The converted gas passes back through the heat interchangers followed by a condenser to remove excess steam.

The steam addition at Oppau is accomplished by an apparatus which we may call a steam interchanger, whereby much of the steam condensed from the converted exit gas is made available to the inlet mixed gas. This cooling and condensation of exit gas is brought about by direct contact with a counter-current spray of cold water in a condenser shell 12 ft. in diameter and 60 ft. tall, filled with suitable packing. The water emerges from the bottom of the condenser at nearly boiling temperature and is fed to the vaporizer, similar in all respects to the condenser, where the cold inlet gas is heated and supplied with steam from the hot water. The water is cooled by this treatment and again repeats its cycle through the condenser.

Two sets of steam interchangers handle the entire plant capacity, interchanging some 1,400 tons of steam per day per pair. The total steam required for the nearly 40,000,000 cu.ft. of inlet mixed gas is about 4,000 tons (i.e., 4 volumes per volume of inlet gas), 300 tons of which actually react, and an additional 1,000 tons of which are not interchanged but lost as condensate. The 2,700 tons that are interchanged to the inlet gas are augmented by 1,300 tons of low pressure steam injected into the mixture just before it enters the converter system.

Path of Gases

There are 24 converter sets, complete with heat interchangers, 12 sets in each of two adjacent buildings. All sets are fundamentally the same and have a capacity of about 75,000 cu.ft. of dry inlet gas per hour. In each building the sets operate in parallel, taking inlet gas and steam from a single main and discharging to one main. The path of the gases in each set is through a large interchanger followed by a small one, which raise the gas temperature to some 500 deg. C. when it passes through the carbon-monoxide catalyst, there further rising in temperature about 60 deg. C. due to reaction heat. All but about 3 per cent of the carbon monoxide in the gas is converted at this point. The gas then passes back through a second catalyst bed at a lower temperature, at the entrance to which air is injected and, if necessary, additional steam. The carbon monoxide is here reduced to 1.5 per cent and the gas passes on through the last heat interchanger.

The heat interchangers consist of large sheet-iron shells with an internal nest of tubes; the inlet gas passes around the tubes and exit gas through the tubes. This path is by far the better, since the external radiation losses are decreased, as well as the temperature transfer head improved. The larger interchanger is about 6 ft. in diameter by 30 ft. high, while the smaller is 6 ft. by 20 ft. high. Both shells are lagged with about 8 in. of magnesia.

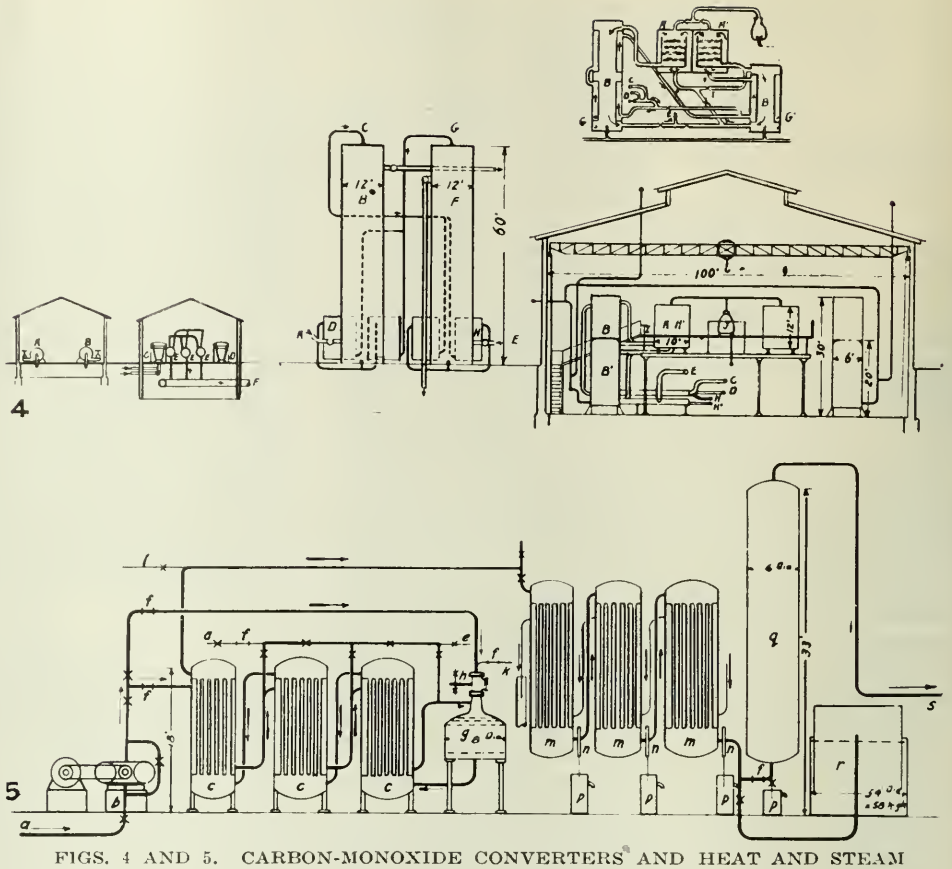
The Catalyst Beds

The two catalyst beds are in a heat-insulated shell about 12 ft. tall. A horizontal cross-section of the shell would be rectangular (10 ft. by 30 ft.) with round corners. A vertical partition divides the shell into two independent compartments. The catalyst in each compartment is placed on five superposed trays all within a container to conduct the gas downward through the catalyst.

The use of two catalyst beds in series, the second at a lower temperature, represents a decided improvement in operation. The water-gas reaction, as well as the later ammonia reaction, has a much more favorable equilibrium at lower temperatures, but also a much slower reaction rate. Thus, it is desirable to accomplish most of the reaction at higher temperature and

follow that by low temperature catalysis. If air or oxygen be available during low temperature catalysis, the oxidation of the carbon monoxide will be much more readily carried to its equilibrium value. Further, the air supply may be adjusted to supply internal heat within the system, if such be necessary for maintenance of temperature. The catalysts used for the carbon monoxide conversion depend for their activity mainly upon iron oxide with chromium oxide as a promoter. Cerium and thorium oxides have also been tried as promoters.

Great care is taken in the control of the converters. Each set is supplied with some 50 base-metal thermocouples reading on an indicating millivoltmeter. There are manometers to read pressures in different parts of each set and Pitot tubes to measure flow of steam and gas and air. The gas obtained at the exit of the converter sets has the approximate composition: 29.5 per cent CO_2, 1.5 per cent CO, 53 per cent H_2, and 16 per cent N_2. The volume of inlet gas has been increased about 35 per cent in the converters, so there is a daily converted gas production of 50,000,000 to 60,000,000 cu.ft. (representing 25,000,000 to 30,000,000 cu.ft. of hydrogen). This converted gas, after condensation of moisture, passes back to the metering house where the inlet gas was measured and mixed. After the gas has been metered, it passes to another 500,000-cu.ft. holder, from which it is directly available to the compressors.



FIGS. 4 AND 5. CARBON-MONOXIDE CONVERTERS AND HEAT AND STEAM EXCHANGERS AT OPPAU (ABOVE) AND SHEFFIELD (BELOW)

Fig. 4 (above).

Meters and Mixers at Oppau (at left).
A. Gas exhauster from water-gas holder.
B. Gas exhauster from lean-gas holder.
C. Gas meters to mixers.
D. Gas meters for converted gas.
E. 3 turbo ventilators for mixing.
F. Mixed gas discharge main to steam interchanger.

Steam Interchangers at Oppau (center).
A. Cold raw gas mixture.
B. Heating and evaporating tower.
C. Hot water inlet to *A*.
D. Cold water reservoir from *A* and feeding to *G*.
E. Hot converter gas inlet.
F. Cooling and condensing tower.
G. Cold water inlet to *F*.
H. Hot water reservoir from *F* and feeding to *C*.

Carbon-monoxide Converter and Heat Interchangers at Oppau (at right).
A-A'. Catalyzers.
B-B'. Large and small heat interchangers.
C. Raw gas inlet.
D. Steam inlet.
E. Converted gas and steam exit.
F-F'. Auxiliary air and steam injection.
G-G'. Nitrogen inlet for flushing.
H-H'. Flushing exit.
I. Main control valve for by-passing small interchanger.
J. Starting burner using producer gas.

Fig. 5 (below). Carbon-monoxide Converter, Heat Exchangers and Condensers at Sheffield.
a. Gas inlet from holder.
b. Connersville blowers, motor driven.
c. Heat exchangers.
d. Steam inlet to heat exchangers.
e. Hot air inlet for starting system.
f. Venturi meters.
g. Catalytic chamber.
h. Auxiliary burner (on catalytic chamber).
k. Air inlet to burner.
l. Gas vent from system.
m. Condensers.
n. Separators.
p. Overflow.
q. Buffer tank.
r. Gas holder.
s. Gas exit to compressors.

Carbon-Monoxide Conversion at Sheffield

The conversion process used at Sheffield was much the same as that at Oppau, especially so toward the close of operation. The gas from the holders was delivered to the converter set by positive pressure exhausters. No steam interchangers were used, but all the steam, 200 lb. per thousand cubic feet of gas (about 4 volumes per volume of inlet gas) was fed from the steam main and all the excess steam on the exit gas was condensed. This method of operation requires about three times as much steam and condensing water as does the method described for Oppau. The steam supply, as the plant was installed, was to feed through a standard gas-fired tubular steam superheater which was to furnish the additional heat required to maintain the converter system at operating temperature. This method of heat supply is inefficient in two ways: (a) The steam superheater efficiency is directly involved and this is low, especially for the large superheat required at Sheffield, and (b) heating the inlet mixture decreases the temperature head across the heat interchangers and their heat transfer is proportionally decreased. On the other hand, air injection for internal combustion of gas at the catalyst chamber yields nearly 100 per cent thermal efficiency and also increases the temperature head across the interchangers, thus improving their heat transfer. After burning out the steam superheater, the internal-combustion method was tried with great success and with a large saving in gas consumption. The steam then was injected as low pressure steam.

The condensation of the excess steam at the exit of the system was accomplished by two surface condensers operating in parallel. These were soon found to be of only a fraction of the necessary capacity and additional condensers were installed. Very little experience is available for the design of condensers for a mixture of 75 per cent steam and 25 per cent gas. Some experiments made by the Nitrate Division looking toward the redesign of the condensers indicate that the coefficient of heat transfer under such conditions is of the order of one-tenth that in standard condensers. The actual value, however, is largely dependent upon the lineal velocity of flow of the steam-gas mixture and of the water. Efficient condensation at the exit of the carbon-monoxide system is important, especially if the mixture passes on directly to the compressors, as it did at Sheffield. The condensate is of no value, due to dissolved gases, and the only reason for using surface, instead of jet condensers, would be to make use of the heated cooling water.

Operation at Sheffield

There was but one carbon-monoxide converter set with a rated capacity of 30,000 cu.ft. of inlet gas per hour, in the operating unit. (Unit No. 1.) This consisted of one catalyst chamber with three heat interchangers, the inlet gas passing through the first and smallest of the three before steam injection. The general construction of the interchangers was much the same as that described for Oppau, although with much less transfer surface. The heat transfer through the interchangers was not very satisfactory and accounted for the fact that the system was so far from self-maintaining in temperature.

There was but one catalyst chamber, of circular section, 8 ft. in diameter and 6 ft. deep, into which was first charged 120 cu.ft. of catalyst in a single bed about 2½ ft. deep. In operation this bed rapidly developed high friction to gas flow, due to crumbling and packing of the catalyst, which is physically delicate and can not withstand the accumulated friction and weight of a deep bed. The converter was repacked with about half the depth and operated quite satisfactorily thereafter, although the Oppau method of placing the catalyst in shallow layers on superposed grids is the best solution.

During operation the catalyst inlet temperature was maintained at 500 deg. C. and the rise in temperature across the catalyst bed was 50 to 60 deg. C. As mentioned before, this heat liberated was far from sufficient to maintain the system at its proper temperature and air was injected for internal combustion at the top connection of the converter through what was known as the auxiliary burner. The air combined with the gas as a flame above the catalyst and not within the catalyst bed. Flame combustion is the better method where any large quantity of heat development is necessary since it prevents too large a temperature gradient through the catalyst bed itself. No provision had been made for ignition of the auxiliary burner, but this difficulty was soon overcome. The more flame used, the more nitrogen is added and the less is to be introduced at the gas house.

Operation at Sheffield required that about 75 per cent of the total nitrogen be added at the burner and finally, in view of the difficulty of nitrogen control in the gas machines, all of it was added through the burner, the excess heat developed being wasted by partly bypassing the heat interchangers.

No secondary converter was used at Sheffield, although the writer, without being acquainted with the process in use at Oppau, tried experimentally in November, 1918, what he called an "oxidizer" in the converter set of Unit No. 2 (not the one in operation). The oxidizer was merely an additional converter connected in the line of the return gas from the primary converter after the gas had passed through one heat interchanger. The oxidizer was charged with the same catalyst as the primary converter, operated at a lower temperature than the latter, and had air injection, but not through a burner, oxidation being desired within the catalyst. For various reasons the experiment was not continued long enough to give decisive data. However, the standard operation at Oppau is somewhat similar to that attempted with the "oxidizer."

During operation, temperatures were measured by 4 or 5 platinum resistance pyrometers; pressures were indicated by manometers in the system; and gas, steam and air inlet volumes were measured by Venturi meters. The converted gas composition was about 29 per cent CO_2, 3 per cent CO, 51 per cent H_2, and 17 per cent N_2; the residual carbon monoxide was about the same as at the first catalyst exit in Oppau, although the nitrogen was higher, since no further nitrogen addition was contemplated. The converted gas passed directly from the condensers to the compressors, a Venturi meter on the line measuring the compressor intake. In the suction line to the compressors was connected a larger buffer tank to absorb the pulsations and also a 75,000-cu.ft. holder to take up the slight variations between supply and demand.

(*Part III will appear in a subsequent issue.*)

Manufacture of Soap in Brazil

Some interesting facts relative to the soap industry in Brazil are presented in the Feb. 6, 1922, issue of *Commerce Reports.*

Brazilian companies are able to turn out all of the laundry and cheap house soap required in that country, using as a basis the fats and greases obtained in their immediate neighborhood. A great many types of toilet soap are also being produced, and although it is said that Brazil is independent from outside sources for goods of this nature, it is admitted that the foreign product is superior to the native goods.

The chemicals required, including rosin, soda ash, coloring matter and perfumes, must all be imported. Rosin comes exclusively from the United States, while England has had almost a monopoly on the soda trade.

The yearly importation of soda averages 10,000 tons, which makes it a business well worth striving for. It was thought a few years ago that recently formed domestic companies would be able to supply the local market, but with the resumption of free trade in this material after the war, it was found that the domestic product was more expensive than the imported, and this at once killed all prospects of local competition.

The finer materials, including essential oils and coloring matter, play a comparatively small part in the soap-making industry, and European houses have been able to get practically all of the business up to the present time.

To compete successfully for this business, active agents, stock for immediate delivery and attractive prices are essential.

Manufacture of Synthetic Cast Iron in the Electric Furnace

Synthetic Iron Produced in the Electric Furnace on the Pacific Coast—Detrimental Effects of Excessive Dry Slags—Comparative Costs of Manufacture for Various Load Factors

By W. L. MORRISON, E. M.

THE MANUFACTURE of synthetic cast iron, so called to distinguish it from the blast-furnace product, has been carried on in various parts of this country and abroad.

The opportunity for research in connection with the manufacture of synthetic iron and the melting of cast iron in the electric furnace is very great.

The first work on synthetic pig iron in Portland, Ore., was started in the summer of 1918. The furnace used was one which had been operating on ferromanganese, being of the three-phase, stationary type, with open top, three 17-in. electrodes being used. The furnace had an electrical capacity of 600 kw. Before starting on the pig iron a 9-in. arch was placed on the furnace with water-cooled bronze bushings for the electrodes. The ends of the arch were left open for charging the furnace.

In the latter part of 1919 a 2-ton furnace of the stationary type was installed for the production of gray iron castings from turnings and steel. The shell is 7 ft. wide, 11 ft. long and 6 ft. high, made of ¾-in. boiler plate reinforced with ship channel. A tap hole was cut in the side of the shell about 12 in. in diameter; a few inches below this main tap hole a 3-in. hole was cut to be used should the bottom be lower at any time than could be drained from the upper hole. The shell was set on I-beams on a concrete foundation, of such height as to allow a 5-ton buggy ladle to pass under the spout. A charging platform was erected at either end of the furnace on the same level as the top of the furnace, to facilitate charging, which was done under the arch at the ends.

The furnace was supplied with electric current by three Acheson graphite electrodes 8 in. in diameter operated by the so-called hand controls. Current was received at 11,000 v. and stepped down to 70 v., using three Packard Electric Transformers, 250 kva. each, the transformers being delta connected. The transformers were of the outdoor type, installed in the open without covering, and no trouble was experienced during the rainy seasons.

Furnace Linings

The side walls of the furnace were lined with highest grade firebrick to a thickness of about 18 in. The furnace bottom was made up with 8 in. of firebrick and 12 in. of rammed coke dust and tar. Between the firebrick and the shell 1 in. of asbestos cement was used for heat insulation. The asbestos insulation gave excellent results, as the furnace shell remained cool enough to hold one's hand on it even during continuous operation.

The carbon bottom lining gave quite satisfactory results, but was troublesome to repair on account of having to warm the coke and tar mixture and ram into place in a hot furnace; furthermore, the supply of fine coke was limited and there was no economical means of pulverizing more. The furnace bottom was repaired weekly without interrupting the operation during the week. The linings lasted from 6 to 8 weeks, operating one and two shifts. The metal poured was free from blow-holes, but at first somewhat low in carbon, as the carbonizer used was all anthracite coal; by operating with a larger excess of coal the carbon content was brought up. The first furnace bottom had to withstand very rough usage on account of considerable experimental work with different carbonizers and fluxes.

After the first 6 weeks of operation the carbon bottom was abandoned and a silica bottom substituted. This was made up of silica rock crushed to about ¼ in., silica sand and about 10 to 15 per cent high-grade fireclay and brickbats. The silica bottom was repaired every 2 weeks, sometimes weekly, depending on conditions. Under normal conditions the bottom gave very satisfactory results.

Furnace Bottom

In order to eliminate the repairs to the furnace bottom it was suggested to use a solid firebrick bottom. A high-grade firebrick was obtained and, when repairing the side walls, a brick bottom was placed in the furnace to a depth of 13 in. in addition to the 8-in. firebrick lining already in. The upper course was stood on end to prevent the brick from floating; hytempite cement was used to bond the brick, but after several days' operation some of the brick began to float, and upon examination it was found that about half the brick had been dissolved by the metal. The furnace was drained and repaired, the brick bottom being removed and a rammed silica bottom substituted. While removing the old brick bottom it was noticed that the iron had run in between the brick and become lens shape due to the action on the brick. Analysis of these specimens showed that silicon and aluminum had been absorbed. Analysis of lens shape mass showed silicon, 5.1 per cent; aluminum, 1.25 per cent. Analysis of iron produced showed silicon, 2.25 per cent; aluminum, 1.12 per cent. The aluminum is high in the iron on account of the iron absorbing it from the brick bottom; iron made on the silica bottom had less than 0.1 per cent Al.

In the long run the silica bottom appeared to give the most satisfactory results both as to operation and quickness of repairs. The repairs were usually made at the end of the week and required 2 to 4 hours.

The arch of the furnace was made up of 9-in. wedge firebrick giving a spring of 15 in. in the 7 ft. An opening was left in the ends approximately 20 in. wide for charging and stirring the metal. Brick-lined doors were fitted to the openings and supported by chains on pulleys and balanced by weights. Bronze water-cooled bushings were fitted in the roof where the electrodes entered the furnace. The usual life of the lining and arch operating two shifts was 2 months.

In the operation of the 2-ton furnace smelting turn-

ings, and borings, the most efficient operation was obtained by continuous charging and tapping at regular intervals. In this way the light materials were preheated before reaching the melting zone. The furnace was fed about every 30 minutes and tapped at intervals of 2 hours.

After thoroughly drying and baking the furnace lining, 200 or 300 lb. of anthracite coal is charged on the bottom, then, if turnings and borings are used, these are charged along with the requisite amounts of coal, silicon, manganese, lime and spar. When using the continuous method it is desirable to weigh up small charges—i.e., 500 to 1,000 lb. A representative charge would be: 500 lb. turnings, 50 lb. anthracite dust, 20 lb. 50 per cent ferrosilicon, 2 lb. 80 per cent ferromanganese, 5 lb. lime and 2 lb. spar. By using small charges the silicon and manganese are more evenly mixed with the turnings, and a more uniform product is obtained.

The first question naturally to be asked is, Can the metal be produced hot enough by continuous charging? The writer has never known of a cold heat by this method of operation using turnings and borings, except when the electric power failed for several hours.

If it is desired to run heavy scrap such as burned grate bars or steel scrap, this heavy scrap is added immediately after tapping, the electrodes being raised to prevent breakage. The continuous method can be used only with the small light scrap, or so-called shoveling scrap, the silica, coal, etc., being added with the scrap.

About every 2 days the entire charge in the furnace is completely melted to permit the accumulated slag to be removed. The slag is in the form of crusts and is removed by means of a long-handled fork.

In making pig iron the slag has to be eliminated more often than when making iron for use direct in castings, because more lime is required for the sulphur removal. When melting cast borings and steel turnings without lime flux the sulphur content of the metal rarely exceeds 0.07 per cent provided the cast scrap does not exceed 50 per cent of the charge. There is a loss of sulphur of from 0.01 to 0.03 per cent during the melting without lime additions.

Carbonizing

The carbonizing of the iron is very simple if the carbonizing material is finely divided (½ in. and smaller), and used in excess.

The first attempts at carbonizing were very discouraging, because the materials used were all large size. Charcoal was first tried but not with very satisfactory results. The charcoal was of about 4 in. average size, being used just as it came from the pit. The electrode would arc in time on the charcoal and would not heat the metal nor carbonize it, the result being cold metal and low carbon (2.80 to 3.00). Coke breeze was next tried with somewhat better results, but the excessive ash and the fact that coke up to 2 in. was in the breeze made this material undesirable. Finally, a few tons of anthracite dust of slack was obtained from a ferromanganese smelter and tried. The first attempt was not very promising, but upon larger additions being made, a carbon content up to almost any desired amount could be attained. The ash in the anthracite coal ran about 5 per cent, while that in the coke ran as high as 25 per cent.

Charcoal was then crushed and found to be equal and in some ways superior to anthracite coal, but on account of the excessive cost of charcoal and having no facilities for crushing, anthracite coal was adopted for carbonizing. The relative cost and value of different carbonizers is given below:

Material	Ash, per Cent	Fixed Carbon, per Cent	Cost per Ton
Anthracite coal	5.0	88.00	$11.00
Charcoal	2.5	76.00	28.00
Coke	21.00	67.00	14.00
Coke	14.00	75.00	18.00

After a series of experiments it was found that a complete and even carbonization could be effected by operating with a cover of coal of from 4 to 6 in. over the metal. This perhaps explains why the continuous method of charging works so successfully with the light scrap. During operation the coal is in a state of incandescence, and the molten iron filtering down through this hot mass of fine coal is carbonized completely due to a combination of high temperature and large exposed area.

The metal is maintained at a white heat due to the hot bed of coal directly over it, the coal separating the semi-fused and cooler scrap from the molten metal. Samples were taken at the beginning and finish of a tap and the analysis was found to be very uniform.

When making gray iron for direct use in the foundry care must be used not to have too high a carbon content and a separation of graphite in the molds. In case the preliminary sample shows an excess of graphite, this can be cut by adding a few hundred pounds of steel scrap. When the excess graphite begins to show in the castings, it is best to cut down the amount of coal in the charge, or omit it altogether from a few charges.

Should it be desired to make a lower carbon iron, or so-called semi-steel, only a small amount of carbon should be added, then if the fracture appears too low the carbon may be raised by adding more coal and boiling the metal with a green pole, or by boiling without the coal addition, as sufficient coal is usually on the bed to completely carbonize when boiling is resorted to. When making the lower carbon irons it is more desirable to run single charges and melt down the entire charge before tapping, as better control of the carbon may thus be had.

An all-steel scrap charge gives a better iron of low carbon content (3.00 per cent) than can be had from cast borings or a mixture of cast iron and steel, being freer from impurities and lower in phosphorus. The iron made from an all-steel scrap mix is very fluid and has plenty of "life," even more than iron of similar analysis from the cupola.

In the production of pig iron one does not need to be so careful about the high carbon content. Pig iron running 3.75 to 4.25 per cent total carbon is readily made in a furnace operating with a thick bed of the proper size material and the right voltage between phases (60 to 75 volts).

In order to see what the cupola could accomplish in the way of carbonizing, a charge of 500 lb. of boiler scrap was run through the cupola along with the requisite amount of lump ferrosilicon. The iron produced was close grained but machined readily. The analysis of the iron produced from boiler punchings in the cupola is as follows:

	Per Cent		Per Cent
Combined C	0.96	Mn	0.35
Graphite C	2.02	P	0.04
Total C	2.98	S	0.08
Si	2.54		

This metal did not have the fluidity that metal of

similar analysis tapped from the electric furnace, although both appeared to have about the same temperature at the time of tapping. The cupola metal set very quickly after being poured in the mold and left a small skull in the ladle. The metal was sound and free from blow-holes. The electric iron made from boiler punchings was very fluid and set slowly in the mold; it poured like oil from the ladle, leaving no skull.

Basic Slag

Lime is added to the charge for the sole purpose of lowering the sulphur content in the finished metal. The addition of lime has been found necessary only when making pig iron to specifications, the high limit ranging from 0.03 to 0.05 per cent sulphur. The basic slag was run on a carbon bottom, also on a silica bottom. One reason why the basic slag worked so well, using an acid furnace, is due to the fact that a very heavy bed of coal held the slag and kept it out of contact with the side walls of the furnace. As a matter of fact, the side walls at times had a tendency to build up with accumulation of slag crust, and spar would have to be added in increasing amounts to cut the slag from the side walls. The iron filtering through the bed of coal and basic slag is both cleansed and carbonized at the same time.

When using lime it is best to add some spar to prevent the lime from entering the metal. Lime under certain conditions appears to have a very deleterious effect upon cast iron, due no doubt to the concentrated heat of the arc-forming carbides of calcium which are absorbed to a greater or less extent by the iron at existing temperatures unless the calcium carbide is in such dilution in the slag by the aid of spar as not to be readily absorbed. The proper control of temperature also aids in preventing the absorption.

The effect of calcium compounds in cast iron is very similar to that produced by aluminum carbide; the iron on being poured has the appearance of burned iron if the total carbon content is not above 3.45 per cent. The iron when poured in green sand molds has a tendency to develop blow-holes beneath the skin of the metal.

However, if the total carbon content is above 3.50 per cent, a very good cast can be made, but the iron does not have the life of ordinary iron. If the total carbon content exceeds 3.65 per cent, with calcium compounds present, the iron, upon cooling somewhat, becomes sluggish with separation of graphite on the ladle, lumps like large marbles separate out and are readily distinguished when pouring; these lumps break up and appear to be mostly graphite with small amount of slag. At times the ladle of 200-lb. capacity would suddenly start an accumulation of graphite and upon trying to skim this off it was found impossible to do so, and it would have to be pigged. The total carbon on these heats rarely exceeded 3.75 per cent and yet the metal would have 1 to 3 in. of graphite covering it. While this high-carbon metal appeared sluggish, the melting point was very low as compared with ordinary iron.

Effect of Aluminum Upon Cast Iron

The effect of aluminum upon cast iron is pretty well known and has been widely discussed; but the effect of carbides of aluminum upon cast iron has been given little attention.

The subject was brought quite forcibly to the writer's notice when the melter was having trouble with his heat, operating with too heavy a slag, and in trying to raise the carbon content additional slag would be formed from the roof and side walls due to the excessive heat; when the metal was finally poured, if the carbon was under 3.25 per cent, the iron would give the appearance of burned iron, producing blow-holes under the skin of the metal when poured in greensand. No lime was used in these heats referred to. Sometimes the metal would purge from the molds when poured into heavy work. Under similar conditions with iron high in carbon, the castings would be free from blow-holes, but would not be as fluid when poured as metal made under the proper conditions. A scum was noticeable over the metal and would continue to form after being lifted off by the skimmer, otherwise the metal lay quiet in the ladle and to all appearances was good iron. The results noted were very similar to those produced by a dry basic slag.

When the trouble was first experienced, increased amounts of silica were added to see if the blow-holes could be eliminated, but even with silicon up to 4 per cent and carbon 3.00 to 3.25 per cent the blow-holes still persisted. Analyses of various irons showed the aluminum content to run from 0.4 to 1.25 per cent. Upon the addition of water to the borings from these bad heats gases were evolved much more readily than from turnings from other heats.

High Temperature Effects Aluminum Content in Iron

The writer believes that with the intense heat produced by the arc and in the presence of aluminous bearing materials such as the firebrick in large excess, carbides of aluminum are formed and absorbed at the high temperatures as the iron passes through the coal mass. These same aluminum carbides, being very energetic chemically, react with the moisture in the molds and produce the gas holes, giving the appearance of the so-called burned iron.

In cupola practice bad iron often results from the use of cheap fireclays, or running the cupola excessively not, accumulating aluminous slag, which, if not properly fluxed, reacts with the coke; especially if the temperature is very high due to high blast pressure and contracted area in coke bed, the iron may absorb aluminum carbide and produce the so-called burned iron. The writer has noticed that from the same ladle of cupola iron a dry mold casting would be perfectly sound, while a greensand casting would develop blow-holes under the skin of the casting.

A small experiment made by the writer in the East upon the action of vanadium thermit in cast iron recalls a condition which tends to cast light upon the action of aluminum or aluminum carbide on cast iron. A mixture of vanadium oxide and 90 per cent silicon was made into a capsule and placed in the bottom of a 200-lb. ladle, the iron was poured on the capsule—the reaction taking place reducing the vanadium—and was then poured into a greensand mold; the casting was perfectly sound. A second ladle was poured, placing the same size capsule on top of the molten iron in the ladle. After the reaction the iron was stirred and poured into greensand mold, and good casting resulted. All together six ladles were poured using the 90 per cent silicon vanadium mixture in varying amounts and good iron resulted every time.

The experiments were repeated, using aluminum-vanadium oxide thermit mixture, and in every case the iron upon being poured into greensand purged upon standing or developed blow-holes upon machining the casting. Thinking that perhaps the theoretical amount

of aluminum was not enough to give complete reduction of the oxide of vanadium, a 10 per cent excess was added, then increased to 25, and finally double the theoretical amount was added, and in every case blowholes developed. The iron to all appearances after the thermit reaction was as good as any, not showing signs of being wild or gassing. The untreated castings from the same heat were all good. Stick aluminum was added in the last ladle after the thermit reaction, but gave no better results. Ten ounces of aluminum was added to an untreated ladle of iron and after stirring well was poured; the iron produced a sound casting, which tends to prove the iron was all right.

Comparing the results in the electric furnace with the reaction of aluminum and vanadium oxide, the conclusion reached is that the temperature produced by the thermit reaction was sufficient to form aluminum carbide in the iron, which reacted with the moisture in the sand. Aluminum carbide is very unstable and active chemically. If the gas in the iron was due directly to oxides being present on account of the vanadium oxide, then one would naturally expect the silicon mixture to give the trouble, because the heat of reaction is much less than that of aluminum with vanadium oxide.

Carl Buberl, in the July 1, 1921, issue of *Foundry*, calls attention to the fact that "cupola daubing clay affects iron." While Mr. Buberl does not say that the iron absorbs aluminum compounds, he does state that the iron absorbed something from the clay and gave poor castings. When a better grade of clay was used and less slagging encountered, the trouble was less frequent. This all tends to prove my theory regarding the absorption of aluminum carbide at high temperatures. I believe that much of the so-called burned iron from the cupola is not due to excess of oxygen absorbed or present as oxides, but is due to bad slag conditions and contamination from aluminous materials.

The only way to overcome this difficulty both in the cupola and in the electric furnace is by the proper selection of refractories, and by keeping dry aluminous slag off the metal. We have tried various additions to the ladle, also poling in the furnace with a green pole, but once the metal has been contaminated by aluminum you must either raise the carbon sufficiently high to overcome the effect of the aluminum carbide or pig the heat. In cupola practice, of course, it is impossible to raise the carbon, but with the electric furnace one has a somewhat wider range of operation.

There is an excellent field for investigation of the influence of calcium and aluminum carbide on cast iron of varying carbon content at high temperatures, such as are attained in the electric furnace.

Spar

Spar is used largely with basic slags to give fluidity, but when using basic slag on an acid bottom should not be used too freely, otherwise the acid lining is attacked and the basic slag goes over to acid slag. The usual additions of lime and spar were 15 to 20 lb. lime and 8 to 15 lb. of spar to the ton of metal melted. The thick bed of coal also aids in keeping the slag from the sidewalls of the furnace.

The sulphur content of the charge is reduced during the melting as the molten metal passes through the coal bed and basic slag. For this reason the acid-lined furnace would not work as well in the duplex process operating a basic slag, for in this case the furnace is usually not operated with a thick bed of coal which holds the slag. However, there is a possibility that a modification of this method of refining might be adopted in the duplex process and work out quite satisfactorily.

Analyses of several consecutive heats are given in Table I to demonstrate the control of the electric furnace on synthetic iron.

TABLE I—ANALYSES OF HIGH-MANGANESE PIG IRON

Heat No.	Silicon	Total Carbon	Manganese	Phos.	Sulphur
71	2.87	3.59	4.02	0.14	0.03
72	2.96	3.46	4.04	0.16	0.03
73	3.10	3.33	4.00	0.17	0.035
74	2.98	3.60	4.08	0.12	0.035
75	2.44	3.46	4.28	0.16	0.03
76	2.92	3.52	4.02	0.12	0.03
77	3.01	3.31	4.24	0.14	0.035
78	2.44	3.35	4.08	0.15	0.035
		Analyses of Foundry Iron			
97	2.54	3.42	0.58	0.14	0.035
98	2.63	3.63	0.64	0.14	0.03
99	2.87	3.59	0.66	0.16	0.035
100	2.84	3.46	0.59	0.15	0.025
101	2.89	3.67	0.77	0.15	0.03
102	2.81	3.77	0.59	0.13	0.03
103	2.85	3.62	0.66	0.15	0.035
104	2.69	3.65	0.61	0.17	0.03

The irons analyzed were all made in the electric furnace with an acid lining, using lime and spar in the charge. Furnace was operated continuous charging with about 6-in. bed of coal over the molten metal. The charge consisted of mixed turnings and borings, which accounts for some variation in the silicon content of the finished metal. Using all steel turnings, the silicon content can be held much more uniform. When an all cast boring charge is used the amount of coal needed is very much less, and this must be taken into consideration to avoid metal too high in carbon.

Comparative Cost of Electric Furnace Operation

One great drawback to an electric furnace operating intermittently is the sliding scale power rates as now existing in many localities. A furnace should be operated 16 hours a day to obtain economical operation and a good power rate. When business is slack and the foundryman is pouring a limited tonnage each week, perhaps operating less than one shift per day, he must pay a greatly increased rate besides getting a lower furnace efficiency.

For this reason a foundryman contemplating a furnace installation should figure a furnace of such capacity as to operate 24 hours when the foundry is at capacity, instead of operating only the one shift. Then when conditions arise to cut the capacity down to say 25 per cent of normal, the electric furnace can still operate practically one shift with economy.

For the sake of comparison I give in Table II comparative costs of one-, two- and three-shift operation.

Summary of Operating Costs

In summing up these figures we find the operating costs as follows:

Total cost per net ton of iron at the spout: One shift, $40.33; two shifts, $30.18; three shifts, $27.40. These figures do not include fixed charges, which vary in different plants, but are given to show the actual necessity of operating the electric furnace at least two shifts to get a desired economical operation. This does not mean that the remainder of the plant or foundry need go on a two-shift basis. The figures are based on actual opera-

TABLE II—COMPARATIVE COSTS OF ONE-, TWO- AND THREE-SHIFT OPERATION

Figures based on 2-ton furnace, 750-kw. electrical capacity

Cost of materials:		
Scrap (turnings and borings), net ton		$10.00
Power:		
1 shift, 1.25 c. kw.-hr.		
2 shifts, 1.00c. kw.-hr.		
3 shifts, 0.80c. kw.-hr.		
Coal (anthracite), net ton		15.00
Electrodes (graphite), lb.		.24
Lime (in bbl.), net ton		30.00
Spar, net ton		40.00
Silicon, gross ton		100.00
Manganese steel (12 per cent), net ton		30.00
Melting loss using tunings not rusted, 10 per cent		
Production of iron:		
1 shift, 6 tons		
2 shifts, 14 tons		
3 shifts, 22 tons		
Power consumption per ton:		
1 shift, 850		
2 shifts, 800		
3 shifts, 750		
Cost of operation one shift 8 hours		
Conversion cost:		
Power, 6 x 850 = 5,100 kw.-hr. @ 1.25c. kw.-hr.		$63.75
Materials:		
Electrodes, 6 x 15 = 90 lb. @ 24c.	$21.60	
Lime, 6 x 20 = 120 lb. @ 1.5c. lb.	1.80	
Spar, 6 x 15 = 90 @ 2c. lb.	1.80	
Coal, 200 x 6 = 1,200 lb. @ 0.75c. lb.	9.00	
Silicon, 6 x 50 = 300 lb. @ $100 ton	13.40	
Mn steel 6 x 50= 300 lb. @ 1.5c. lb.	4.50	48.90
Labor:		
1 melter @ $6	6.00	
2 laborers @ $4	8.00	
		14.00
Repairs and miscellaneous:		
Furnace	6.00	
Tools	3.00	
Water and miscellaneous	3.00	12.00
Total		$138.65
Conversion cost per ton, $138.65 ÷ 6		29.33
Cost of scrap @ $10 plus 10 per cent loss		11.00
Total cost net ton at the spout		$40.33
Cost of furnace operation, 2 shifts		
Conversion cost:		
Power, 14 x 800 = 11,200 kw.-hr. @ 1c		$112.00
Materials:		
Electrodes, 12 x 14 = 168 lb. @ 24c	$40.32	
Lime, 14 x 20 = 280 lb. @ 1.5c.	4.20	
Spar, 14 x 15 = 210 lb. @ 2c.	4.20	
Coal, 14 x 200 = 2,800 lb. @ 0.75c.	21.00	
Silicon, 14 x 50 = 700 lb. @ $100 ton	31.25	
Mn steel, 14 x 50 = 700 @ 1.5c. lb.	10.50	111.47
Labor:		
2 melters @ $6	12.00	
4 laborers @ $4	16.00	
		28.00
Repairs and miscellaneous:		
Furnace	8.00	
Tools	6.00	
Water and miscellaneous	3.00	17.00
Total		$268.47
Conversion cost per ton, $268.47 ÷ 14		$19.18
Scrap cost @ $10 ton plus 10 per cent loss		11.00
Total cost per net ton at spout of furnace		$30.18
Cost of furnace opera ion, 3 shifts		
Conversion cost:		
Power 22 x 750 = 16,500 kw.-hr. @ 8c. kw.-hr.		$132.00
Materials:		
Electrodes, 22 x 10 = 220 @ 24c. lb.	$52.80	
Lime, 22 x 20 = 440 @ 1.5c. lb.	6.60	
Spar, 22 x 15 = 330 @ 2c. lb.	6.60	
Coal, 22 x 200 = 4,400 @ 0.75c. lb.	33.00	
Silicon, 22 x 50 = 1,100 @ $100 ton	49.11	
Mn steel, 22 x 50 = 1,100 @ 1.5c. lb.	16.50	
		164.61
Labor:		
3 meltera @ $6	18.00	
6 laborers @ $4	24.00	42.00
Repairs and miscellaneous:		
Furnace	10.00	
Tools	9.00	
Water and miscellaneous	3.00	
		22.00
Total		$360.61
Conversion cost per ton, $360.61 ÷ 22		$16.40
Scrap cost, $10 ton plus 10 per cent for loss		11.00
Total cost per net ton of iron at the spout		$27.40

tions covering several months. The average analysis of the iron made was as follows: Silicon, 2.25; carbon, 3.50; manganese, 0.65; sulphur, 0.04; phosphorus, 0.15.

Many suggestions have been offered regarding the possibility of smelting iron ore with scrap in localities where ore was available and only a limited amount of scrap. In view of present power cost, high labor cost and the fluctuating market of pig iron, this proposition appears for the present entirely out of question, as the figures in Table III will show.

TABLE III—ESTIMATED COST OF PRODUCING GRAY IRON FROM TURNINGS, BORINGS AND IRON ORE (Hematite or Limonite)

For comparison with the preceding figures we will assume a furnace of 750-kw.-hr. electrical capacity, stationary furnace of the crucible type, with arch and charging doors under the arch.

Charge to produce 2 net tons pig iron:		
1.1 tons scrap		
2.2 tons ore high grade		
80 lb. lime		
30 lb. spar		
1,400 lb. coal		
100 lb. silicon		
100 lb. Mn scrap		
Power required for scrap per ton of iron produced, kw.-hr.		750
Power required per ton iron from ore, kw.-hr.		2,200
Power required to smelt one charge producing 2 tons iron, kw.-hr.		2,950
The furnace operating on 90 per cent load factor would consume 750 x 24 x 0.9 = 16,200 kw.-hr. per 24 hours		
The number of charges run in one day or 24 hours would be 16,200 ÷ 2,950 = 5.5 charges, or a daily production of 11 net tons iron		
Conversion cost:		
Power, 16,200 kw.-hr. @ 0.8c. kw.-hr.		$129.60
Materials:		
Electrodes, 220 lb. @ 24c. lb.	$52.80	
Lime, 440 lb. @ 1.5c.	6.60	
Spar, 165 lb. @ 2c. lb.	3.30	
Coal, 5.5 x 1,400 = 7,700 @ 0.75c.	57.75	
Silicon, 5.5 x 100 = 550 @ $100 ton	24.55	
Mn steel, 5.5 x 100 = 550 @ 1.5c. lb.	8.25	
Labor (see 3-shift operation)		42.00
Repairs and miscellaneous (see 3-shift operation)		22.00
Total		$346.85
Conversion cost per net ton, $346.85 ÷ 11		31.45
Scrap cost, 1.1 tons @ $10 ton ÷ 2		5.50
Ore cost, 2.2 tons @ $5 ton ÷ 2		5.50
Total cost of iron per net ton from ore and scrap based on 3-shift operation		$42.45

Under similar operating conditions we have an iron cost of $27.40 per net ton using all scrap, as against $42.45 using ore and scrap mixed. The greatly increased power required to smelt ore cuts down the output and brings up the cost.

If it is desired to produce pig iron with a higher silicon content, it is only necessary to add to the total cost the extra expense of the silicon, which runs about $2 additional for each 1 per cent. For convenience the figures given have been for net tons.

Furnace Construction Costs

The cost of furnace construction varies with different localities, but high and low figures are given for comparison.

The figures are based on 750-kw. stationary furnace, acid lined, three phase, three electrodes, hand operated. High tension voltage, 11,000; low tension side, 70 volts, sixty cycle. Three transformers, air-cooled type.

Furnace steel work	$700.00	$900.00
Transformers and freight	3,200.00	4,200.00
Furnace lining	400.00	700.00
Foundations	250.00	300.00
Plumbing	100.00	150.00
Electrical equipment and castings	1,000.00	1,500.00
Miscellaneous	300.00	500.00
Total	$5,959.00	$8,250.00

The higher figure would cover installations of this type in the West and includes all labor, but not engineering service. While this furnace gives very good results and is especially adapted for the production of pig iron, the so-called tilting furnaces are better adapted for general casting work in the foundry, and are almost universally used for this purpose.

Flake Graphite as a Lubricant

A study of flake graphite as a lubricant is being made by the Bureau of Mines. An interesting development in connection with the graphite work is that the lower grades can be purified by the Trent process, thus rendering them suitable for lubrication purposes.

The Relation Between the Composition of Vapor and Liquor in Distillation

An Experimental Study of Some of the Fundamental Laws Governing the Distillation of Mixtures, Including the Derivation of a Number of Formulas of Use in the Solution of Practical Problems Connected With the Design and Operation of Distillation Equipment

BY EMIL PIRON
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THERE are many in the chemical industries, especially among the younger members of operating and production departments, who are more or less unfamiliar with the basic laws of distillation. It is therefore the intention of the present paper to review some of these theoretical considerations and to show that they have an important bearing on practical problems confronting the operator, as well as the designer, of distillation apparatus.

If s is the proportion of one component in a mixture such as a gas liquor, and S the proportion of the same component in the vapor distilled from this liquor, the relation between the composition of the vapor and liquor in regard to the considered component is $k = \frac{S}{s}$

In industrial distillation, liquors are either concentrated or exhausted and in both cases the strength of the liquor passes through a number of stages of different concentration. Knowing the values of k corresponding to these different stages, we are in a better position to study the design of the distillation apparatus and to control its operation.

DETERMINING DISTILLATION CONSTANT EXPERIMENTALLY

One way in which the values of k can be obtained is to submit a relatively large quantity of liquor to distillation, taking very small fractions of the distillate, so that the composition of the liquor can be considered as constant during the distillation of each fraction. An analysis of the liquor and of the corresponding distillate will give corresponding values of s, S and k.

In Table I a distillation test on 1,000 c.c. of ammonia liquor, as obtained by coal distillation, is given as an example. It will be noted that the value of k varies with the strength of the liquor.

OBTAINING THIS VALUE BY CALCULATION

On the other hand, in distillation problems we need an ideal or average constant value of k, which, when applied to the problem, will give a result conforming to the actual. This ideal value of k can be found by the following method.

Suppose we distill out of a quantity Q of liquor, containing a proportion s of a component, an infinitesimal quantity dQ. The proportion of the same component in the distillate at the beginning of the distillation is S, at the end $S - dS$. The average strength of the distillate is $S - \frac{1}{2}dS$, while the quantity of the component we have in the distillate is $(S - \frac{1}{2}dS)\,dQ$.

During the distillation, the proportion of the component in the liquor changed from s to $(s - ds)$, the quantity remaining in the liquor after distillation being $(Q - dQ)\ (s - ds)$.

Hence the relation

$$Qs - (Q - dQ)\ (s - ds) = (S - \tfrac{1}{2}dS)\,dQ$$

which gives, after neglecting the differentials of the second order,

$$\frac{dQ}{Q} = \frac{ds}{S - s}$$

or, if the initial quantity of liquor was Q_o:

$$\log_e Q_o - \log_e Q = \int_{s_o}^{s} \frac{ds}{S - s}$$

If $\frac{S}{s} = k$ (constant), then

$$\log_e Q_o - \log_e Q = \frac{1}{k - 1}\,(\log_e s_o - \log_e s)$$

or

$$\left(\frac{Q_o}{Q}\right)^{k-1} = \frac{s_o}{s} \qquad (1)$$

which gives the desired value of k.

For instance, according to the distillation test given in Table I, we have

$$Q_o = 1{,}000 \qquad Q = 500$$
$$s_o = 7.72 \qquad s = 0.006$$

hence

$$\left(\frac{1{,}000}{500}\right)^{k-1} = \frac{7.720}{0.006}$$

$$k - 1 = \frac{\log_e 7.72 - \log_e 0.006}{\log_e 2} = 10.3$$

$$k = 11.3$$

This value of k, applied to distillation operations where the concentration of the ammonia liquor of the quality given above varies from 7.72 to 0.006 g. per liter, will give results corresponding with those actually obtained.

There are, however, instances in which it is not so easy to find the value of k—that is, cases where the pro-

TABLE I—DISTILLATION TEST ON 1,000 c.c. OF AMMONIA LIQUOR

Liquor in Distillation				Distillate			
Quantity, c.c.	Volatile Ammonia—g. Total	Volatile Ammonia—g. per Liter	Aver.	Quantity, c.c.	Ammonia—g. Total	Ammonia—g. per Liter	$S = -$
1,000	7.7200	7.7200					
				25	1.7660		
975	5.9540	6.1060	5.835	5	.4580	91.590	15.7
970	5.4960	5.5630		70	3.7110		
900	1.7850	1.9830	1.915	5	.1388	27.762	14.5
895	1.6462	1.8470		95	1.1727		
800	0.4735	.5920	.575	5	.0304	6.086	10.6
795	0.4431	.5570		95	.3056		
700	0.1375	.1950	.191	5	.0073	1.4625	7.6
695	0.1302	.1870		95	.0892		
600	0.0410	.0680	.066	5	.0030	.6120	9.3
595	0.0380	.0640		95	.0350		
500	0.0030	.0060					

There are, however, instances in which it is not so easy to find the value of k—that is, cases where the pro-

portion of the considered component cannot be readily determined by chemical analysis, as happens, for instance, with mixtures of components of the same organic group. In such cases the following method will often give fair results.

Laws Applicable to Mutually Soluble Mixtures

In industrial practice, such mixtures consist generally of components of one chemical group which dissolve perfectly one in the other and respond very nearly to the relation

$$a_{1\times 2} = \sqrt{a_1 \times a_2}$$

where $a_{1\times 2}$ represents the mutual attraction of the unlike, and a_1, a_2 the mutual attraction of the like molecules.

Under such conditions, the following general laws can be applied:

(1) The partial vapor pressure of each component equals the product of the vapor pressure p of the same component considered separately, multiplied by the molecular proportion m of the said component in the mixture.

(2) The vapor pressure P of the mixture equals the sum of the partial vapor pressures of the components:

$$P = p_1 m_1 + p_2 m_2 + \ldots$$

(3) The molecular proportion M of a component in the vapor is in ratio with the partial pressure pm of same component in the mixture:

$$\frac{M_1}{m_1 p_1} = \frac{M_2}{m_2 p_2} = \ldots \qquad (2)$$

These two relations give:

$$\frac{M_1}{m_1 p_1} = \frac{M_2}{m_2 p_2} = \ldots = \frac{M_1 + M_2 + \ldots}{m_1 p_1 + m_2 p_2 + \ldots} = \frac{1}{P} \qquad (3)$$

and consequently the relation k' between the molecular proportions of each component in the vapor and in the liquor is:

$$k' = \frac{M}{m} = \frac{p}{P}$$

in which p is the vapor pressure the investigated component (considered separately as a pure liquor) would have at the temperature of the mixture, and P the pressure under which the distillation is made.

If we consider the proportions in weight S and s of a component in the vapor and in the liquor respectively, we have further:

$$\frac{S_1}{M_1 \text{ mol}_1} = \frac{S_2}{M_2 \text{ mol}_2} = \ldots = \frac{1}{M_1 \text{ mol}_1 + M_2 \text{ mol}_2 + \ldots}$$

$$\frac{s_1}{m_1 \text{ mol}_1} = \frac{s_2}{m_2 \text{ mol}_2} = \ldots = \frac{1}{m_1 \text{ mol}_1 + m_2 \text{ mol}_2 + \ldots}$$

where "mol" represents the molecular weight of the component.

This introduced in the relation (2) gives:

$$\frac{S_1}{p_1 s_1} = \frac{S_2}{p_2 s_2} = \ldots = \frac{1}{p_1 s_1 + p_2 s_2 + \ldots}$$

and

$$k = \frac{S}{s} = \frac{p}{p_1 s_1 + p_2 s_2 + \ldots}$$

But the use of this relation is not as easy as that of the relation (3), because $p_1 s_1 + p_2 s_2 + \ldots$ is not equal to the pressure P and must be calculated whenever the proportion of the components in the liquor is altered.

When we go further into the question, we see that the knowledge of k' given by the expression

$$k' = \frac{p}{P}$$

presupposes the knowledge of p (the vapor pressure of the pure component at the temperature of distillation of the mixture) with a degree of exactness we cannot find, in general, through the information we have available concerning vapor pressures.

Compensating for Differences in Vapor Pressure

For instance, for benzene, we find, according to different authors, vapor pressures varying as follows:

Temperature, Deg. C.	Vapor Pressure, Mm. of Hg
50	272.1 to 268.9
60	393.0 to 380.5
70	554.2 to 548.2
80	756 to 755
90	1,018 to 1,016
100	1,335 to 1,344
110	1,740 to 1,748

If we take the pressures shown in the third column and given by the Bureau of Longitudes of Paris,[1] as being the more correct, we still find considerable divergence from the calculated values. First, we note that the pressure 380.5 mm. should be 389.5 mm. Then, making the differences between this pressure and that of the vapor pressure at 50 deg. the first difference, and making the second difference the spread between the first differences, and then continuing the process to the third difference, we obtain the following values:

Vapor Pressures Mm. of Hg	First Difference	Second Difference	Third Difference
268.9			
	120.6		
389.5		38.1	
	158.7		10
548.2		48.1	
	206.8		6.1
755		54.2	
	261		12.8
1,016		67	
	328		9
1,344		76	
	494		
1,748			

As vapor pressure increases according to natural laws, it is evident that the third difference should vary uniformly, at least as long as no disturbing phenomena are met. The reason it does not vary uniformly is that the indicated pressures are not absolutely correct, but are located sometimes above, sometimes below, the real curve of pressures. We must therefore try to locate a uniform and more correct curve between these pressures. Values for such a curve can be obtained empirically after a few trials, and we derive the following table:

Temperature, Deg. C.	Corrected Pressure, Mm. of Hg	First Difference	Second Difference	Third Difference
50	268.9			
		120.6		
60	389.5		38.5	
		159.1		8.8
70	548.6		47.3	
		216.4		8.8
80	755		56.1	
		262.5		8.8
90	1,017.5		64.9	
		327.4		8.8
100	1,344.9		73.7	
		401.1		
110	1,746			

These values appear to correspond very closely to the reality.

Within the small range of temperatures used in distillation and using a constant third difference as a basis we can derive an expression which will give us a scale of temperatures sufficiently accurate for most purposes.

This is not absolutely general, but the practical results obtained by this method are more accurate than any other results based on experience.

[1] Annuaire du bureau des longitudes de Paris. Données physiques.

This scale of pressures is constructed as follows:

Third Difference	Second Difference	First Difference	Vapor Pressure a	Row 1
		b		
	c—		$a + b$	2
d		$b + c$		
	$c + d$		$a + 2b + c$	3
d		$b + 2c + d$		
	$c + 2d$		$a + 3b + 3c + d$	4
d		$b + 3c + 3d$		
	$c + 3d$		$a + 4b + 6c + 4d$	5
		$b + 4c + 6d$		
			$a + 5b + 10c + 10d$	6

where the expression of the pressure is given by the following equation:

$$p = a + b\frac{n-1}{1} + c\frac{n-1}{1}\times\frac{n-2}{2} + d\frac{n-1}{1}\times\frac{n-2}{2}\times\frac{n-3}{3} + \ldots.$$

This equation, when applied to the table already given for the vapor pressures of benzene, would give

$$n = \frac{t-40}{10}$$

$$p = 268.9 + 120.6\frac{t-50}{10} + \frac{38.5}{2}\times\frac{t-50}{10}\times\frac{t-60}{10} + \frac{8.8}{6}\times\frac{t-50}{10}\times\frac{t-60}{10}\times\frac{t-70}{10}$$

or

$$p = -64.6 + 6.58t - 0.9715t^2 + 0.001466t^3$$

But the use of this equation is difficult and it would be more convenient to have a table of pressures varying from degree to degree. In order to prepare such a table, we can make use of the quantities A, B, C, D, calculated from the equations:

$$D = \frac{d}{1{,}000};\ C = \frac{c - 900D}{100};\ B = \frac{b - 45C - 120D}{10};\ A = a$$

Applying these to the data for benzene, we obtain:

$$A = 268.9$$
$$B = 10.5783$$
$$C = 0.3058$$
$$D = 0.0088$$

and vapor pressures as shown in Table II.

TABLE II—CORRECTED VAPOR PRESSURES FOR BENZENE AND TOLUENE

Benzene Temp., Deg. C.	Toluene Vapor Pressure, Mm. of Hg	Toluene Pressure Difference per Deg. C.	Toluene Temp., Deg. C.	Benzene Temp., Deg. C.	Benzene Pressure Difference per Deg. C.	Benzene Vapor Pressure, Mm. of Hg
50	268.9		77.6	80		755.0
51	279.5	9.8	78.7	81	23.6	778.6
52	290.4	10.0	79.8	82	24.1	802.7
53	301.6	10.3	80.9	83	24.7	827.4
54	313.1	10.6	82.0	84	25.4	852.8
55	324.9	10.9	83.0	85	25.9	878.7
56	337.1	11.2	84.1	86	26.5	905.2
57	349.7	11.6	85.2	87	27.1	932.3
58	362.6	11.9	86.3	88	27.8	960.1
59	375.9	12.2	87.4	89	28.4	988.5
60	389.5	12.5	88.5	90	29.0	1,017.5
61	403.5	12.9	89.6	91	29.7	1,047.2
62	418.0	13.3	90.6	92	30.3	1,077.5
63	432.8	13.6	91.7	93	31.0	1,108.5
64	448.0	14.0	92.8	94	31.7	1,140.2
65	463.7	14.4	93.9	95	32.3	1,172.5
66	479.8	14.8	95.0	96	33.1	1,205.6
67	496.3	15.2	96.1	97	33.7	1,239.3
68	513.3	15.6	97.2	98	34.5	1,273.8
69	530.7	16.0	98.2	99	35.2	1,309.0
70	548.6	16.5	99.3	100	35.9	1,344.9
71	567.0	16.9	100.4	101	36.6	1,381.5
72	585.8	17.3	101.5	102	37.4	1,418.9
73	605.2	17.8	102.6	103	38.2	1,457.1
74	625.0	18.2	103.7	104	38.9	1,496.0
75	645.3	18.7	104.8	105	39.7	1,537.5
76	666.2	19.2	105.8	106	40.5	1,576.2
77	687.6	19.7	106.9	107	41.2	1,617.4
78	709.5	20.2	108.0	108	42.1	1,659.5
79	732.0	20.7	109.1	109	42.8	1,702.3
80	755.0	21.2	110.2	110	43.7	1,746.0

Knowing the vapor pressures of benzene, we can readily find the temperatures at which the other members of the benzene group have the same vapor pressure, by applying the law of proportion of absolute temperatures at equal pressures:

$$\frac{T_1}{T_2} = \frac{T'_1}{T'_2}$$

For instance, we have at a pressure of 760 mm. of mercury:

Boiling point of toluene.... 110.4 deg. C.
Boiling point of benzene.... 80.2 deg. C.

$$\frac{T_{tol}}{T_{ben}} = \frac{273 + 110.4}{273 + 80.2} = 1.0855$$

which will give the corresponding temperatures for toluene as indicated in Table II.

Once we have derived, by this method or any other, a sufficiently complete and correct table of the vapor pressures of the components, we can easily find the values of

$$k' = \frac{p}{P}$$

We have, for instance, for benzene and toluene in mixture boiling at the following temperatures, under a pressure of 760 mm. of mercury:

Temperature, Deg. C.	Benzene	Toluene
80.2	$k' = 1.000$	$k'_2 = 0.385$
81.8	1.050	0.409
83.7	1.112	0.438
85.75	1.182	0.478
88.1	1.267	0.506
90.75	1.368	0.553
93.8	1.492	0.608
97.2	1.640	0.677
101.0	1.818	0.758
105.3	2.036	0.863
110.4	2.320	1.000

In this case, as with ammonia liquor and almost any other mixture, k is variable. Sometimes, however, we are able to find an ideal constant value of k as was done for ammonia liquor, by a similar method. Knowing the composition of the final liquor we want to obtain, we find its boiling temperature with the help of our tables of vapor pressures. Then we can make a distillation test on the original liquor and note the quantity of residue that is left, when the temperature reaches the boiling temperature of the final liquor. With this value Q, and the composition of the original and final liquor s_0 and s, equation (1) will give the average value of k.

More often, however, such a distillation test will not give us any definite result. The purpose of industrial distillation, in general, is to separate almost pure products out of a mixture, and when we distill a sample of the mixture in the laboratory the whole liquor often distills over before the temperature reaches that of the component supposed to remain as residue. The reason is that for these mixtures the value of k is too near to unity and the evacuation of the more volatile components proceeds so slowly that only a quantity of residue, too small to be estimated, remains in the flask. But for liquors distilling according to the laws previously mentioned, if we cannot find the ideal constant value of k by experience, we can calculate it.

We have seen before that

$$\log_e Q_0 - \log_e Q = \int_{s_0}^{s}\frac{ds}{S - s}$$

The values of this integral if determined graphically are the surfaces located between the x-axis, the curve $y = \frac{1}{S - s}$ and the values of s_0 and s. Suppose this value is N and we have

$$\log_e Q_o - \log_e Q = N$$

which, combined with equation (1), gives

$$k = 1 + \frac{\log_e s_o - \log_e s}{N}$$

This value of k will then take the place of its variable values in our distillation problems.

Application to Distillation Problems

For instance, we take a mixture containing 80 per cent of benzene and 20 per cent of toluene from which we wish to extract the benzene until only 0.5 per cent is left in the residue of toluene. Suppose these percentages are molecular proportions for which we have to use the expression $\frac{1}{M - m}$ instead of $\frac{1}{S - s}$. We calculate first, with our tables of pressures, the values of M and $\frac{1}{M - m}$ for different values of m, in order to construct the curve $y = \frac{1}{M - m}$ with sufficient exactness between the values $m_o = 0.8$ and $m = 0.905$.

We find, for instance, that the mixture of 80 per cent benzene and 20 per cent toluene under a pressure of 760 mm. of mercury boils at 84.45 deg. C., since at this temperature

$$p_1 m_1 + p_2 m_2 = 692 + 68 = 760$$

and further, that

$$M = \frac{mp}{P} = \frac{692}{760} = 0.91$$

which, combined with $m = 0.8$, gives

$$\frac{1}{M - m} = \frac{1}{0.11} = 9.091$$

The following table and diagram (Fig. 1) are based on this calculation:

m	M	$\frac{1}{M-m}$	m	M	$\frac{1}{M-m}$
0.80	0.91	9.091	0.20	0.374	5.763
0.70	0.854	6.506	0.10	0.2072	9.328
0.60	0.789	5.277	0.06	0.1300	14.286
0.50	0.711	4.737	0.04	0.08873	20.500
0.40	0.620	4.553	0.02	0.04530	39.516
0.30	0.508	4.805	0.01	0.022974	77.077
			0.005	0.011545	152.790

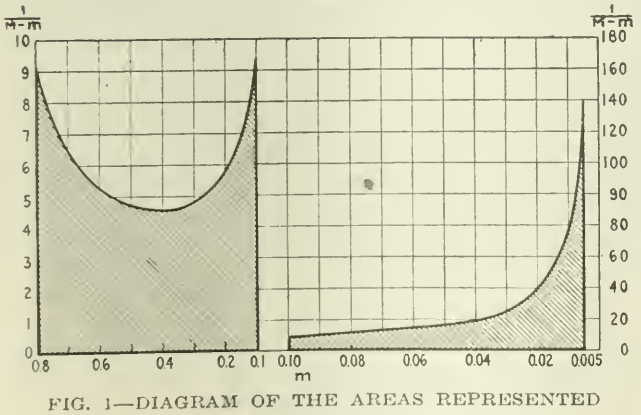


FIG. 1—DIAGRAM OF THE AREAS REPRESENTED BY $\int_{m_o}^{m} \frac{dm}{M-m}$

The area between the curve, the x-axis, the extreme values of m is $N = 6.52$, which gives

$$k = 1 + \frac{1}{6.52} \log_e \frac{0.8}{0.005} = 1.778$$

This represents, therefore, the relation between the composition of vapor and liquor for benzene distilled out of mixtures of benzene and toluene during the distillation of which the concentration of benzene in the liquor passes from 80 per cent to 0.5 per cent.

It is interesting to verify the correctness of the calculated results as compared with those obtained experimentally. During the war, considerable attention was paid to mixtures of benzene and toluene. In an article[2] which appeared in 1916 in the *Journal of the Society of Chemical Industry* are given the boiling points of such mixtures containing the proportion of benzene indicated in the second column of following table. The third column gives the composition calculated according to the method previously discussed:

Temperature, Deg. C.	Percentage of Benzene in Mixture. Observed	Calculated
81.8	90	90.98
83.7	80	80.96
85.75	70	71.17
88.1	60	61.06
90.75	50	50.74
93.8	40	40.30
97.2	30	30.07
101.0	20	20.04
105.3	10	10.08

As will be observed, the differences are small enough to be neglected in ordinary distillation practice. The laws we have utilized to arrive at this result can also be applied to the distillation of other mixtures of the aromatic hydrocarbons as well as those of the paraffin series. It will be noted that the method is to be applied to a chosen component, independently of, and disregarding other components in the mixture.

Ceramic Imports and Exports of Belgium

Commerce Reports for Jan. 16, 1922, summarizes the foreign trade of Belgium in ceramics.

Reviving trade with Germany was one of the outstanding features of Belgium's 1921 imports of ceramic products. Of the ten classes of pottery imports shown in Belgian official statistics, Germany was the chief source for six, France for three and the Netherlands for one. In glassware out of twelve items Germany led in ten and France in two.

Belgium is, however, a much larger exporter than importer of ceramics, its sheet and plate glass having a world-wide reputation for quality and even its more bulky pottery products finding markets in South America and other distant fields. The latest available figures relating to Belgium's foreign trade in ceramic products are those covering the first nine months of 1921. These, with corresponding 1920 data for comparison, are summarized below:

	Imports		Exports and Re-exports.	
Pottery	Jan.-Sept., 1920, Kilos	Jan.-Sept., 1921, Kilos	Jan.-Sept., 1920, Kilos	Jan.-Sept., 1921, Kilos
Earthenware, fine (except tiles)	2,592,890	3,405,721	1,735,355	1,668,371
Chinaware (except tiles)	668,743	1,065,216	77,798	171,818
Terra cotta:				
Bricks, drainage pipes, etc.	41,806,517	75,171,989	342,779,715	598,509,249
Tiles—				
Varnished or enameled, and tongued-and-grooved	2,178,970	4,582,965	21,464,157	28,702,901
Other	2,000,537	531,115	16,310,140	19,232,390
Paving and building blocks and tiles:				
Of earthen or stoneware	443,343	272,783	16,400,408	11,108,272
Of concrete	225,307	75,396	14,399,797	11,921,717
Of fine earthenware or china	132,385	184,940	4,490,460	3,241,376
Not specified	166,121	451,350	5,936,398	1,626,787
Common pottery	1,758,432	1,892,900	4,481,400	1,876,553
Total quantity	51,973,245	87,634,375	428,075,628	678,059,464
	Francs.	*Francs.*	*Francs.*	*Francs.*
Total value	24,619,360	27,947,507	53,011,314	63,523,762

[2] *J. Soc. Chem. Ind.*, 1916, vol. 10, p. 586, "The Estimation of Benzene and Toluene in Commercial Mixtures."

Production of Shrunk Coke in Electrode Manufacture

By J. L. McK. Yardley
General Engineer, Westinghouse Electric & Manufacturing Co.

CARBON and graphitized electrodes are made from retort carbon, petroleum coke or anthracite coal. Petroleum coke is probably the most desirable material for this purpose, since it consists of from 90 to 95 per cent of fixed carbon of from only 5 to 10 per cent of volatile matter, and has less than 1 per cent of either sulphur or ash. In addition, it is easily obtainable in quantity. It has been quoted recently at $12 to $13 per net ton at the refinery Atlantic seaboard. It is the final product in the dry or cracking distillation of paraffine base petroleum and is obtained by the destructive distillation of the tar. The yield is about 10 per cent of the tar or 1 per cent of the petroleum dry distilled. It is particularly desirable to have this material as the principal constituent of electrodes which are to be used in furnaces or in electrolytic processes, into which the least possible amount of silicon impurity should be introduced.

The manufacture of electrodes must meet most exacting requirements from the various industries in

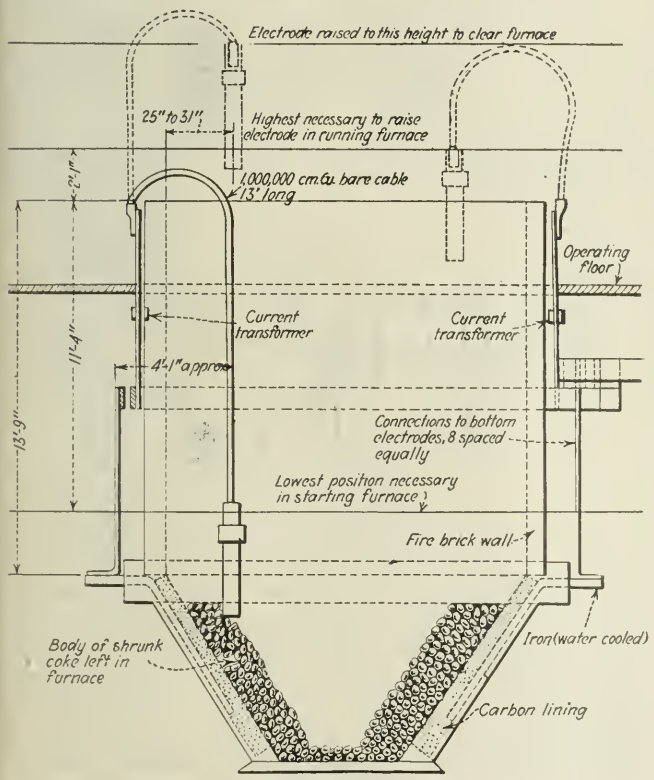


FIG. 1—CALCINING FURNACE, TOP AND BOTTOM ELECTRODE TYPE

which they are employed, and success is dependent upon attention to particulars in the various departments, such as

1. Selection of materials.
2. Calcination of materials.
3. Grading and mixing of materials.
4. Extrusion of homogeneous green electrodes under pressures up to 600 tons.
5. Gradual and uniform baking to an ultimate temperature in the neighborhood of 1,400 deg. C.
6. (Where desired) Graphitizing of baked electrodes in an electric furnace at a temperature above 2,000 deg. C.

These steps in the process of manufacture are all

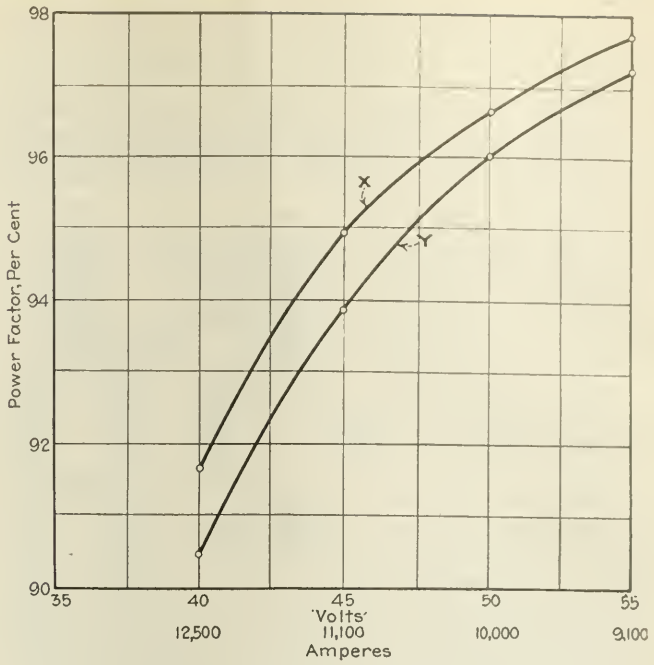


FIG. 2—POWER FACTOR OF 500 KVA. CALCINING FURNACE. SINGLE PHASE, 25 CYCLE

important and interesting, particularly the baking of the electrodes. This is carried out in a large number of producer gas-fired furnaces or pits of ingenious construction and arranged so as to give a high thermal efficiency. In recent installations the calcining of materials is carried on in the electric furnace. Since the raw materials contain considerable volatile constituents, these must be driven off in the calcining operation to form what is called shrunk coke.

Calcining is performed in an open top, single-phase electric furnace of either the two-top electrode type or the top and bottom electrode type. Usual capacity for the former is 500 kva., and around 1,000 kva. for the latter type. Power is applied approximately 24 hours, or until a certain kw.-hr. energy has been expended as pre-established for the material charged. The furnace is left idle to cool for the next day, and on the following day it is emptied and made ready for the next heat. Therefore three furnaces of the present type are required for a cycle for continuous operating, giving an output of about 25 tons a day.

The 1,000-kva. top and bottom electrode type furnace itself consists of a cylindrically shaped steel shell, about 13 ft. in diameter and 14 ft. high. A brass strip is inserted to prevent a complete magnetic circuit. The cylindrical walls are lined with firebrick. The bottom, which may be flat or shaped like an inverted truncated cone, is also lined with firebrick, over which a high-grade dry carbon lining is placed and over this is placed a thin layer of sheet metal to prevent the tar from the petroleum coke from soaking into the lining and ruining it. Eight iron bars are laid in the carbon lining projecting radially toward the center. The bars and the carbon lining constitute one set of electrodes, the current being carried from them by copper connectors to the busbars, which encircle and are supported by the steel shell. The other set of electrodes consists of eight carbons about 7 in. in diameter and 4 ft. long, which are cast about an iron bar approximately 1 x 6 in. in section and 4 ft. long. These bars are attached to flexible copper cables 13 ft.

long. The upper electrodes are adjusted manually by means of winches. A furnace of this type is shown in Fig. 1.

Having had occasion to make a rather thorough investigation of this operation several years ago with my associates, it is proposed to describe an electrical installation which was developed to meet the difficult conditions involved. The conditions are difficult, particularly with 60-cycle power supply, owing to the heavy currents at low voltages which are employed. The particular ends to be attained in addition to high over-all efficiency, are high over-all power factor and uniform division of current between electrodes where there are a number in parallel, so as to produce a uniform heating effect and also ease in operation, and between the parallel secondary supply circuits to the electrodes. As an example of the care with which such furnace installations should be designed, Figs. 2 and 3 are supplied, showing the results of an analysis of two proposed lead arrangements for a number of 500-kva., single-phase, two-top electrode type calcining furnaces. In this case, the rate at which power would be paid for, as well as the amount of power into the furnace, was dependent upon the power factor, and although the supply was at 25 cycles, extra precautions in design were deemed necessary. In Fig. 2, curve *X*, as compared with curve *Y*, shows the calculated improvement in power factor obtained by interlacing the copper bars for the 6-ft. run according to diagram *X*, Fig. 3, as compared to the non-interlaced arrangement shown in diagram *Y*, Fig. 3.

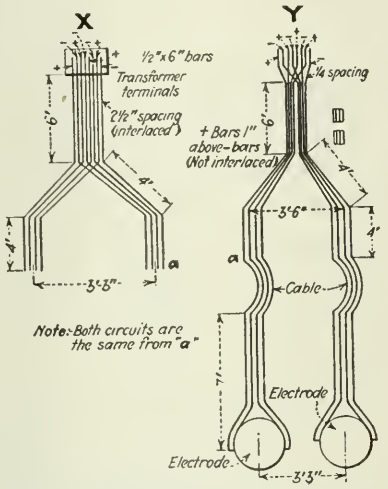


FIG. 3. METHODS OF CONNECTING LEADS
X = 6-ft. run leads interlaced.
Y = 6-ft. run leads non-interlaced

Referring to the installation layout shown in Fig. 4 in order to have an output of 50 or 60 tons per day, it was proposed to operate a total of six furnaces similar to the one described. The furnaces would be arranged in two groups of three each. By converting from the three-phase transmission voltage to two-phase furnace voltage, the two furnaces taking power each day would form a practically balanced load upon the power system. Power would be cut off from the other furnaces by lifting up and disconnecting their movable electrodes. Each furnace taking power would receive its current through eight movable electrodes and eight corresponding fixed electrodes. There would be eight separate circuits back to the transformer, each capable of being independently adjusted to give the desired amount of current and each tending, on account of its own impedance, more readily to give that current. The principal equipment proposed for this installation includes:

Two 1,250-kva., single-phase, 60-cycle, maximum rated stepdown transformers, Scott connected for three-phase, 13,200 volt high tension, two-phase 2,200 volt low tension and provided with full capacity taps to give 2,310. 2,420, 2,530 and 2,640 volts low tension. Two 1,200-kva., single-phase, 60-cycle, maximum rated furnace transformers, with 2,640 volt high-tension and low-tension voltages 48, 54, 60, 66, 72 and 84 at full capacity, and 42 at reduced capacity. When operated at 2,200 volts high tension, these transformers designed to give low-tension voltages from 35 to 70 in 5-volt steps.

The operation of the furnace is as follows:

One electrode is lowered to the bottom of the furnace and an arc is set up. The petroleum coke is placed around that arc until current will flow through it. Then an arc is started at a second electrode in similar manner, and this process is continued until all electrodes are in operation. The furnace is then loaded and the electrodes are raised as rapidly as possible, while still maintaining a condition of having considerable current flowing through them. Finally the furnace is practically full and the electrodes are in their upper position imbedded in the coke. Except at starting, the heating of the mass is entirely through the resistance of the material itself.

The average total power consumption of this plant would be in the neighborhood of 900 kw.-hr. per ton

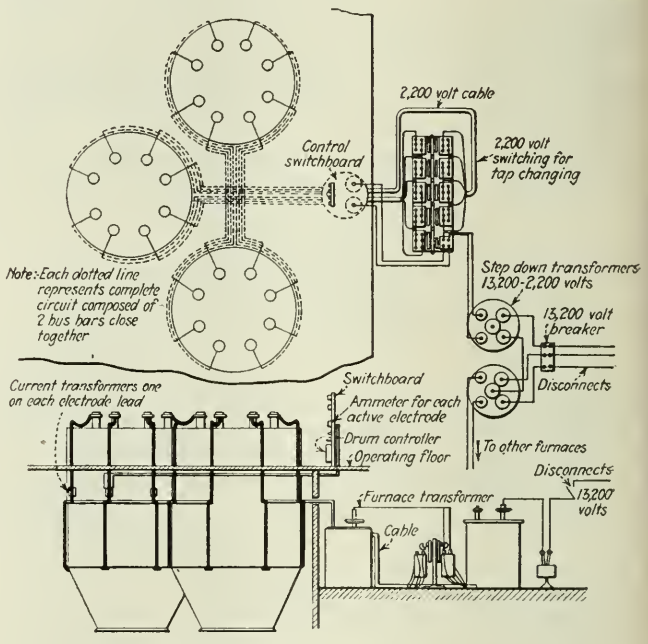


FIG. 4—INSTALLATION OF CALCINING FURNACE

of shrunk coke, and at a power factor above 90 per cent. The demand for electrodes in the electric steel and ferro-alloy industries and in the electrolytic chlorine industry, as well as in the aluminum industry, where approximately ⅔ to ¾ lb. of electrodes is required for each pound of aluminum produced, is great enough to demand the output of several such calcining plants in the manufacture of electrode carbon and graphite.

Panama Canal to Sell Surplus Supplies

The Panama Canal is about to offer for sale a large quantity of surplus material now in stock on the Isthmus, including manila rope, copper screening, nails, glass, paints, lubricating oils and greases, millwork, chemical materials, hose, chain, pig iron, non-ferrous metals, burlap, canvas, foundry supplies and numerous other commodities.

Interested parties should communicate with the General Purchasing Officer, the Panama Canal, Washington, D. C., for detailed information as to the material available for sale, terms of sale, etc.

Synopsis of Recent Chemical & Metallurgical Literature

Bond Clay Mixtures for Glass Pots.—D. H. Fuller, of the U. S. Bureau of Standards, has made some studies to determine whether as good results can be obtained from mixtures of American clays as from the Gross Almerode clay in glass pot bodies and reported in the *Journal* of the American Ceramic Society for November. Two American ball clays were combined in various proportions with two siliceous American bond clays and compared with the Gloss Almerode clay in bodies containing 50 per cent grog. Physical properties and resistance to glass batch corrosion were determined. It was not found possible to duplicate the physical properties, especially the low water of plasticity and low drying shrinkage of the Gross Almerode body, but several of the bodies gave better results as regards resistance to corrosion than the one containing the Gross Almerode clay. In general it was concluded that it is possible by blending American clays to produce a body equal or superior to the Gross Almerode body. More thorough heat-treatment of pots or tank blocks in the arches and greater uniformity in temperature during the burning is required.

On the Distribution of Temperature in Steel Ingots During Cooling.—Seizô Saitô, the author of this paper appearing in the 52nd report from the Japanese Iron and Steel Research Institute (*Science Reports*, vol. 10, No. 4, Sept. 1921), aware of the complexity of the mathematics that accompanies the consideration of octagonal and hexagonal shapes, deals only with cylindrical and square molds. The heat of

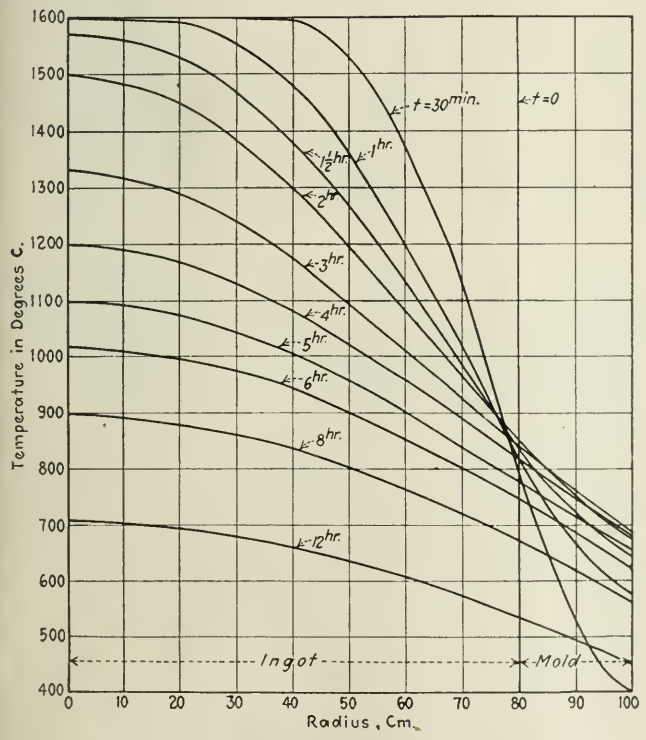


FIG. 1—TEMPERATURE-DEPTH CURVES AT VARIOUS TIME INTERVALS AFTER POURING

solidification is also omitted, hence the calculations apply to cooling below the solidification point. The initial temperature of the melt is supposed to be 1,600 deg. C., and that of the mold is 0 deg. C., and it is assumed that there is no convection of heat and that the constants have the same value both in the liquid and solid states. The complex derivations of the mathematical formulas cannot be abstracted, but the plotted diagrams obtained from the numerical values are reproduced as far as they are of interest.

The numerical data on heat conduction obtained for a cylindrical ingot of infinite length disclose the distribution of temperature in the ingot and the mold after different lapses of time; also the variation of temperature at different distances from the center for definite time intervals are given.

In Fig. 1 there is shown the manner in which the isothermals fall from the center toward the surface of the mold in an ingot 160 cm. (5 ft. 3 in.) in diameter—that is, corresponding to about a 60-ton ingot. This graph also shows the magnitude of the temperature gradient in the inner portions, which coincides with the known rules of solidification and which is visible in an etching of the cross-section as a segregation ring.

Fig. 2 discloses the fact that with the exception of points near the inner surface of the molds the temperature at a

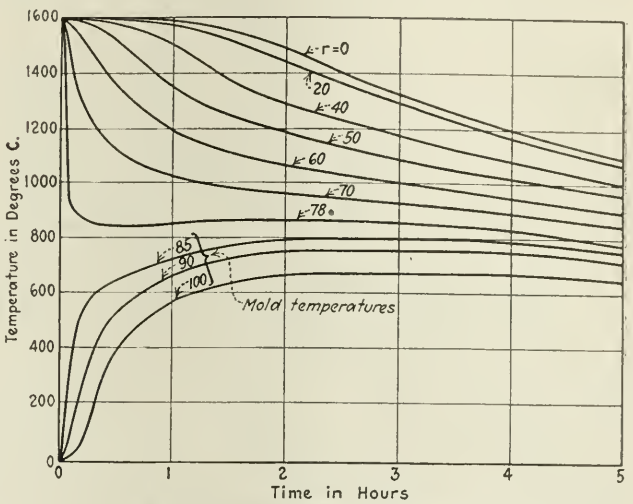


FIG. 2—TEMPERATURE-TIME CURVES FOR VARIOUS POSITIONS IN INGOT AND MOLD

given point falls continuously as time goes on, but that at points near the mold the temperature falls rapidly at first and then increases as the time elapses, after which a gradual cooling proceeds in the usual way. The temperature of the mold increases rapidly at first and after reaching a maximum gradually decreases with time. In other words, the mold and the ingot equalize and after equalizing both appear to cool as a unit. In fact, this is only a mathematical result which supports the actual facts of everyday practice. Since in practice the weight of a mold is equal to the weight of the ingot, the temperature reached by the mold will be approximately half the temperature of the ingot.

Fig. 3 represents an actual experiment with a melt that has been cast in a mold of an outer radius of 40 cm. and inner radus of 27 cm. of 180 cm. mold length, the tempera-

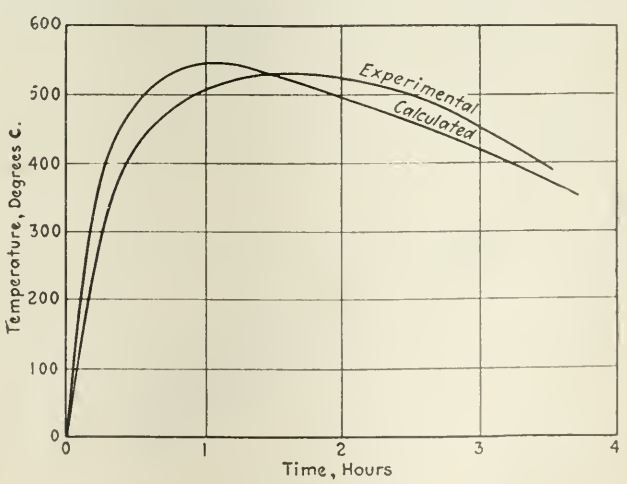
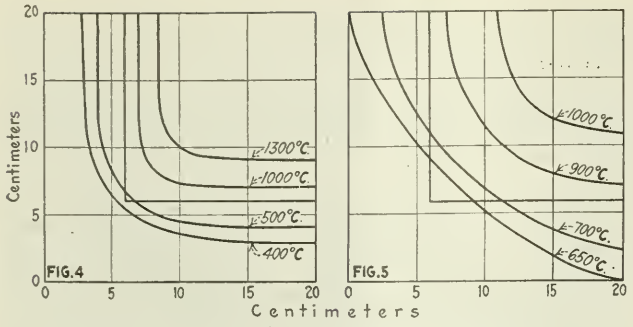


FIG. 3—COMPARISON OF CALCULATED AND OBSERVED TEMPERATURES OF OUTSIDE OF INGOT MOLD



FIGS. 4 AND 5

Fig. 4—Isothermals in square ingot after 1 minute.
Fig. 5—Isothermals in square ingot after 5 minutes.

ture of the melt being 1,500 deg. C. The temperature of the outer surface of the mold at midheight as measured coincides closely with the calculated result.

There is also a numerical calculation given for a case which assumes that the mold is kept at 0 deg. This case is of no practical value. However, it points out that after 12 hours the temperature at the center of the cylinder is only 200 deg. C., a temperature considerably lower than that in the former case after the same lapse of time (710 deg. C., from Fig. 1). A plot similar to Fig. 2 shows that in the inner portion of the cylinder the rate of the temperature fall with increasing radius is very small and its gradient almost the same as with an uncooled mold. Hence we may conclude that in the case of such a large ingot, although the outer surface of the mold is rapidly cooled by some special means, segregation cannot be prevented, and the diameter of the segregation ring also remains almost unaffected.

An infinitely long prism with a section 68 cm. square (2 ft. 3 in.) was calculated. Figs. 4 and 5 show the calculated and plotted curves, with the characteristic that the isothermal lines round off the corners of the square.

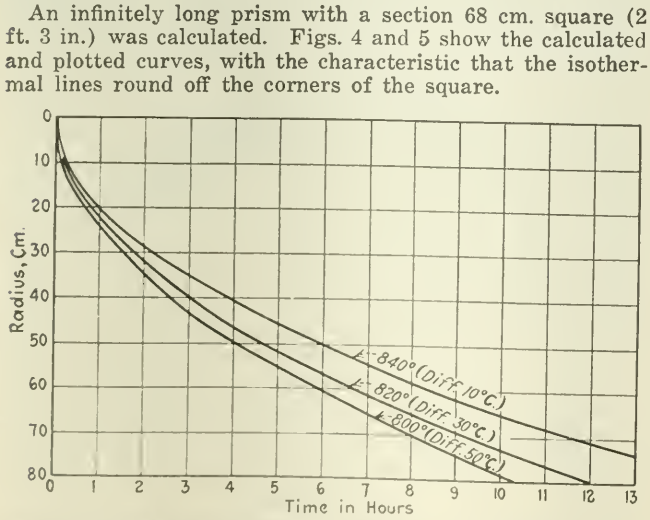


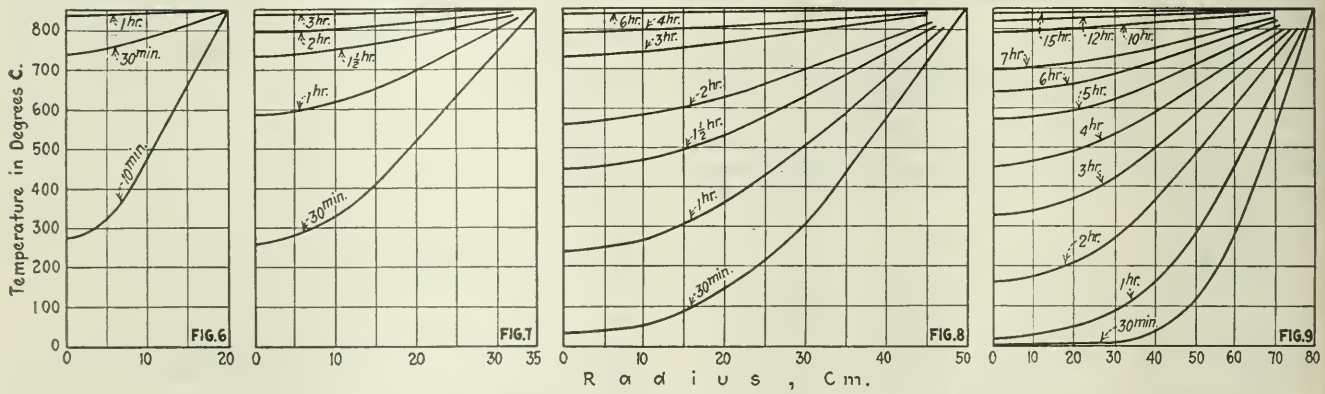
FIG. 10—TIME REQUIRED TO REACH TEMPERATURE AT THE CENTER OF INGOTS OF VARIOUS SIZES

Thermal stress in a steel ingot in which the temperature distribution is not uniform has already been solved by Lorenz, in his "Technische Elastizitäts Lehre," and Saitô's calculations follow his method.

A problem of practical importance dealt with is that of annealing large ingots or thick plates. A mathematical solution of this is already well known, but the author states that the data at hand are not trustworthy.

It is assumed that the cylinder in the mathematical problem is initially at 0 deg. C., and its surface is always kept at 850 deg. C. The calculations show the distribution of temperature at different time intervals for the radii 20 cm., 35 cm., 50 cm. and 80 cm., and the results are given in Figs. 6, 7, 8 and 9. Calculated results are also given for the temperature at axis of each cylinder corresponding to different time intervals. The time required for obtaining 800 deg. C., 820 deg. C. and 840 deg. C. at the axes of various cylinders are shown in Fig. 10, assuming a constant skin temperature of 850 deg. C. The curves resemble parabolas.

When computing data on the cooling of heated cylinders or plates, the surrounding temperature is assumed to be kept at zero and the temperature distribution is just the reverse of the above. In practice, however, the boundary conditions are not the same as those required in the assumed theory. In actual heating the outer surface will acquire the heat by radiation and hence it will require a much longer time than that expected from the theory. Verification of this fact is given by E. F. Law, *Journal*



FIGS. 6 TO 9—TEMPERATURE-DEPTH CURVES AFTER VARIOUS HEATING PERIODS

Fig. 6—40-cm. cylinder. Fig. 7—70-cm. cylinder. Fig. 8—100-cm. cylinder. Fig. 9—160-cm. cylinder.

Iron and Steel Institute, No. 1, 1918. In his experiment Law shows that the interval of time required to heat the center of a steel cube from ordinary temperature to 900 deg. C. is considerably greater than that required for the center to cool from 900 deg. C. to room temperature.

The author also deals with the cooling of a thick plate or cylinder of infinite length, the heat of transformation of which is taken into account.

Titanium Alloys.—M. A. Hunter and J. W. Bacon (Rensselaer Polytechnic Institute, Engineering and Science Series, No. 12) have investigated the electrical properties of various alloys of pure metallic titanium, reduced by sodium. If 0.5 per cent is added to commercial Norway iron and melted in an Arsem furnace, all but a trace of titanium is lost, but the resulting metal exhibited improved magnetization and hysteresis curves. Larger additions were not beneficial. Pure titanium, forged into a rod at red heat, possesses a high specific resistance — 88 microhm-cm. — but when alloyed with various alloys of nickel, copper and iron, produced wires of only moderately high resistance. It is exceedingly hard to draw such alloys containing more than 5 per cent titanium.

Terra Cotta Casting.—Technology in the manufacture of terra cotta has become an accomplished fact. R. F. Geller of the U. S. Bureau of Standards published a paper in the November issue of the *Journal* of the American Ceramic Society on possibilities of terra cotta casting. The experimental methods described therein involved the treatment of clays and bodies with varying amounts of salts and cast in the form of small ashlars. The casting properties, vis-

cosity, specific gravity and drying behavior of three kaolins, two ball clays, one fireclay and four representative commercial bodies, together with terra cotta clays, were studied. The author concluded that kaolins have an open structure, but do not develop strength on drying. Bonding properties are furnished by ball clays, which, however, tend to seal against the mold. Commercial terra cotta bodies tested do not possess good casting properties, but can be modified through a study of the component clays. Mechanical difficulties attending the casting of terra cotta render the feasibility of the process doubtful at the present time.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Crystallizing.—Granular crystals—for example, of sodium chloride—are obtained from solutions by supersaturating a solution out of contact with crystals by evaporation or by cooling, and circulating the supersaturated solution through a mass of crystals which are caused to grow. The agitation of the mass of crystals may cause the formation of spherical granules. The solution drawn from an evaporating chamber *b*, Fig. 1, is forced by a pump *g* through a superheater *a* and pipe *i* back to the evaporating chamber. Evaporation takes place at the upper surface *o* and the supersaturated solution is drawn upwards through an inner chamber *e* containing a mass of crystals. When the crystals have attained a certain size they fall against the flow

FIG.1.

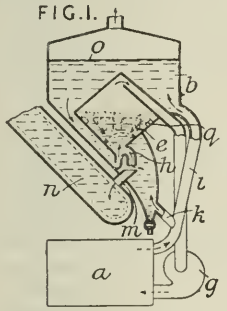
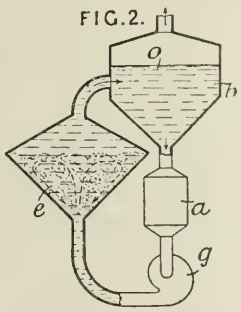


FIG.2.



of the liquid into the base of the vessel *e* and are discharged through an opening *h* and through a pipe *m* to an elevator *n*. Curved baffles *q* inside the vessel *e* cause all parts of the crystal mass to pass over the opening *h*. When the solubility of the substance does not increase rapidly with the temperature, the solution may be passed through the superheater *a*, Fig. 2, directly into the crystallizing vessel *e* and thence into the evaporating vessel *b*. To prevent fine crystals being carried from the crystallizing vessel, fresh solution may be fed by a jet discharging into an open coiled pipe or chamber in the upper part of the vessel *e*. Alternatively, the small crystals may be removed from the circulating current of solution by filtration, centrifugal treatment or by settling, or the discharge opening *h* may be arranged so that some small crystals are discharged with the large crystals. The separation by settling may be effected by leading a part of the circulating flow through a pipe *k*, Fig. 1, into the lower part of the vessel *b* in which settling occurs and from which the liquid passes again into the main circulation. Supersaturation of the solution may be effected by cooling the solution at the surface *o* of the vessel *b*, the superheater *a* being dispensed with. The evaporation or cooling may be accelerated by blowing air through the solution. (Br. Pat. 171,370. Not yet accepted. Aktieselskabet de Norske Saltverker, Bergen. Dec. 31, 1921.)

Chromic Sulphate.—Chromate or bichromate of sodium or potassium is treated with sulphuric or other acid to give a solution of chromic acid. The latter is freed from the alkali salt present by cooling to 0 deg. F. and separating the resulting crystals, preferably by centrifugal action. The chromic acid, on saturating with sulphur dioxide, gives a chromic sulphate solution. The alkali salt may be removed from the extractor by dissolving the crystals in water. (Br. Pat. 171,149. F. M. Mooney, Montreal. Dec. 30, 1921.)

Tanning Materials.—Waste sulphite-cellulose lye is treated with lime or calcium carbonate to neutralize the acids, and is separated from the precipitate. The calcium is then precipitated by alkali compounds such as sodium carbonate or silicate. Hydrochloric, sulphuric or other acid is added to the resulting solution of sulpho-lignates in amount equivalent to 50 to 100 per cent of the alkali used in precipitation. The liquid can then be used for tanning. Instead of acid, there may be added salts of metals such as are used in mineral tanning—for instance, aluminum, iron, or chromium chloride; the liquids thus obtained can be used directly for tanning. The liquid may be fermented after the addition of the lime or calcium carbonate, and may be concentrated by evaporation after the treatment with the alkali compound. (Br. Pat. 171,136. A. Romer, Stuttgart, and Deutsch-Koloniale Gerb. & Farbstoff Ges., Karlsruhe. Dec. 31, 1921.)

Heat- and Sound-Insulating Material.—A heat- and sound-insulating composition comprises slag wool or other fibrous material such as asbestos, hair felt, fossil earth and aqueous solution of casein, a sodium compound such as borax, soda ash or caustic soda and tung oil, or coal tar, pitch or asphaltum. Preferred proportions are slag wool 100 parts, casein 10 to 15 parts in 100 parts of water, tung oil 10 to 15 parts, borax 3 parts. The fibers are placed in a container, the other ingredients are boiled together and added, the manhole cover is screwed down, and compressed air or steam is admitted to mixing jets. The mixture is then forced into a porous or perforated mold. The composition may be applied directly to steam pipes, etc. (Br. Pat. 171,550. H. Smith and J. Fullock, London. Dec. 31, 1921.)

Purifying Cellulose Solutions.—Cellulose solutions such as are used for spinning artificial threads are freed from foreign or undissolved particles by subjecting the solutions to powerful centrifugal force. The separation may be effected in a rapidly rotating hollow cylinder, bottle shaped at the upper part and suspended vertically in ball bearings; the solution is introduced through an opening in the base of the cylinder, overflows at the neck and is collected in a surrounding rim, while the particles thrown out by centrifugal force collect as a compact layer along the walls of the cylinder, and are from time to time removed. For effective separation, the value of the centrifugal force must be higher than that ordinarily employed; thus with a cylinder having an internal diameter of 10 cm., the speed of revolution must be 15,000 r.p.m. or higher. (Br. Pat. 171,384. Not yet accepted. K. Fürst, Berlin. Dec. 31, 1921.)

Heat-Insulating Coverings.—Relates to heat-insulating coverings for the pipes of refrigerating machines and the like of the kind comprising a tubular sheath of fibrous material filled with granulated cork or similar material and adapted to be wrapped as a rope in one or more layers around the pipe. According to the invention, a sheath is made in a braiding machine and the granulated material is simultaneously delivered from a shoot, being guided into the sheath by means of a ring of warp threads which pass through the chute into the rope and form an integral part of the finished rope. (Br. Pat. 171,428. A. Nadin, Lancashire. Dec. 31, 1921.)

Glass Manufacture.—Black glass, which is of use as an electric insulating material, and which has a small thermal expansion, is made by melting a natural rock, such as schist, consisting chiefly of quartz, lime and alumina, and adding a further quantity of one or more of these substances until the melted product contains approximately 1 part aluminum oxide, 1.65 parts calcium oxide, and more than 3.56 parts of silica, the excess of silica beyond 3.56 parts being calculated so that all other oxides present may be converted into silicates. The main ingredient of the finished product has the chemical formula $(SiO_2)_6$, Al_2O_3, $(CaO)_3$ and melts at about 1,250 deg. C. (Br. Pat. 171,692. Not yet accepted. P. T. Freuler, Schwanden, Switzerland. Jan. 11, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Secretary Weeks Doubtful of Ford Offer at Initial Hearing Before House Committee

Doubt as to the ability of Henry Ford to reduce materially the cost of fertilizer by the operation of the Muscle Shoals nitrate plant was expressed by the Secretary of War at the initial hearing on the Ford offer before the Military Affairs Committee of the House of Representatives. If he were convinced that, by the acceptance of this offer, the price of fertilizer could be reduced materially to the farmer, Secretary Weeks said, he would vote for its acceptance if he were a member of Congress. In view of the doubt as to the ability of Mr. Ford to cheapen fertilizers, Secretary Weeks expressed the personal opinion that more advantageous schemes for the utilization of the power at Muscle Shoals could be worked out. He said that the part of the contract referring to the obligation to produce 110,000 tons of ammonium nitrate per annum is not in business-like form. He called attention, however, to the generally held belief that the fixation of nitrogen is in its infancy and that great development in this art may be expected in the next few years.

Thinks Ford Would Accept Modifications

The attitude of the committee is evidently one of establishing whether or not the Ford offer is a business-like proposition. In answer to questions, Secretary Weeks expressed the personal opinion that Mr. Ford would accept modifications which will make the offer a very much better one. In justifying his apparent delay in handling the Ford offer, Secretary Weeks pointed to the fact that the offer in its present form not only establishes additional safeguards for the public interest, but is tantamount to an increase of about $14,000,000. He revealed that Mr. Ford is contemplating the immediate investment of $10,000,000 to $12,000,000 of his own funds, in addition to the amounts which Congress would be called upon to expend on dam construction.

Does Not Favor Government Operation

The Secretary emphasized his opposition to any attempt to embark the government in the manufacture of fertilizer. If the Ford offer is not accepted, he favors the completion of the dam by the government, but he made it very clear that the government's activity should not be extended to include the operation of the nitrate plant.

Few new points were brought out during the Secretary's testimony. He amplified the explanation contained in his letter transmitting the Ford offer and gave new emphasis to many points. Among those was his insistence that the lease should be for no longer period than 50 years. He also suggested that any sale of power by Mr. Ford, in case he did not use the entire output for his own industries, should be under regulations to be formulated by the Federal Power Commission.

That difficulties may be expected in adjusting claims with the Alabama Power Co. and that a substantial sum will be required to purchase the right of way for the 88-mile transmission line to the Warrior River plant, were predicted by Secretary Weeks.

Urges Guarantee of Continuous Operation

He urged that responsibility should be definite with regard to the manufacture of nitrate. There is difference of opinion as to whether or not the agreement would compel the operation of the nitrate plant at a loss. The Secretary suggested that there should be a guarantee, either by the formation of a company with sufficient capital or by the giving of a bond in sufficient amount, to insure the continuance of this operation throughout the life of the contract.

While several members of the committee very obviously have preconceived ideas as to just what ought to be done with the Ford offer, most of them appear to be open to conviction.

Bill for Reclassification of Technical Employees in Federal Service Reported to Senate

The bill reclassifying employees in the federal service, which was passed recently by the House of Representatives, has been reported to the Senate by its Committee on Civil Service with important amendments. The Senate committee has substituted the Civil Service Commission for the Bureau of the Budget as the classifying agency and has increased the salary range for professional and scientific services. In addition, the professional groups have been expanded so as to include editors, illustrators, transportation experts and nurses. The Senate bill also extended the classification to the field services. The House bill limited the compensation schedules to civilian employees in the District of Columbia.

Provides for Efficiency Records

The bill permits the transfer of employees between departments at a higher rate of payment. It establishes an efficiency rating system, and provides that the efficiency records are to be accessible to employees. The bill establishes a minimum efficiency standard which must be maintained or the employee will be dropped from the list. In reporting the bill Senator Sterling, the chairman of the committee, said in part:

> For the professional and scientific service the committee would restore the rates recommended by the reclassification commission. Under that scale the entrance salary for the lowest positions requiring scientific or professional training equivalent to that reached by graduation from a college or university would be $1,800 instead of $1,620. To the highest successful professional or scientific man who is placed in full administrative charge of a major professional or scientific bureau, it would pay from $6,000 to $7,200 unless a higher salary is specifically authorized by law. The House bill would give such an employee $5,400 to $6,600 unless a higher salary is specifically authorized by law. Such a change would add less than 2 per cent to the cost of reclassification.
>
> The government probably never can compete on the basis of salary with private business and industrial enterprises seeking to secure scientific and professional services. Those salaries, however, should bear a fairly close relationship to those being paid by the largest and strongest colleges and universities of the country.

Since the measure affects the budget, the bill does not go directly to the Senate calendar, but was referred to the Committee on Appropriations. There is a possibility that the Appropriations Committee will insist that it take its turn and follow the regular appropriation bills, which would mean a delay of many weeks.

New Chemical Laboratory Planned for University of West Virginia

The University of West Virginia, Morgantown, is having plans prepared for the erection of a new chemical laboratory at the institution, estimated to cost about $400,000. It is expected to call for bids late in February or early in March. Paul A. Davis, 1713 Sansom St., Philadelphia, Pa., is architect.

Dr. Richards' Metallurgical Library Given to Lehigh

In accordance with the will of the late Joseph W. Richards, his entire personal technical library of over 5,000 volumes has been donated to the department of metallurgy of Lehigh University. Dr. Richards, who was head of the department at the university until his death, felt the need of a complete library of metallurgical volumes separate from the university library. The removal of the standard works on metallurgy from the university library to supplement the Richards collection is being considered and would give the university one of the most complete metallurgical libraries in the country.

Industrial Developments of the Week

Glass. The Indiana Window Glass Co., Vincennes, Ind., has resumed operations at its plant, following a considerable period of curtailment. Employment will be given to more than 300 men.

The Hawley Glass Co., Hawley, Pa., manufacturer of bottles and other hollowware products, has reopened its plant after a shutdown of about 7 months. Orders are said to have been received to insure continuous operation well into next fall.

The Tampa Glass & Bottle Manufacturing Co., Tampa, Fla., recently organized to succeed the Southern Bottle Manufacturing Co., is arranging for the resumption of operations at the local plant before the close of the month.

The different window glass plants in the Clarksburg, W. Va. district are resuming operations, and since the first of the month about 2,500 workers have returned to the factories.

Paper. The Warren Manufacturing Co., Milford, N. J., has recently added about fifty men to its working force and is operating at full capacity. The company manufactures glassine and other papers.

J. G. Wieder, Macungie, Pa., operating a paper box-manufacturing plant, has adopted a night working schedule for increased production.

Rubber. The Fiske Tire Co., Chicopee Falls, Mass., has increased production at its local plant to about 9,000 tires a day, as compared with 3,000 per day during the low point of manufacture last spring. It is planned to advance the output gradually during March, April and May until capacity of about 15,000 casings per day is reached. The Cudahy, Wis., branch of the company is maintaining an output of about 3,000 tires a day.

The Du Bois Tire & Rubber Co., Chattanooga, Tenn., has commenced operations at its new local plant, recently completed, and is said to have taken orders to insure capacity output for the entire year.

The B. F. Goodrich Co., Akron, Ohio, has adopted a production schedule of from 17,000 to 18,000 casings a day at its local works.

Cement. Practically all of the cement companies in the Nazareth, Pa., district have adopted a night shift at their mills for increased production, including the Nazareth Cement Co., Phœnix Portland Cement Co., Hercules Cement Corporation and the Dexter Portland Cement Co. The mills are giving employment to more than 3,000 workers.

Iron and Steel. The Scranton Iron & Steel Co., Scranton, Pa., has resumed production at close to normal in all departments of the plant for the first time in several months.

The Cumberland Steel Co., Cumberland, Md., has recently resumed production at its plant following a short shutdown.

For the first time in many months the Allegheny Steel Co., Brackenridge, Pa., is operating at practically 100 per cent in all departments of the works.

The Inland Steel Co., Chicago, Ill., is increasing production at its mills to close to 75 per cent capacity.

The Cambria Steel Co., Johnstown, Pa., has placed three more open-hearth furnaces at its Franklin Works in operation, making a total of fifteen furnaces in service. The No. 3 mill at the lower plant has also been reopened.

Coke. After more than a year of idleness, the H. C. Frick Coke Co. has resumed partial operations at its Colonial No. 3 and Hecla No. 1 plants in the Uniontown, Pa., section.

Miscellaneous. The Nickel Alloy Co., Hyde City, near Clearfield, Pa., has resumed operations, following a shutdown for about 13 months past. The production will be devoted exclusively to nickel alloys and steel manufacture will be entirely discontinued.

The J. B. Ford Co., Detroit, Mich., manufacturer of soda ash, etc., is increasing production at its plant, and during the first 3 weeks of January the output was larger than for any month during the past year.

Procter & Gamble, Kansas City, Mo., manufacturers of soaps, etc., are operating their local plant at close to normal, with regular force of employees.

The Mathieson Alkali Works, Niagara Falls, N. Y., have increased production at their local plant to about 80 per cent of capacity.

Fire destroyed the main building of the American Aniline Products, Inc., plant at Lock Haven, Pa., on Feb. 1. The fire originated in one of the color grinding mills and destroyed considerable quantities of raw materials and finished dyes, the loss being estimated at $200,000.

Voluntary Refund of Excess War Profits by Eastman Kodak Co.

The Eastman Kodak Co. has presented to the government a check for $182,770.60, representing the profit of the company on apparatus and materials for the Aircraft Service of the War Department in excess of 10 per cent. In the letter accompanying this purely voluntary refund George Eastman explained that in accepting the contracts from the government during the war, the company had no definite figures upon which to base costs and it was necessary to make a liberal estimate in order to protect the company against loss. As soon as the complete final cost figures could be compiled, the profit in excess of the agreed 10 per cent, represented by the present payment, was made.

Acknowledgment was made by General Pershing as acting Secretary of War in the following letter:

> My dear Mr. Eastman: In receiving your check for $182,770.60, representing the monetary refund to the government by the Eastman Kodak Co. of its profits on War Department war contracts in excess of 10 per cent, I wish to express to you my high appreciation of this fine and patriotic action on the part of your company. Such a wholesome and generous attitude might well be expected during war times, but with the lapse of 3 years since the armistice, it is truly refreshing and inspiring to find such motives and high ideals animating a large business organization in its relation with the government.
>
> JOHN J. PERSHING,
> Acting Secretary of War.

Start of Dye Investigation Still Indefinite

An organization meeting of the sub-committee of the Senate Committee on the Judiciary which will conduct the dye investigation was held Feb. 7. Senator Shortridge was designated as chairman of the sub-committee. The date for the first open hearing will not be fixed until Senator Reed can be present.

The attitude of the American Dyes Institute with respect to the inquiry was made known in a letter by R. C. Jeffcott, addressed to Senator Shortridge.

"The American Dyes Institute and its members wish to let you know that they want to co-operate with you and facilitate your labors in every way," the letter states. "The resolution is comprehensive, and those engaged in the dye industry of the country welcome a most thorough and impartial examination of all questions covered by it."

Patent Bill Near Final Stage

Approval of the plan for the early consideration of the Patent Office relief bill has been secured from Senate leaders. It is expected that the bill will be called up in the very near future and passed with a minimum of discussion.

Soap, Oil and Alkali Manufacturers Ask for Lower Freight Rates

Petitions were presented to the Interstate Commerce Commission Feb. 8, asking for a reduction in the freight rates on cottonseed oil, soaps and soda ash, bicarbonate of soda and caustic soda. The petitioners represented the Southern Cotton Oil Co., the American Cotton Oil Co., all of the manufacturers of nationally advertised and distributed soaps and the members of the Alkali Manufacturers' Association.

It was testified that in general wages and other operating costs have been reduced to about 140-150 per cent of pre-war, while the freight rates on these products remain at 180-220 per cent of the pre-war level.

S. J. Cassels, the district manager for the Southern Cotton Oil Co. at Montgomery, Ala., testified that in 1921 only 300 of the 750 cottonseed crushing mills were in operation throughout the entire season. Two hundred operated at part time but the remainder were closed down continuously. To some extent this was due to the shortage in the cotton crop, but the witness said that the high freight rates have been a contributing cause. They have had the effect of localizing the business of each mill so that it could draw its seed only from short distances and likewise limited it in distributing cattle feed, fertilizer and other bulky byproducts.

American Welding Society Issues First Copy of Its "Proceedings"

The American Welding Society has issued, under date of January, 1922, the first copy of its *Proceedings*, in the form of a well-printed 44-page pamphlet. About half the space is taken up with society activities, related news and a bibliography of welding literature. The remainder is filled with technical papers, discussing methods and principles of various phases of welding.

This society was organized in 1919, and an attempt was then made to issue a journal, but it proved too expensive. Then for more than a year the *Welding Engineer* gave part of its space for the society proceedings. Even with the best will in the world, such an arrangement could not prove altogether satisfactory to each party, and the present *Proceedings* is an attempt to improve the society's service to its members.

Navy Department Solicits Bids

The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will receive bids up to Feb. 28 for 15,000 lb. of lump rosin; 200 qt. of liquid bronze; 5,000 gal. of turpentine, and 3,000 lb. of artificial vermilion, for use at the Mare Island (Cal.) Navy Yard. (Schedule 9420.)

Personal

E. O. Benson, Jr., has left the Jackson Laboratory of E. I. du Pont de Nemours & Co., Wilmington, Del., to accept a position as research chemist with John Campbell Co., manufacturer of dyestuffs, Newark, N. J.

G. S. Brown has been re-elected president of the Alpha Portland Cement Co., Easton, Pa.

Dr. Harold S. Davis has resigned from his industrial fellowship at the Mellon Institute of Industrial Research of the University of Pittsburgh to accept a position on the research staff of Arthur D. Little, Inc., Cambridge, Mass.

Philip DeWolf has severed his connection with the Davison Chemical Co. and entered consulting work, with headquarters at Westport, Conn. He will specialize in the manufacture of sulphuric acid, problems of evaporation and the industrial applications of silica gel.

William C. Dudley has been re-elected president and general manager of the Dudley Paper Co., Lansing, Mich.

Andrew H. Green, Jr., vice-president of the Solvay Process Co., Syracuse, N. Y., and connected with that organization for many years, has been elected president and general manager of the Charcoal Iron Co. of America, Detroit, Mich., succeeding Frank W. Blair, resigned.

J. S. Negru, Managing Editor of Chemical & Metallurgical Engineering, sailed Feb. 11 for a 6 months' trip through Germany, France, Belgium and other European countries. The purpose of the trip is to study industrial and economic conditions and observe the latest advances in science, engineering and technology.

Dr. Ernest Fox Nichols, who recently resigned the presidency of the Massachusetts Institute of Technology, Cambridge, Mass., is to return to Cleveland to resume the directorship of pure science research in the Nela Research Laboratory of the General Electric Co.

Dr. William H. Nichols, chairman of the board of trustees of the Brooklyn Polytechnic Institute for the past 17 years and a member of the board for 32 years, has resigned. He will, however, continue to serve the Institute as vice-chairman.

F. W. Pickhard, one of the vice-presidents of E. I. du Pont de Nemours & Co., has been appointed general manager of the dyestuffs department, with W. F. Harrington as assistant manager. C. A. Meade, vice-president and former general manager of the dyestuffs department, and M. F. Poucher, former director of sales, have been made executive staff officials.

James H. Ransom has changed his position as research chemist with the Michigan Smelting & Refining Co., Detroit, Mich., to head the department of chemistry in James Millikin University, Decatur, Ill.

J. W. Smith and D. R. Sharpe, superintendent and manager, respectively, of the minerals department of the Louisiana State Conservation Commission, have resigned.

Robert Steinemann has been elected vice-president and general manager of the Tide Water Corp., New York, following his recent resignation from the National Aniline & Chemical Co., Inc.

Bradley Stoughton, formerly secretary of the American Institute of Mining and Metallurgical Engineers, was elected president of the Yale Engineering Association at the annual meeting on Feb. 2, 1922.

Obituary

Thomas Francis Crowley, for about half a century past prominently identified in an official capacity with the Lambertville Rubber Co., Lambertville, N. J., died at his residence in that city, Jan. 29, at the age of seventy-four years.

Charles Lewis Taylor, E.M., Eng.D., prominent as a metallurgist, chemist and philanthropist, died on Feb. 3 at his winter home in Santa Barbara, Cal. Mr. Taylor was born in Philadelphia on April 3, 1857, and was graduated from Lehigh University in the class of 1876. He was connected with the Cambria Iron Co. at Johnstown, Pa., as assistant chemist and later as assistant superintendent of blast furnaces. He was superintendent of the Homestead works of the Pittsburgh Bessemer Steel Co. from 1882 to 1886 and the development of the present methods of production of steel pipe, nails and ship plate was due largely to his ability as a chemist and metallurgist. He was general manager of the Hartman Steel Co. of Pittsburgh until 1890, when he became associated with Andrew Carnegie in the firm of Carnegie, Phipps & Co., Ltd., and later became Mr. Carnegie's assistant in the Carnegie Steel Co. Mr. Taylor retired from active business in 1901 and devoted his time and energy to philanthropic work. He was president of the Carnegie Hero Fund Commission and chairman of the Carnegie Relief Fund from the time of their foundation in 1904. He was also a trustee of the Carnegie Peace Fund, the Carnegie Library, Carnegie Institute, Carnegie Institute of Technology and Lehigh University. In his biography Mr. Carnegie states, in referring to a dormitory building donated by him and named in honor of Mr. Taylor: "Visitors who may look upon that structure and wonder who Taylor was may rest assured that he was a loyal son of Lehigh, a working, not merely a preaching, apostle of the gospel of service to his fellow men and one of the best men that ever lived."

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Statistics of Chemical Production

The study and compilation of the statistics collected for the 1919 census of manufactures have now proceeded to the stage where accurate comparisons can be made with the results of prior censuses. Through the courtesy of the Bureau of the Census, certain of the chemical industries are now being furnished with detailed statistics in approximately the form in which they will appear in the tables of the forthcoming Abstract. Revisions have been made in many of the preliminary totals published in CHEMICAL & METALLURGICAL ENGINEERING for Sept. 7, 1921, and much additional information is included, notably that regarding the number of establishments, and the production for sale and for direct consumption. The final report of the Census Bureau will show the distribution of these establishments by states and cities as well as detailed data concerning the number of wage earners, power and fuel consumption, etc.

From time to time it is our intention to publish the more important of these statistics as they relate to the chemical and allied industries. It is unnecessary, perhaps, to point out that the value of the 1919 figures lies principally in their relation to our maximum peace-time production. In other words, they represent capacities of these industries after most, if not all, of the war-time activities had been discontinued. In the case of some chemical products, the maximum rate of output was probably reached in 1920, while in the cases of others, the consumption of war-time reserves inhibited production both in 1919 and 1920. However, it is believed that 1919 is a satisfactory year for comparing productive capacity with that of 1914 and of 1909.

THE ACID INDUSTRIES, 1909—1919

The detailed statistics for the production of the principal acids during the last three census years are compared in the accompanying tabulation. It will be noted that the total value of products increased from $32,837,254 in 1914 to $87,011,618 in 1919. It would appear at first glance that our output of these products had more than doubled, but when correction is made for the greatly increased prices of 1919 it will be observed that the increase is but slightly more than that which occurred during the 5-year period 1909-1914. The CHEM. & MET. Index of Chemical Prices for 1919 was 242 per cent of 1913-1914 figures. If the value of the 1914 production is increased in this proportion, we obtain the figure $79,500,000, which is only approximately 7.5 million dollars less than the reported value of the 1919 output. The increase between 1909 and 1914 was about 6.8 million dollars.

The output of the inorganic acids in 1919 showed less relative increase than did the organic acids. However, the quantities reported for each of the individual acids increased with the exception of hydrofluoric, acetic, tannic and certain strengths of sulphuric acid. In several instances there are decreases in the number of establishments, indicating larger scale of operations and possible merging of producing interests.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	147.46
Last week	147.33
February, 1921	166
February, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The index number remains practically unchanged notwithstanding the continued strength of the vegetable oil markets. The higher prices for cottonseed and linseed oils were almost entirely offset by the lower figures quoted for hydrochloric acid, bleaching powder, soda ash, caustic soda and caustic potash.

PRODUCTION OF PRINCIPAL ACIDS IN 1919 COMPARED WITH PRODUCTION IN 1909 AND 1914.

(Census of Manufactures, 1919)

	1919	1914	1909
Value of products	$87,011,618	$32,837,254	$26,068,617
INORGANIC ACIDS, value	$59,875,958	$25,082,873	.....
Arsenic and arsenious acids:			
Number of establishments	10	.....	.....
Total production, lb.	3,100,389	.....	.....
For sale:			
Lb.	1,076,000	(1)	(1)
Value	$108,233	.....	.....
Made and consumed, lb.	2,024,389	.....	.....
Boric acid:			
Number of establishments	6	5	5
Lb.	13,454,100	8,584,311	5,554,914
Value	$1,754,632	$588,981	$295,776
Unit value, lb.	$0.12	$0.07	$0.06
Carbonic acid (carbon dioxide. CO_2)			
Number of establishments	42	38	35
Lb.	59,771,411	50,445,779	47,953,291
Value	$6,574,250	$2,320,685	$2,345,743
Unit value, lb.	$0.11	$0.04	$0.05
Hydrochloric acid:			
Number of establishments	39	31	38
Total production, tons	221,613	168,584	122,367
For sale:			
Tons	150,090	85,438	101,607
Value	$4,312,253	$1,348,805	$1,758,335
Unit value, ton	$29	$16	$17
Made and consumed, lb.	71,523	83,145	20,760
Hydrofluoric acid:			
Number of establishments	6	9	10
Total production, lb.	5,732,198	7,209,248	8,027,290
For sale:			
Lb.	4,320,017	5,373,657	6,842,914
Value	$440,184	$325,540	$294,379
Unit value, lb.	$0.10	$0.06	$0.04
Made and consumed, lb.	1,412,181	1,835,591	1,184,376
Mixed acid (sulphuric-nitric):			
Number of establishments	23	37	14
Total production, tons	114,886	112,124	.....
For sale:			
Tons	46,428	42,725	28,591
Value	$4,426,637	$2,204,480	$1,860,787
Unit value, ton	$95	$51	$65
Made and consumed, tons	68,458	69,399	.....
Nitric acid:			
Number of establishments	42	52	25
Total production, tons	86,992	78,589	68,717
For sale:			
Tons	19,436	14,685	13,663
Value	$2,976,095	$1,591,625	$1,357,098
Unit value, ton	$153	$108	$99
Made and consumed, tons	67,556	63,904	55,054
Phosphoric acid:			
Number of establishments	9	7	9
Total production, lb.	22,109,302	.....	.....
For sale:			
Lb.	13,379,501	12,420,191	.....
Value	$1,711,148	$680,239	$667,505
Unit value, lb.	$0.13	$0.05	.....
Made and consumed, lb.	8,729,801	.....	.....
Sulphuric acid:			
Number of establishments	208	194	183
Total production, reduced to 50 deg. Bé., tons	5,402,347	4,071,566	2,764,455
For sale:			
Tons	3,190,333	2,338,284	1,479,200
Value	$34,559,252	$15,395,133	$10,103,425
Unit value, ton	$10.32	$6.58	$6.89
Made and consumed, tons	2,212,014	1,733,282	1,285,255
Production according to strength:			
For sale:			
50 deg. Bé.			
Tons	845,346	451,121	528,263
Value	$9,626,608	$2,709,350	$3,176,430
60 deg. Bé.			
Tons[2]	943,805	545,562	177,414
Value	$9,415,310	$3,754,866	$1,038,358
60 deg. Bé.			
Tons	704,070	732,186	453,370
Value	$13,521,316	$8,042,422	$5,454,002
Oleum or fuming:			
Tons[3]	63,816	62,354	28,594
Value	$1,996,018	$888,495	$434,635
Unit value, ton	$31	$14	$15

PRODUCTION OF PRINCIPAL ACIDS IN 1919 COMPARED WITH PRODUCTION IN 1909 AND 1914 (Continued)

(Census of Manufactures, 1919)

	1919	1914	1909
Made and consumed, tons:			
50 deg. Bé.	1,911,331	1,250,112	1,115,018
60 deg. Bé.	70,681	249,927	11,970
66 deg. Bé.	126,892	96,280	99,249
Oleum or fuming	12,862	15,404	3,743
Sulphur trioxide (sulphuric anhydride):			
Number of establishments	4	.....	.....
Total production, tons	74,213	.....	.....
For sale:			
Tons	68,926	(4)	(4)
Value	1,373,353	.....	.....
Made and consumed, tons	5,287	.....	.....
Sulphuric acid, reclaimed:			
Number of establishments	11	14	.....
Total production, tons	134,513	.....	.....
For sale:			
Tons	95,119	136,360	7,069
Value	$803,144	$518,890	$62,935
Made and consumed, tons	39,394	.....	.....
ORGANIC ACIDS, value	$27,135,660	$7,754,381	.....
Acetic acid, value	$4,264,044	$1,272,294	.....
Acetic, dilute and pyroligneous:			
Number of establishments	16		
Total production, lb.	56,585,386		
For sale:			
Pounds	46,820,736		
Value	$2,816,252		
Unit value, lb.	$0.06		
Made and consumed, lb.	9,764,650		
Acetic, glacial			
Number of establishments	4	14	13
Total production, lbs.	5,794,904	75,503,375	58,000,602
For sale:			
Lb.	5,482,000	70,817,637	56,923,773
Value	$869,196	$1,272,294	$1,336,874
Unit value, lb.	$0.15	.....	.....
Made and consumed, lb.	312,904	4,685,738	1,076,829
Acetic anhydride:			
Number of establishments	7		
Total production, lb.	1,794,985		
For sale:			
Lb.	1,213,861		
Value	$578,596		
Unit value, lb.	$0.47		
Made and consumed, lb.	581,124		
Citric acid:			
Number of establishments	6	3	5
Total production, lb.	3,260,428	2,729,943	.....
For sale:			
Lb.	3,163,676	2,657,840	2,102,256
Value	$3,047,371	$1,516,336	$777,235
Unit value, lb.	$0.96	$0.57	$0.37
Made and consumed, lb.	96,806	72,103	.....
Lactic acid:			
Number of establishments	.....	.....	.....
Value	$781,828	(1)	(1)
Oleic acid:			
Number of establishments	11	7	8
Total production, lb.	44,895,453	23,187,579	.....
For sale:			
Lb.	44,350,574	21,932,736	16,377,063
Value	$6,548,564	$1,301,353	$845,106
Unit value, lb.	$0.15	$0.06	$0.05
Made and consumed, lb.	544,879	1,254,843	.....
Stearic acid:			
Number of establishments	11	10	11
Total production, lb.	20,149,988	14,960,109	.....
For sale:			
Lb.	20,071,445	14,351,404	.....
Value	$4,613,862	$1,242,492	$1,143,213
Unit value, lb.	$0.22	$0.09	.....
Made and consumed, lb.	78,543	608,705	.....
Tannic acid:			
Number of establishments	4	5	.....
Lb.	845,065	853,830	(1)
Value	$746,825	$287,142	
Unit value, lb.	$0.88	$0.34	.....
Tartaric acid:			
Number of establishments	4	.....	.....
Lb.	5,312,965	(1)	(1)
Value	$4,262,376	.....	.....
Other acids:			
Inorganic[5]	$836,777	$108,495	$3,220,206
Organic[6]	$2,870,790	$2,417,906	

[1] Not separately reported.
[2] Includes a large production under a long-term, low-priced contract.
[3] Includes "Battery acid" and "Electrolyte sulphuric." 4,694 tons.
[4] Included above with oleum.
[5] Includes, 1919, chlorsulphuric, chromic, hydrobromic, hydrofluosilicic, hydrophosphorous, molybdic, silicic, tungstic, vanadic, etc., and for 1914, sulphurous, hypophosphorous, arsenic and hydrofluosilicic.
[6] Includes, 1919, butyric, caproic, carbolic, oresylic, formic, gallic, glycerophosphoric, hydrocyanic, monochloracetic, oxalic, phthalic anhydride, propionic, pyrogallic, thymol and valerianic.

Mathieson Alkali Works to Show Deficit for 1921

The forthcoming annual report of the Mathieson Alkali Works is expected to show a deficit of about $200,000 after the charges have been made to the depreciation account. It is reported that since October the company has been operating at a profit and at the present time its earnings are at the rate of about $8 per share on its common stock.

Recent Activity of Davison Stock

The recent advances in the quotations for the stock of the Davison Chemical Co. have occasioned considerable interest in the activities of the company as well as of its subsidiary, the Silica Gel Corporation. The stock of the Davison company advanced to 62⅜ on Jan. 25 and at the end of the day had shown a net gain of 5⅜ points. Since that time the stock has been held at 60 or above. Although there is considerable mystery surrounding the present flurry, it is generally believed that the activity is a direct result of certain negotiations between the Davison company and the Persian Oil Co. of Great Britain, which is said to be interested in using the silica-gel process for refining gasoline. The process is now being tried out on a considerable scale in the East Braintree (Mass.) plant of the Island Oil & Transport Co.

Recent financial statements of the Davison Chemical Co. are not available, but according to the *Wall Street Journal*, the net earnings of $822,602 for the year ended Dec. 31, 1920, were equal to $4.11 a share on the outstanding 200,000 shares of stock of no par value, after deductions had been made for expenses, interest, depreciation and revaluation of ore stocks in Cuba. In 1919 the earnings were $1.91 per share. It should be pointed out, however, that these profits are based on the company's business in sulphuric acid and acid phosphate. As yet there have been no earnings from the Silica Gel Corporation.

The New York Market

NEW YORK, Feb. 13, 1922.

The chemical market during the past week showed little signs of recovering and in general transactions were limited to orders for immediate requirements. Miscellaneous chemicals were more active during recent sales, but prices in many instances had to be sacrificed. Producers of late are acquiring most of the regular consuming business.

The alkali trade is apparently well covered by standing contracts as far as the leading consumers are concerned and competition on any new business of sizable proportions is extremely keen. The export situation on caustic soda is a trifle better with several new transactions reported to Italy and Japan. A feature in the alkali market was the entry of Germany as a buyer of caustic soda. Recent internal disturbances are said to be the cause of the purchases of that country. South American markets have not shown any signs of real activity, but it is believed that Argentina will probably offer a market as soon as conditions have become more sound. Other countries are buying alkalis in a moderate way.

In many instances large quantities of imported chemicals have been offered in the open market at prices which represent heavy losses to the importers. Among these products are cyanide of soda, chlorate of soda, caustic potash, citric acid, salammoniac and others. The principal explanation for this situation has been the irregular delivery and poor quality of the foreign goods. Preference for American cyanide and salammoniac has recently been shown in several transactions where buyers paid the differential as an assurance for quality and delivery.

General Chemicals

Bleaching powder is becoming more irregular under a keener state of first-hand competition. Orders for domestic consumption were accepted by producers at 2c. per lb., f.o.b. works. Bichromate of soda was steadier on spot with only a small-lot inquiry being noted. It is doubtful if better than 7¾c. per lb. could be obtained. Prussiate of soda sold at lower prices, with sales reported down to 16¾c. per lb. Shipments were also quoted at this figure c.i.f. N. Y. The demand was not as active as earlier in the year. Oxalic acid is holding steady both on spot and at the works. Prices have remained firm on spot at 14½@15c. per lb., with works material held around 14c. Sales of yellow prussiate of potash were recorded during the week at 24¾@25c. per lb., with the higher figure generally asked by most sellers of spot material. The red variety is entirely nominal, owing to the scarcity of supplies.

Resale lots of imported caustic potash, 88-92 per cent, are in the market at $5.55 per 100 lb., and it is understood that sales have been made down to 5½c. per lb. It is surprising to note the decline in prices on this chemical when existing conditions seem to show every tendency to advance it. There is a steady absorption of resale material owing to a firmer condition developing in the German market and the fact that leading importers feel very doubtful if stock can be replenished at current quotation. Export inquiries on caustic soda have been sufficiently active to permit dealers to place some business, although prices have been subject to shading. Dealers quoted $3.35 @$3.40 per 100 lb. f.a.s. Some of the larger interests quote the market around $3.45. Nitrite of soda was reported very scarce on spot by leading factors, with a noticeably improved inquiry. Prominent sellers refused to trade 7c. per lb. at the close of the week and several sales of carload quantities were recorded at this figure. Prices of domestic soda ash on spot have drifted to a slightly lower level, single bags being offered at $1.65 per 100 lb. in carload lots.

Linseed Oil

There was a substantial rise recorded in linseed oil when the market closed at 78c. per gal. in barrels for carlots. The rising market, however, did not bring with it much new business, most consumers evidently being covered for February-March-April. Imported oil was subject to some violent fluctuations, business passing at prices ranging from 58@63c. per gal., duty unpaid, c.i.f. New York, for February-March shipment from abroad.

The Chicago Market

Chicago, Feb. 10, 1922.

The heavy chemical market continues exceedingly quiet, with no developements worthy of notice. Buyers show a pronounced reluctance to come into the market and are buying only very small supplies for immediate consumption. A variety of prices are obtainable from the small brokers, but manufacturers or their agents are making no effort to meet this competition. It is noticeable that many buyers will pay a somewhat higher price for an item from a manufacturer rather than go to a small dealer or broker. Supplies of most items are only moderate, although it is said that a few speculators are carrying rather heavy stocks.

General Chemicals

The alkali situation is unchanged, with spot stocks only moderate and current quotations unchanged. There is little doubt that prices could be shaded with firm business. Ground caustic soda, 76 per cent, is quoted at $4.50 per 100 lb. and the solid at $3.75. Soda ash continues quiet and is offered at $2.30 per 100 lb. for medium-sized lots in cooperage. There is a small amount of caustic potash moving and the price is firm at 6½c. per lb. for the 88-92 per cent material.

Potash alum is quiet on spot, with only small lots moving. The lump is quoted at 5½@6c. per lb. and the powdered at 6@6½c. Iron-free aluminum sulphate is slow and unchanged at 3¼c. per lb. White arsenic continues firm with only small quantities available at 8@8½c. per lb. Barium chloride is obtainable on spot at $55 per ton but little is moving. Small quantities of blue vitriol changed hands at 5c. per lb. but nothing of any consequence was reported. Holders report a fair demand for borax, which is quoted at 5c. per lb. for single barrels. Carbon bisulphide is very quiet and spot stocks are still quoted at 7@7½c. per lb. Carbon tetrachloride is in a similar position and large drums are offered at 11c. per lb. Glycerine is very firm, with c.p. material quoted by refiners at 16½@17c. per lb., bulk basis. Epsom salts attract little attention and are quoted at 2¾c. per lb. for U.S.P. material in barrels.

Bichromates are enjoying a fair demand for small lots and are unchanged as to price. Potash bichromate is offered at 11¾c. per lb. in single casks and similar lots of the soda at 9½c. Red prussiate of potash is entirely off the market and not a single pound could be located. Single casks were offered to arrive at 52@55c. per lb. Yellow prussiate of potash is firm at 26@27c. acording to quantity and holder. Potassium permanganate is very slow with spot U.S.P. crystals quoted in small lots at 17@18c. per lb. Hypo is very quiet at $3.95 per 100 lb. for pea crystals in barrels.

Vegetable Oils and Naval Stores

Linseed oil is reported to be moving very slowly, although the price is showing unusual firmness. The boiled oil is quoted at 82c. per gal. in 5-bbl. lots and similar quantities of the raw at 80c. Higher prices on this oil are freely predicted by all factors.

Turpentine, like linseed oil, while very firm as to price, is moving very slowly. Pure spirits are quoted in 5-drum lots at 96c. per gal. Rosin is showing firmness and is said to be moving fairly well to the paper trade. Prices lacked quotable change and were only nominal for less than carlots.

The Iron and Steel Market

Pittsburgh, Feb. 10, 1922.

The improvement in the volume of steel orders placed since the first of the year is found by the January ingot production report to have been greater than commonly estimated. The American Iron and Steel Institute's report, giving the production of steel ingots in January by the thirty reporting companies, indicates that production by the industry as a whole was at the rate of about 22,750,000 tons per annum during January. The average production during December was about 19,750,000 tons, and as production during December was declining, the rate at the close of the month was much less, probably between 16,000,000 and 18,000,000 tons. From such a rate there has been a more or less progressive increase to date, and with a January average of about 22,750,000 tons the rate by this time may be close to 25,000,000 tons. If so, we have already exceeded the high level of last autumn, shown by a production rate of 23,000,000 tons during October and November. Meanwhile there has been a lull, which is to be attributed to its being winter rather than to the much mentioned holidays and annual inventory.

Competition for steel orders continues keen. The openly quoted or "regular" prices are practically unchanged, but the average price realized on all the tonnage sold has probably been sagging a trifle from week to week. The extreme prices may be much the same, but smaller and smaller orders, in many commodities, become subject to concessions from the "regular" prices. Apart from general shading, there is the case of mills well removed from Pittsburgh departing from "Pittsburgh plus." Chicago has long had its own basing for bars, shapes and plates, 1.60c., as against a Pittsburgh market of 1.50c., while by "Pittsburgh plus" the Chicago market would be 1.88c., the freight Pittsburgh to Chicago being 38c. per 100 lb. Of late the East has likewise departed, Eastern mills making delivered prices which Pittsburgh producers do not meet when they represent extreme concessions.

Pig Iron and Coke

In most districts pig iron continues to show a slight sagging tendency, with now and then a definite, though small, decline. Many buyers doubt whether prices are really below cost of production, as so generally claimed by furnaces.

Connellsville coke has undergone a sharp stiffening in the past week, mostly because of the threatened suspension at the union bituminous coal mines April 1. The trade generally regards the suspension as assured, and assumes that the non-union mines will not be able to supply the entire demand. Some foundries are stocking foundry coke, while Connellsville coke operators are turning their attention to coal, which even at recent prices has been bringing more as coal than when made into coke. Spot furnace coke of fair grade could be had a week ago at $2.75, while at present no passable coke is available at under $2.85 and the best grades command $3. Foundry coke remains quotable at $3.75@$4.25, but there is little at the lower prices and much more request for the $4.25 brands.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.40 – $0.42
Acetone	lb.	$0.12½ – $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.60	2.65 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9.50	9.75 – 10.00
Boric, crystals	lb.	.12½ – .12¾	.13 – .13½
Boric, powder	lb.	.12¾ – .13	.13¼ – .14
Citric	lb.	—	.44 – .45
Hydrochloric	100 lb.	1.15 – 1.25	1.30 – 1.75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11 – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg	lb.	.06½ – .06½	.06¾ – .07
Nitric, 42 deg	lb.	.06¾ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.14½ – .15	.15¼ – .16
Phosphoric, 50 per cent solution	lb.	.08½ – .08¾	.09 – .10
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	—	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 – 11.00	—
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	—
Sulphuric, 66 deg., tank cars	ton	16.00 – 16.50	—
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	—	.65 – .75
Tannic (tech.)	lb.	.45 – .50	.51 – .55
Tartaric, imported crystals	lb.	—	.25½ – .27
Tartaric acid, imported, powdered	lb.	—	.26 – .29
Tartaric acid, domestic	lb.	—	— .30
Tungstic, per lb. of WO	lb.	—	1.00 – 1.10
Alcohol, ethyl	gal.	—	4.75 – 5.50
Alcohol, methyl (see methanol)		—	—
Alcohol, denatured, 188 proof	gal.	—	.39 – .40
Alcohol, denatured, 190 proof	gal.	—	.40 – .41
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½ – .04	.04¼ – .04½
Alum, chrome lump	lb.	.07½ – .08	.08¼ – .08½
Aluminum sulphate, commercial	lb.	.01¾ – .02	.02¼ – .02½
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07¼ – .07¾
Amylacetate tech	gal.	—	2.00 – 2.40
Arsenic, white, powdered	lb.	.07½ – .07¾	.07¾ – .08¼
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	54.00 – 55.00	55.50 – 70.00
Barium dioxide (peroxide)	lb.	.21 – .21½	.22 – .23
Barium nitrate	lb.	.06½ – .07	.07¼ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	—
Blanc fixe, pulp	ton	45.00 – 55.00	—
Bleaching powder	100 lb.	2.10 – 2.25	2.30 – 3.25
Blue vitriol (see copper sulphate)		—	—
Borax	lb.	.05½ – .06	.06¼ – .07
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.20 – .21	.21½ – .26
Calcium acetate	100 lbs.	1.75 – 2.00	—
Calcium carbide	lb.	.04¼ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27.00
Calcium chloride, granulated	lb.	.01¾ – .02	.02¼ – .02½
Calcium peroxide	lb.	—	1.40 – 1.50
Calcium phosphate, tribasic	lb.	—	.15 – .16
Camphor	lb.	—	.96 – .98
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10¾	.11 – .12
Carbonyl chloride, (phosgene)		—	.60 – .75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	—
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	—
Chalk, precip.—imported, light	lb.	.04½ – .05	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	—	.37 – .40
Cobalt oxide	lb.	—	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 20.00
Copper carbonate, green precipitate	lb.	.20 – .20½	.21 – .21½
Copper cyanide	lb.	—	.58 – .60
Copper sulphate, crystals	100 lb.	5.55 – 5.65	5.70 – 6.25
Cream of tartar	lb.	—	.23 – .24½
Epsom salt (see magnesium sulphate)		—	—
Ethyl acetate com. 85%	gal.	—	.58 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	—	.93 – —
Formaldehyde, 40 per cent	lb.	.10 – .10½	.10¾ – .11¼
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	—
Fullers earth—imported powdered—net ton		30.00 – 32.00	—
Fusel oil, ref	gal.	—	2.50 – 3.00
Fusel oil, crude	gal.	—	1.40 – 1.75
Glauber's salt (see sodium sulphate)		—	—
Glycerine, c. p. drums extra	lb.	—	.16½ – .17
Iodine, resublimed	lb.	—	3.80 – 3.90
Iron oxide, red	lb.	—	.12 – .18
Lead acetate	lb.	—	.10½ – .12½
Lead arsenate, powd	lb.	.15 – .15½	.15¾ – .16¼
Lead nitrate	lb.	—	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2.75 – 3.00
Magnesium sulphate, technical	100 lb.	—	1.05 – 1.80
Methanol, 95%	gal.	—	.60 – .62
Methanol, 97%	gal.	—	.62 – .63
Nickel salt, double	lb.	—	.11 – .11½
Nickel salt, single	lb.	—	.11 – .11½
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	—	.30 – .35
Potassium bichromate	lb.	.10¼ – .10½	.10¼ – .11
Potassium bromide, granular	lb.	—	.13 – .17
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.05¼ – .05½	.05¾ – .08
Potassium cyanide	lb.	—	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.55 – 5.65	5.70 – 6.50
Potassium iodide	lb.	—	2.90 – 3.00
Potassium nitrate	lb.	.07⅞ – .07½	.08 – .09
Potassium permanganate	lb.	.13 – .14	.14½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.24 – .25	.25½ – .25½
Rochelle salts (see sodium potas tartrate)		—	—
Salammoniac, white, granular	lb.	.06¾ – .07	.07¼ – .07½
Salammoniac, gray, granular	lb.	.06½ – .06¾	.07 – .07½
Salsoda	100 lb.	1.60 – 1.70	1.75 – 2.00
Salt cake (bulk)	ton	17.00 – 20.00	—
Soda ash, light	100 lb.	1.65 – 1.80	1.85 – 2.40
Soda ash, dense	100 lb.	1.75 – 1.85	1.90 – 2.40
Sodium acetate	lb.	.04 – .04¼	.04½ – .05
Sodium bicarbonate	100 lb.	2.20 – 2.25	2.30 – 2.75
Sodium bichromate	lb.	.07¾ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04¾	.05 – .05½
Sodium chlorate	lb.	.06¼ – .06¾	.07 – .07½
Sodium chloride	long ton	12.00 – 13.00	—
Sodium cyanide	lb.	.26 – .26½	.26¾ – .27
Sodium fluoride	lb.	.08 – .08½	.08¾ – .09½
Sodium hydroxide (caustic soda)	100 lb.	3.35 – 3.40	3.45 – 4.10
Sodium hyposulphite	lb.	.03¼ – .03½	.03¾ – .04
Sodium nitrite	lb.	.07 – .07½	.07⅞ – .08
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¾ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	—	.18 – .21
Sodium prussiate, yellow	lb.	.16¾ – .17	.17¼ – .17½
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.25 – 1.30	1.35 – 2.00
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ – .04½	.04½ – .05
Sodium sulphite, crystals	lb.	.03½ – .03¾	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, red	lb.	.05 – .05¼	.05¾ – .06
Sulphur, crude	ton	18.00 – 20.00	—
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	—	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	—	2.00 – 2.75
Talc—imported	ton	30.00 – 40.00	—
Talc—domestic powdered	ton	18.00 – 25.00	—
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	—	.39 – .40
Zinc carbonate	lb.	.15 – .15¼	.15½ – .16
Zinc chloride, gran	lb.	.08 – .08½	.08¾ – .09
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.17 — .18
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.30 — 1.35
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.29 — .32
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.20 — .22
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.00 — 1.10
Dimethylaniline	lb.	.41 — .45
Dinitrobenzene	lb.	.21 — 25
Dinitroclorbenzene	lb.	.25 — 27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.25 — 30
Dip oil, 25%, car lots, in drums	gal.	.28 — 30
Diphenylamine	lb.	.60 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	1.00 — 1.05
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.15 — 1.20
Naphthalene crushed, in bbls.	lb.	.07 — .08
Naphthalene, flake	lb.	.07 — 08
Naphthalene, balls	lb.	.08 — .09
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.35 — 1.40
Para-dichlorbenzene	lb.	.17 — 18
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.60 — 1.65
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.37 — 40
Phenol, U. S. P., drums	lb.	.12 — 16

Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.85 —	2.00
Salicylic acid, tech., in bbls.	lb.	.18 —	.20
Salicylic acid, U. S. P.	lb.	.22 —	.23
Salol	lb.	.80 —	.82
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.26 —	.28
Toluidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Stearic Acid, single pressed	lb.	8½—	9
Stearic Acid, double pressed	lb.	9¼—	9½
Stearic Acid, triple pressed	lb.	10¼—	10½

All other prices remain quotably unchanged.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.40 —	5.45
Rosin E-I	280 lb.	5.50 —	5.55
Rosin K-N	280 lb.	6.15 —	6.90
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	91½ —	.....
Wood turpentine, steam dist.	gal.	.89½ —	.....
Wood turpentine, dest. dist.	gal.	.88½ —	.....
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, bulk	100 lb.	$2.50 —	2.60
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.37 —	2.40
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	37.00
Potassium sulphate	unit	1.00 —	.....

Crude Rubber

Quotations Unchanged as of Feb. 8.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.14 —	.14¼
Coconut oil, Ceylon grade, in bbls.	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09¾ —	.10
Corn oil, crude, in bbls.	lb.	.08¾ —	.09
Cottonseed oil, crude (f. o. b. mill)	lb.	.08¼ —	.08½
Cottonseed oil, summer yellow	lb.	.09¾ —	.10
Cottonseed oil, winter yellow	lb.	.10½ —	.10¾
Linseed oil, raw, car lots (domestic)	gal.	.78 —	.79
Linseed oil, raw, tank cars (domestic)	gal.	.73 —	.74
Linseed oil, in 5-bbl lots (domestic)	gal.	.82 —	.84
Olive oil, denatured	gal.	1.10 —	1.12
Palm, Lagos	lb.	.07¾ —	.08
Palm, Niger	lb.	.06⅛ —	.06⅜
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08¼ —	.08½
Peanut oil, refined, in bbls.	lb.	.10¾ —	.11
Rapeseed oil, refined in bbls.	gal.	.85 —	.86
Rapeseed oil, blown, in bbls.	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07¼ —	....

FISH

Light pressed menhaden	gal.	$0.45 —	....
Yellow bleached menhaden	gal.	.48 —	....
White bleached menhaden	gal.	.47 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

Prices Remain the Same as Feb. 8 Report

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½—	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	12 —	..
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 78-82%Mn, Foreign, c. i. f. Atlant c seaport	gross ton	58.00 —	59.00
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb of Mo	lb.	2.25 —	
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	.....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.00 —	4.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00 —	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	21.00 —	22.00
Coke, foundry, f.o.b. ovens	net ton	3.50 —	3.75
Coke, furnace, f.o.b. ovens	net ton	2.75 —	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24 —	....
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.48 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport.	unit	27.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½—	.13¼

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.25
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.45
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	31.875
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375–4.40
Zinc, spot, New York	4.95
Zinc, spot, E. St. Louis	4.50

OTHER METALS

Silver (commercial)	oz.	$0.66⅝
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	90.00@ 95.00
Iridium	oz.	170.00@190.00
Palladium	oz.	60.00
Mercury	75 lb.	49.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21.25
Copper bottoms	28.75
Copper rods	19.75
High brass wire	17.45
High brass rods	14.75
Low brass wire	18.75
Low brass rods	19.25
Brazed brass tubing	25.50
Brazed bronze tubing	30.50
Seamless copper tubing	21.25
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.75
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Cleveland	Chicago
Structural shapes	$2.63	$2.63	$2.63
Soft steel bars	2.53	2.53	2.53
Soft steel bar shapes	2.53	2.53	2.53
Soft steel bands	3.13	3.13	3.13
Plates, ¼ to 1 in. thick	2.63	2.63	2.63

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

ASHDOWN—The new company being organized by A. D. Banks, Little Rock, Ark., and associates, to operate a cement mill in the White Cliffs section, has concluded negotiations with the Ashdown Chamber of Commerce for the construction of a road to the property and for other work incidental to the establishment of the plant. Construction will be commenced at once, and equipment orders placed. In addition to the cement mill the company will also establish a plant for the manufacture of fertilizer products and whiting. The new organization will operate with a capital of $1,000,000.

California

ALAMEDA—The Direct Steel Process Co., San José, Cal., with experimental plant at Alameda, has preliminary plans under way for the construction of a new steel-manufacturing plant in the vicinity of San Francisco, and is negotiating with the Chamber of Commerce at the latter place for a suitable site. H. Bardue, vice-president and general manager, is in charge.

TORRENCE—Officials of the John E. Thropp's Sons Co., Lewis St., Trenton, N. J., manufacturer of rubber mill machinery, etc., have acquired the local plant of the Hendrie Rubber Co., and will organize a new company under the name of the Hendrie Rubber Tire Co. to operate the Torrence works for the manufacture of automobile tires, tubes and other rubber products. The new company will have a capital of $200,000, and will equip the plant for an initial daily capacity of about 350 tires and 200 tubes. Thomas H. Thropp is president and general manager; John E. Thropp, secretary; and William Baker, treasurer. The last noted will take up a residence in southern California, and will be in charge of operations at the plant.

NAPA—The Pacific Portland Cement Co. will discontinue operations at its mills at Napa Junction, near Napa, and the plant will be dismantled. It is proposed to remove the machinery to a new mill site.

Connecticut

NEW MILFORD—The New England Lime Co., Danbury, Conn., has awarded a contract to the Berlin Bridge Co., Berlin, Conn., for the construction of three 1-story buildings at New Milford, to replace its works recently destroyed by fire, with loss approximating $125,000. The new buildings will be 30 x 300 ft., 40 x 200 ft. and 25 x 75 ft., and with machinery will cost about the amount of fire loss. A number of other buildings will be erected at a later date. E. C. Grinning is president.

DANBURY—Fire, Feb. 3, destroyed a portion of the plant of the Beaverbrook Paper Mills, Inc., with loss estimated at about $125,000, including equipment.

NEW HAVEN—The Seamless Rubber Co., Hallock Ave., manufacturer of small rubber goods, has awarded a contract to Sullivan & McKeown, New Haven, for the construction of its proposed 1-story and basement addition, 140 x 160 ft., with wing extension, 60 x 60 ft., estimated to cost about $100,000. It will be used for spraying and other branches of manufacture. R. W. Foote, 185 Church St., is architect.

Idaho

COEUR D'ALENE—Idaho Clays, Inc., recently organized with a capital of $500,000, is arranging for the erection of a new plant on local site for the manufacture of brick, sewer pipe, terra cotta and other burned clay products. The company is headed by Laurence A. Spear and William M. Colby, both of Spokane, Wash.

Kansas

WICHITA—The Derby Oil Co. has construction under way on a new local oil refinery, estimated to cost about $500,000, with machinery, and will place the plant in service at the earliest date possible.

Louisiana

MONROE—The Sterling Carbon Co., Sterlington, near Monroe, is planning for the rebuilding of the mechanical department at its works destroyed by fire, Jan. 11, with loss estimated at about $25,000.

AVONDALE—The Standard Oil Co. of Louisiana has acquired the local plant of the Export Oil Corp., totaling about 800 acres, with frontage on the Mississippi River, for a consideration said to be about $950,000. The plant comprises a number of buildings, pumping plant, pipe line, storage facilities approximating 790,000 bbl., and will be used by the new owner primarily for export trade.

Massachusetts

SPRINGFIELD—The Strathmore Paper Co. has commenced the erection of its proposed new plant addition at West Springfield, to be 2-story, brick and concrete, 25 x 65 ft. The Casper Ranger Construction Co., Holyoke, Mass., has the general contract.

Maryland

BALTIMORE—The Mineral Potash Co., 712 Equitable Bldg., is completing plans and will soon take bids for the erection of a new 1-story plant at Ilchester, Md., to be 50 x 150 ft., and estimated to cost about $50,000. Louis A. Hazard is president.

BALTIMORE—Gilpin, Langdon & Co., Inc., 300 West Lombard St., manufacturer of drugs, chemicals, etc., has filed plans for the erection of a 1-story factory, 65 x 211 ft., at Eagle and Smallwood Sts., estimated to cost about $40,000.

VIENNA—The Nanticoke Flour Mill, operated by R. H. Baumgartner, is planning for the immediate rebuilding of the portion of its plant, destroyed by fire, Jan. 26, with loss estimated at about $17,000.

BALTIMORE—The Water Board, City Hall, has authorized the immediate preparation of plans for the construction of a new filtration plant for the waterworks system at Montebello, comprising new settling basins, coagulating basins, filtration plant proper and filtered-water reservoirs, estimated to cost about $1,200,000. William A. Megraw is water engineer in charge.

Michigan

KALAMAZOO—The Kalamazoo Vegetable Parchment Co., has completed plans and will take bids early in March for the erection of a 2-story addition to its plant, 90 x 925 ft., estimated to cost about $400,000. It will consist of two complete machine units. Billingham & Cobb, Press Bldg., are architects. J. Kindleberger is president and general manager.

BAY CITY—The Wildman Rubber Co. is perfecting plans for the early completion of its new local plant, now in course of erection, to be used for the manufacture of tires and other rubber products. To provide sufficient funds for the project, the company has arranged for a stock issue of $5,000,000, and this will be used, in part, for buildings and equipment purchases. W. W. Wildman, formerly president of the Portage Rubber Co., is head of the company; C. R. Twynham is treasurer.

DETROIT—The Aetna Portland Cement Co., 412 Union Trust Bldg., has completed plans for the erection of the first unit of its new cement mill at Essexville, near Bay City, and will commence work at an early date. It is estimated to cost in excess of $500,000. Franklin R. Johnson is president, and O. J. Lingeman, secretary.

Missouri

JEFFERSON CITY—The Standard Crate & Filler Co., operating at the former local plant of the J. M. Hays Wood Products Co., has acquired property totaling about 50 acres as a site for a new plant for the manufacture of strawboard products. It will cost about $350,000 with machinery. Plans will be prepared at an early date. The company was organized recently with a capital of $350,000.

New Jersey

NEWARK—The Nickelsburg Brothers Co., Meadow St., manufacturer of leather, has filed plans for the erection of a 1-story addition, 50 x 100 ft., to cost about $12,000.

WOODSTOWN—The South Jersey Farmers' Exchange has tentative plans under consideration for the erection of a 1-story fertilizer works, 50 x 180 ft., to replace its plant recently destroyed by fire. A. B. Lippincott is in charge.

JERSEY CITY—Colgate & Co., 105 Hudson St., manufacturers of soaps, etc., have filed plans for the erection of an addition to their plant at 17-25 Grand St., to cost about $22,000.

New York

BOLIVAR—The Bolivar Refining Co. is planning for the erection of a new oil refinery on local site. An extensive oil storage plant will also be constructed. Charles A. Chapman is head.

OSWEGO—The local plant of the National Starch Co., of the Corn Products Refining Corp., 17 Battery Pl., New York, has been acquired by the Oswego Factories Corp., which will take possession on July 1. The new owner plans for the operation of the works.

BROOKLYN—Fire on Feb. 3 partly destroyed the three buildings at 61-65 Taaffe Pl., occupied by the Columbia Cement Co., Floradale Chemical Co. and the Eastern Bronze Wire Works, respectively, with loss estimated at close to $25,000, divided among the different companies.

Ohio

FOSTORIA — The Bellevue Rubber Co., Bellevue, O., H. B Skinner, president, is planning for extensions and improvements in its 2-story and basement plant at Fostoria.

Pennsylvania

LOCK HAVEN—Fire on Feb. 1 destroyed the main building at the plant of the American Aniline Products Co., with loss estimated at about $200,000.

MOUNT UNION—The plant of the Mount Union Tanning & Extract Co. has been acquired by Calvin Greene and associates, who will operate the property in the future. The factory heretofore has been devoted to the manufacture of sole leather.

HAZELHURST — Fire on Jan. 27 destroyed a portion of the local plant of the Interstate Window Glass Co., with loss estimated at about $125,000.

MOUNT HOLLY SPRINGS—Llewllyn A. Marr, 176 Federal St., Boston, Mass., and E. J McDonnell, associated paper manufacturers, have acquired the local plant of the Mount Holly Paper Mills Co. at a receiver's sale for a consideration stated as $55,000. The new owners plan to place the mill in service at an early date, giving employment to about 125 operatives.

Tennessee

CHATTANOOGA—The Crane Enameling Co., recently organized as a subsidiary of the Crane Co., 835 South Michigan Ave., Chicago, Ill., with capital of $1,500,000, has taken possession of the local plants of the Mutual Enameling Co. and the Cahill Iron Works, and will operate these plants for the manufacture of high-grade enamel ware. The new factory of the Mutual company in the Alton Park section will be used as the main plant unit, and the Cahill works on Chestnut St. will be used as a branch. When operating full the two plants will give employment to about 600 operatives. R. T. Crane, Jr., Chicago, is president.

Texas

HOUSTON—The Switzer-Parke Co., 105 Paige St., recently organized with a capital of $30,000, has awarded a contract for the erection of a new plant, totaling about 11,000 sq.ft. of floor space, to be equipped as an electroplating and enamel-baking works. It is planned to commence production at an early date. Willard M. Parke is president, and Homer E. Switzer, secretary-treasurer.

TERRELL—Fire on Jan. 27 destroyed a portion of the plant of the Terrell Cotton Oil & Refining Co., with loss estimated at close to $40,000.

West Virginia

BLUEFIELD — The Tri-State Chemical Co., Box 46, recently organized, is planning for the establishment of a local plant for the manufacture of special chemical powders for fire-extinguishing service. Edward Palmer is manager.

New Companies

THE ATLANTIC CHEMICAL MFG. CO., Atlantic ty, N. J., has been incorporated with a pital of $50,000, to manufacture chemicals d chemical byproducts. The incorporators e John A. G. Iden, Fred P. Steckel and ving P. Parsons, 33 Real Estate Bldg., lantic City.

THE IRONIZED YEAST CO., Atlanta, Ga., has en incorporated with a capital of $300,- 0, to manufacture yeast and kindred oducts. The incorporators are W. P. oodworth, Mark Bolding and R. G. ephens, all of Atlanta.

THE MARCO CHEMICAL CO., 501-2 Genesee ank Bldg., Flint, Mich., has been incor- rated with a capital of $10,000, to manu- cture chemicals, alkalis and affiliated oducts. The incorporators are Clyde ewman, Lee L. Martin and H. Martin.

THE EASTERN BRICK CO., New York, N. Y., as been incorporated under Delaware laws ith capital of $2,000,000, to manufacture ick, tile and other burned clay products. he company is represented by the United tates Corporation Co., 65 Cedar St., New ork.

THE OSWEGO FALLS CORP., Fulton, N. Y., as been incorporated with a capital of 2,500,000, to manufacture pulp and paper oducts. The company will comprise a erger of the Oswego Falls Pulp & Paper o., Fulton; the Skaneateles Paper Co., kaneateles, N. Y.; and the Sealright Co., this same district. The incorporators are . L. Paddock, F. G. Weeks and C. W. ooke. Headquarters will be at the plant the Oswego Falls Pulp & Paper Co., ulton.

THE HORMONE CHEMICAL CORP., East range, N. J., has been incorporated with a pital of $50,000, to manufacture chemicals nd chemical byproducts. The incorpora- rs are Arthur L. Walsh, Joseph F. McCoy nd Harold L. Lyman, 331 Main St., East range.

THE JOSE OIL CO., Los Angeles, Cal., has en incorporated with a capital of $200,- 00, to manufacture petroleum products. he incorporators are H. A. Bordeen, J. aul Getty and Russell Avery. The com- any is represented by Anderson & Ander- n, 1112 Black Bldg., Los Angeles.

E. W. JEFFRESS, INC., Detroit, Mich., has en incorporated with a capital of $10,000, manufacture chemicals and affiliated roducts. The incorporators are J. G. Ham- len, Jr., E. W. and M. M. Jeffress, 1350 efferson Ave., East, Detroit.

THE ABBOTT INK CO., Room 1400, 69 West Vashington St., Chicago, Ill., has been in- orporated with a capital of $9,000, to anufacture inks and kindred specialties. he incorporators are Thuriow W. Brewer, icholas F. Roeder and Francis B. Regan.

THE FARMERS' FERTILIZER CO., Sumter, . C., has been incorporated with a capital f $10,000, to manufacture fertilizer prod- cts. H J. Harby is president; H. W. larby, vice-president; and J. H. Guthrle, ecretary, all of Sumter.

THE INGERSOLL PRODUCTS CO., Newark . J., has been incorporated with 500 shares f stock, no par value, to manufacture oil ompounds, etc. The incorporators are J. S. eichliter, H. T. Maloney and Palmer radner, Kinney Bldg., Newark.

THE EDDYLITE SPARK PLUG CO., Buffalo, . Y. has been incorporated with a cap- tal of $100,000, to manufacture porcelain park plugs and affiliated products. The ncorporators are W. F. Feser, L. J. and . B. Eddy. The company is represented y J. H. Ryan, attorney, Olean, N. Y.

THE INTERNATIONAL CHEMICAL PRODUCTS o., San Fernando, Cal., has been incor- orated with a capital of $250,000, to manu- acture chemicals and chemical byproducts. he incorporators are H. J. Poppelman, rthur G. and Bernard A. Munn, all of an Fernando.

THE DAMASCUS STEEL PRODUCTS CORP., 500 Fourteenth Ave., Rockford, Ill., has een incorporated with a capital of $50,000, o manufacture steel specialties. The in- orporators are C. F. Maitland, C. P. Two- ney and J. R. Hughes.

THE SUNFLOWER OIL CO., Shreveport, La., as been incorporated with a capital of 120,000, to manufacture petroleum prod- cts. A. W. Baird, Sr., is president; John B. Hutchinson, vice-president; and A. W. Baird, Jr., secretary and treasurer, all of Shreveport.

THE LA SALLE PAPER CO., South Bend, nd., has been incorporated with a capital of $250,000, to manufacture paper and pulp roducts. The incorporators are E. O. and Claude E. Nicely, and John G. Yeagley, all of South Bend.

THE GOODCHILD GLASS MFG. CO., Haw- thorne, N. J., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture glassware products. The incorporators are Walter Goodchild, Walter Hohenhausen and Harry Grundy, 177 Washington Ave., Hawthorne.

THE PORT UNION BRASS FOUNDRY CO., New York, N. Y., has been incorporated with a capital of $30,000, to manufacture brass, bronze and other metal castings. The incorporators are H. V. Bebarfald, B. F. Vineburg and P. E. Uhr. The company is represented by Manken Bros., 206 Broad- way, New York.

THE MARYLAND SMELTING & REFINING CO., INC., 23 West Antietam St., Hagers- town, Md., has been incorporated with a capital of $35,000, to manufacture refined metals, operate a smelting works, etc. The incorporators are Henry H. Keedy, Jr., Leon R. Yourtee and John D. Keith.

THE AMERICAN LEATHER GOODS CO., New- ark, N. J., has been incorporated with a capital of $100,000, to manufacture leather products. The incorporators are Abraham Danzig, Edward Faragasso and John Par- lante. The company is represented by Philip J. Schotland, 9 Clinton St., Newark.

THE NATIONAL INK CO., Baltimore, Md., has been incorporated under Delaware laws with capital of $100,000, to manufacture inks, chemicals and kindred products. The incorporators are James L. Bell, Harry D. Howell and Harry A. Kendall, Baltimore. The company is represented by the Colo- nial Charter Co., Ford Bldg., Wilmington, Del.

THE SUMMER RUBBER CO., Boston, Mass., has been incorporated with a capital of $5,000, to manufacture rubber products. John Woolf is president, and Victor Miller, 53 Strathmore Road, Brookline, Mass., treasurer.

THE ARCHER PHOSPHATE DEVELOPMENT CO., Archer, Fla., has been incorporated with a capital of $75,000, to manufacture phosphate and kindred products for fertil- izer and other service. W. F. Walker is president; S. G. Moyers, vice-president; and E. N. Morrow, secretary and treasurer, all of Archer.

THE HART LEATHER FINISH CO., 1046 West Division St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture finishes and compounds for leather and kindred products. The incor- porators are James M. Hart, William B. Carroll and Edward S. Cummings.

THE SMITHFIELD OIL CO., Wilmington, Del., has been incorporated under state laws with capital of $100,000, to manufac- ture petroleum products. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

ZIEGEL, EISMAN & CO., Newark, N. J., has been incorporated with a capital of $1,000,- 000, to manufacture leather products. The incorporators are M. and H. Seymour Eis- man, and Leo Goldsmith, 99 Frelinghuysen Ave., Newark.

THE FRANKFORD PAPER BOX CO., Phila- delphia, Pa., is being organized by Wil- liam J. Zimmerman, Jr., George E. Beck and J. Edward Linck, to manufacture paper products. Application for a state charter will be made at once. The company is represented by R. P. Frank Maxwell, 1919 East Chelten St., Philadelphia.

THE TRAVIS COTTONSEED PRODUCTS CO., Austin, Tex., has been incorporated with a capital of $50,000, to manufacture cotton- seed oils. The incorporators are E. H. Perry, D. G. Reed and Oscar Robinson, all of Austin.

ZURA, INC., 608 South Dearborn St., Chi- cago, Ill., has been incorporated with a capital of $50,000, to manufacture chemi- cals and affiliated products. The incorpora- tors are Joseph B. Duncan, E. C. Auld and William B. Ziff.

THE UTAH SHALE PROCESS CORP., Denver, Col., has been incorporated under Dela- ware laws with capital of $1,000,000, to manufacture coal-tar products and affili- ated specialties. The incorporators are Frederick M. Browning, Denver; William S. Pitts, and David C. Dodge, New York. The company is represented by the Colonial Charter Co, Ford Bldg., Wilmington, Del.

THE MUTUAL OIL PRODUCTS CO., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture refined oil products. The incorporators are Harvey C. Harrison, Clarence L. Powell and Rob- ert Rogers, 17 Margaretta St., Newark.

THE PINEVILLE PAINT & VARNISH CO., Pineville, Ky., has been incorporated with a capital of $20,000, to manufacture paints, varnishes, etc. The incorporators are H. M. Ernst, W. N. Payne and W. L. Long, all of Pineville.

Capital Increases, Etc.

THE INDIAHOMA REFINING CO., East St. Louis, Ill., operating a local oil refinery and with similar plant at Okmulgee, Okla., has disposed of a bond issue of $1,750,000, the proceeds to be used for financing, general operations, etc. Elmer E. Schock is presi- dent.

THE AMERICAN ART CLAY CO., Indian- apolis, Ind., has filed notice of dissolution under state laws.

THE WISCONSIN CHEMICAL CO., Detroit, Mich., capitalized at $100,000, has filed notice of dissolution.

THE HOOKER ELECTROCHEMICAL CO., Niagara Falls, N. Y., has filed notice of a mortgage on its property taken by the Equitable Trust Co., New York, N. Y., totaling $12,500,000.

THE GENERAL LINSEED OIL CO., 1637 West Roosevelt St., Chicago, Ill., has filed notice of change of name to the General Paint & Varnish Co., at the same time in- creasing its capital from $10,000 to $50,000.

A. Parker Nevin has been appointed re- ceiver for the EL SALVADOR SILVER MINES CO., 11 Pine St., New York, N. Y., operat- ing properties in San Salvador. Edward D. Dowling is president.

THE COLUMBUS FOUNDRY CO., Columbus, Ga., and the W. L. LEMLY FOUNDRY CO., Bessemer, Ala., have been merged under the latter name, and the plant of the first noted company will be removed to Bessemer.

THE MAINE PULP & PAPER CO., D. S. Morgan Bldg., Buffalo, N. Y., with pulp and paper mills in Maine, has filed a volun- tary petition in bankruptcy, listing liabili- ties of $420,391.96, and assets of $454,021.09. Andrew Krieger is president.

Stockholders of the KELLEY TIRE & RUB- BER CO., New Haven, Conn., manufacturer of tires and other rubber goods, with local plant, are arranging for a reorganization, abolishing the receivership under which operations have been conducted for some time.

The flour mill property of the C. A. GAMBRILL MFG. CO., Ellicott City, Md., will be offered for sale by the trustees in bank- ruptcy, Herman A. Tingley and John B. H. Dunn, 110 Commerce St., Baltimore, Md., on Feb. 20.

Manufacturers' Catalogs

THE QUIGLEY FURNACE SPECIALTIES CO., New York, has recently issued Bull. 51 on the method of applying successful boiler setting patches. Another bulletin presents information, with illustrations, regarding re- fractory linings and the use of Hytempite in power plant work, as well as its uses in connection with Carbosand for baffles, patching boiler settings, etc. Pages 18 and 19 give some information on the uses of Insulbrix and show comparative heat losses of uninsulated and insulated walls. This company also calls attention to Bull. 52, describing the use of Hytempite in making one-piece baffles of refractory concrete. This bulletin is well illustrated and tells an interesting story of the experience of a large Brooklyn concern.

THE NORTON CO., Worcester, Mass., has issued two new bulletins: one on "Metal Polishing" and the other on "Factors Af- fecting Grinding Wheel Selection."

THE CAREY CO., Pittsburgh, Pa., has issued a circular describing its newly patented carboy inclinator, which is claimed to be a much more economical way of handling acids and other chemicals, when received in carboys.

ROBERT L. STILLSON CO., New York has published an attractive book on "Out- spinning the Spider, the Story of Wire and Wire Rope," by John Kimberly Mum- ford. It tells the history of wire-rope making in this country from the beginning of the industry in 1840, and relates the romance of the Brooklyn Bridge; of the wire rope barrage laid down in the English Channel during the late war; and other interesting engineering achievements.

INGERSOLL-RAND CO., New York, has issued a catalog on "Steam Condensing Plants" which is a reprint of Paul Bancel's paper read before the Baltimore Section of the American Society of Mechanical Engi- neers, May 16, 1921.

WILLIAMS TOOL CORP., Erie, Pa., calls attention to its latest booklet entitled "Don't Let It Happen to You." This book- let was written for the man who owns or

operates a power pipe machine, and represents an endeavor on the company's part to educate and instruct all operators of power pipe machines for better threads and greater production. Copies will gladly be sent on request.

THE CUTLER-HAMMER MFG. CO., Milwaukee, has issued a new bulletin, No. 2039, covering the New Thomas Calorimeter, which records total heating values of gas graphically.

THE GENERAL ENGINEERING CO., Salt Lake City, Utah, has issued a new metallurgical bulletin describing its facilities for investigations in ore treatment. The pamphlet is illustrated with representative mills, design and construction by the company. It contains also considerable general information on metal statistics, cost of mill operations, cost of steam and electric power, etc. The company has made an unusual and successful effort to produce a bulletin of exceptional value.

THE AMERICAN STEAM GAUGE & VALVE MFG. CO., Boston, Mass., in an 8-page folder illustrates and describes the new American recording thermometer, which has been designed after years of experimental work and field tests. These instruments are designed to record accurate temperatures and to meet every industrial need and can be furnished for any desired temperature range up to 1,000 deg. F.

BEACH-RUSS CO., New York City announces a new 4-page bulletin, No. 27, on Rotary Pumps.

THE ABBE ENGINEERING CO., New York City has issued Bull. 18 on its products, which include pebble mills, ball mills, tube mills, pulverizing machinery, bolting cloth, rotary cutters, disintegrators, mixers, etc.

THE GOULDS MFG. CO., Seneca Falls, N. Y., is distributing Bull. 123 descriptive of the newest addition to its pump line—the Goulds steam turbine-driven centrifugal pump.

THE DURIRON CO., INC., Dayton, O., calls attention to Bulletin 127, illustrating and describing the Duriron-Merco lubricated plug cock, which should be of interest where corrosion must be controlled in pipe lines. In Bulletin 126-A this company treats sanitary drain pipe and fittings.

THE INDUSTRIAL WORKS, Bay City, Mich., has published Catalog 113, illustrating and describing the Type BC "Industrial crawling tractor crane, which has a capacity of 20,000 lb. and can be equipped to handle a hook and block, grab bucket, drag-scraper bucket, wood grapple, electric-lifting magnet shovel dipper, and pile driver leads with drop hammer. This crane should prove useful to road contractors, lumber and coal dealers, gravel, sand and stone producers, foundries, railroad reclamation and storage yards, and moderate-size manufacturing plants.

THE ATLAS VALVE CO., Newark, N. J., has just published Catalog 21, on Atlas, Ideal and Victor reducing valves, pump governors, pressure regulators, hot water tank regulators, control valves and damper regulators. This 20-page catalog illustrates, describes and lists all sizes and gives prices. A copy will be sent free on request.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., calls attention to Bulletin 1108, on Power Transformers. This attractive 32-page booklet illustrates and describes power transformers.

STROMBERG ELECTRIC CO., Chicago, Ill., has issued a bulletin describing its process timing and signaling instruments. This instrument has been developed as an accurate means of automatically operating a signal at the end of a predetermined time, to announce the completion of a process or operation, and has a very broad field of application.

THE UNION MINING CO., INC., Mount Savage, Md., has issued Catalog H, on Firebrick. It contains 150 pages, 4 x 6½ in., and describes the company's products and also gives general information.

SKINNER, SHERMAN & ESSELEN, Boston, Mass., have issued a booklet entitled "Mr. Banker, Meet Old Man Chemistry," by James H. Collins. It is an interesting booklet, which has been published in the endeavor to give publicity to chemical matters. Copies will be sent on request.

THE VACUUM OIL CO., New York, has issued two educational publications: One on "Oil Engines" and the other on "Stationary Steam Engines." In the first-mentioned booklet the principle is described as well as the construction, operation, cooling, fuel, methods of lubrication, lubricating oil and deposits. The second booklet treats reciprocating steam engineers and boiler plant and steam production. Interested individuals will be furnished copies on request.

THE OILGEAR CO., Milwaukee, Wis., announces the publication of Bull. 2, on Oilgear variable speed hydraulic power transmissions, and Bull. 6, on the Oilgear Control Pump.

THE CUTTER CO., Philadelphia, Pa., has issued a bulletin on U-re-lite, which is an I-T-E circuit breaker inclosed in a specially constructed steel case from the front of which projects a convenient operating handle.

THE BRISTOL CO., Waterbury, Conn., has published Catalog 1501, descriptive of its round chart recording electrical instruments, including voltmeters, ammeters and wattmeters, which can be furnished in the strip chart type.

New Publications

NEW BUREAU OF MINES PUBLICATIONS: Eleventh Annual Report of the Director of the Bureau of Mines to the Secretary of the Interior for the fiscal year ended June 30, 1922; Bull. 187, Treatment of the Tungsten Ores of Boulder County, Col., by J. P. Bonardi and J. C. Williams; Tech. Paper 248, Gas Masks for Gases Met in Fighting Fires, by Arno C. Fieldner, Sidney H. Katz and Selwyne P. Kinney; Tech. Paper 249, The Determination of Oxides of Nitrogen, by V. C. Allison, W. L. Parker and C. W. Jones; Tech. Paper 284, Coal and Coke Mixtures as Water-Gas Generator Fuel, by W. W. Odell.

NEW BUREAU OF STANDARDS PUBLICATIONS: Circular 38, The Testing of Rubber Goods; Circular 113, Structure and Related Properties of Metals; Circular 115, Recommended Specifications for Pneumatic Tires, Solid Tires and Inner Tubes; Circular 117, Recommended Specification for Interior Varnish; Circular 118, Recommended Specification for Limestone, Quicklime and Hydrated Lime for Use in the Manufacture of Glass; Sci. Paper 419, The Production of Liquid Air on a Laboratory Scale, by J. W. Cook; Sci. Paper 420, Specific Volume of Liquid Ammonia, by C. S. Cragoe and D. R. Harper; Tech. Paper 193, Design of Atmospheric Gas Burners, by Walter M. Berry, I. V. Brumbaugh, G. F. Moulton and G. B. Shawn; Tech. Paper 196, High Fire Porcelain Glazes, by H. H. Sortwell; Tech. Paper 197, Cementing Qualities of the Calcium Aluminates, by P. H. Bates; Tech. Paper 199, Method for Precision Test of Large Capacity Scales, by C. A. Briggs and E. D. Gordon.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: I: 8, Antimony in 1920, by Frank C. Schrader (Mineral Resources of the U. S., 1920, Part I), published Oct. 27, 1921; I: 9, Lead in 1920, by C. E. Siebenthal and A. Stoll (Mineral Resources of the U. S., 1920, Part I), published Oct. 14, 1921; I: 10, Secondary Metals in 1920, by J. P. Dunlop (Mineral Resources of the U. S., 1920, Part I), published Nov. 11, 1921; I: 12, Gold, Silver, Copper and Lead in South Dakota and Wyoming in 1920, by C. W. Henderson (Mineral Resources of the U. S., 1920, Part I), published Nov. 3, 1921; I: 13, Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1920, by Charles G. Yale (Mineral Resources of the U. S., 1920, Part 1), published Nov. 25, 1921; I: 15, Zinc in 1920, by C. E. Siebenthal and A. Stoll (Mineral Resources of the U. S., 1920, Part I), published Dec. 19, 1921; I: 23, Iron Ore, Pig Iron and Steel in 1919, by Ernest F. Burchard (Mineral Resources of the U. S., 1919, Part I), published Oct. 14, 1921; I: 24, Zinc in 1919, by C. E. Siebenthal and A. Stoll (Mineral Resources of the U. S., 1919, Part I), published Oct. 13, 1921; I: 25, Gold and Silver in 1919, by J. P. Dunlop (Mineral Resources of the U. S., 1919, Part I), published Oct. 31, 1921; I: 26, Cobalt, Molybdenum, Nickel, Tantalum, Titanium, Tungsten, Radium, Uranium and Vanadium in 1919, by Frank L. Hess (Mineral Resources of the U. S., 1919, Part I), published Nov. 10, 1921; II: 13, Potash in 1920, by M. R. Nourse (Mineral Resources of the U. S., 1920, Part II), published Oct. 4, 1921; II: 14, Sodium Compounds in 1920, by Roger C. Wells (Mineral Resources of the U. S., 1920, Part II), published Sept. 30, 1921; II: 15, Slate in 1920, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1920, Part II), published Oct. 12, 1921; II: 16, Carbon Black Produced From Natural Gas in 1920, by E. G. Sievers (Mineral Resources of the U. S., 1920, Part II), published Oct. 13, 1921; II: 17, Silica in 1920, by L. M. Beach (Mineral Resources of the U. S., 1920, Part II), published Oct. 11, 1921; II: 18, Feldspar in 1920, by L. M. Beach (Mineral Resources of the U. S., 1920, Part II), published Oct. 29, 1921; II: 19, Abrasive Materials in 1920, by L. M. Beach and A. T. Coons (Mineral Resources of the U. S., 1920, Part II), published Oct. 28, 1921; II: 20, Mineral Waters in 1920, by W. D. Collins (Mineral Resources of the U. S., 1920, Part II), published Oct. 29, 1921; II: 21, Sand and Gravel in 1920, by L. M. Beach (Mineral Resources of the U. S., 1920, Part II), published Nov. 5, 1921; II: 22, Lime in 1920, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1920, Part II), published Nov. 3, 1921; II: 23, Barytes and Barium Products in 1920, by George W. Stose (Mineral Resources of the U. S., 1920, Part II), published Dec. 6, 1921; II: 29, Abrasive Materials in 1919, by L. M. Beach and A. T. Coons (Mineral Resources of the U. S., 1919, Part II), published Sept. 16, 1921; II: 31, Lime in 1919, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1919, Part II), published Oct. 6, 1921; II: 32, Stone in 1919, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1919, Part II), published Oct. 18, 1921; II: 34, Natural-Gas Gasoline in 1919, by E. G. Sievers (Mineral Resources of the U. S., 1919, Part II), published Dec. 7, 1921.

THE UNIVERSITY OF ILLINOIS has issued Bulletin 125, on "The Distribution of the Forms of Sulphur in the Coal Bed," by H. F. Yancey and Thomas Fraser.

THE NATIONAL RESEARCH COUNCIL has issued pamphlet No. 15, on "Researches on Modern Brisant Nitro Explosives," by C. F. vanDuin and B. C. Roeters vanLennep, and No. 23, on "American Research Chemicals," by Clarence J. West.

THE HERCULES POWDER CO., Wilmington, Del., has reprinted in pamphlet form N. S. Greensfelder's article on "Explosives' Part in China Making," which appeared in the *Hercules Mixer* for January, 1922.

"REZISTAL STEEL" is the title of a pamphlet by Charles Morris which is being issued with the compliments of the Crucible Steel Co. of America, New York.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting, Friday, March 3, at the Hotel McAlpin, New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

NORTHWEST MINING ASSOCIATION is holding a convention in the Chamber of Commerce Bldg., Spokane, Wash., Feb. 14 to 18.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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Industrial Editor

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

R. S. McBRIDE
A. E. BUCHANAN, JR.
CHARLES N. HULBURT
Assistant Editors
J. S. NEGRU
Managing Editor

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The Trade Association's Relation to Industry

WHILE the announcement of the government's attitude toward the trade association leaves much to be desired, it is nevertheless a distinctly forward step in our industrial program. It relieves business to a great extent of the burden of uncertainty which had been heaped upon its shoulders by the Supreme Court decision last December in the case against the Hardwood Lumber Manufacturers' Association. The outcome of that case has affected the whole network of industries, for the open price association or "open competition plan," which it threatened, had become thoroughly established in many basic industries. Consumers and distributors as well as producers had felt its effect. Now comes the word that the plan, with certain definite limitations and under the very close supervision of the Department of Commerce, can be continued.

Secretary HOOVER, whose recent work with that department has been largely based on the establishment of a comprehensive statistical service as well as an intimate contact with all trade agencies, has endeavored to obtain a public statement from the Department of Justice from which business might derive final and official legal guidance. The fear that such a statement might be used in the courts against the government, however, has no doubt actuated the Attorney-General in his desire to confine his opinion to the form in which it is now made public—namely, as an informal interdepartmental inquiry defining the policy to be pursued by the Commerce Department in its future relations with business.

Of all the many activities of the trade associations, those connected with the statistical services have involved questions of perhaps the most serious and complex legal character. The decision in the case of the hardwood manufacturers, it will be recalled, was not a condemnation of the gathering and dissemination of statistics *per se*, nor did it prevent the recipient from using such statistical information as a basis for his future business transactions. It is only when the statistics are collected by some centralized authority and so interpreted by him as to evoke or otherwise result in combined action in restricted production, price fixing or some other equally unlawful activity that the government has held the procedure to be in restraint of trade and therefore a violation of the Sherman act. The Secretary put the case well and forcefully when he said, "The fact that the minority may be known to violate given laws does not establish a principle that the primary means, lawful in itself, which they have adopted for the purpose of performing the unlawful acts, should be entirely abolished and its use forbidden to law-abiding citizens." Thus the revolver in the hands of the criminal may be used illegally, but there are many good reasons why the revolver should not be legislated out of existence. The reckless automobile driver is a dangerous law-breaker, but certainly we are not justified in abolishing the automobile simply because he chooses to use it illegally. Those users of the open competition plan who in the past have offended the majesty of the law should be made to suffer, but the plan when properly conducted can be made a legitimate service to business.

The inquiries of Secretary HOOVER, reproduced on another page of this issue, outline a plan by which the Department of Commerce is to become a general clearing house for statistical information from all trade associations. Through him these data are then to be transmitted to the general public. Thus buyer and seller, producer and consumer, receive the same information regarding industrial conditions and are able to base their business judgment on the same facts and figures. Another plan which has received serious consideration in many quarters has been the proposal to use the industrial press as the medium for the dissemination of this information. One of our readers, whose letter we are glad to publish under "Readers' Views and Comments," has outlined a definite form of co-operation between the association secretary and the editor of the business paper. Such an arrangement naturally meets with the approval of the technical magazine interested in furthering the best interests of the industry it serves.

There can be no question about the legality of many of the activities which are discussed in the Hoover-Daugherty correspondence. The value of constructive endeavor such as the handling of educational and welfare work, the elimination of wasteful practices, co-operative advertising, and strengthening foreign and domestic trade, is not to be questioned. An investigation recently made by the Chamber of Commerce of the United States has resulted in a list of almost eighty different activities which in the past have absorbed the attention of the various trade and business organizations. Some of these, to be sure, have been discontinued because of the decision, but undoubtedly there are many ways in which associations can benefit industry.

The chief good arising from the government's statement is the official recognition of the trade association as an essential element of modern business. We can now be sure that we are not going to revert to the days when business was characterized by ignorant, wasteful competition, price cutting, over- and underproduction, and periodic labor shortages followed by unemployment. The officers and members of trade associations must see that illegal practices are abolished and must do their share in dispelling the suspicion that has surrounded their activities. And, finally, by accepting the government's offer of co-operation, they can pave the way to a better and more intelligent service to industry and to the general public.

When Does an Employment Contract Terminate?

HOW much of a man's brain does the law allow him enforceably to sign away through the necessities of making a living? How far do enactments against peonage protect a technical man from the operation of contracts terminable at the will of his employer, but with provisions stipulating duties after termination?

The questions above have an added pertinence today when so many technically trained men, precipitately let go during the past year at the first pinch of adversity, are now put to the necessity of bargaining their training and intelligence for the means of a living. Old contracts that meant bread and butter yesterday may be the means of denying it today—at least in the profession chosen. A man's experience and training in this world, barring the possession of wealth, are the capital whereon he must seek returns for a livelihood. The practice of some large technical corporations which extort, as the price of employment, the signing of a contract forever limiting a man's usefulness outside their own factory walls is open to serious discussion in the light of present conditions. Some protection is undoubtedly due the employer of confidential technicians who labor and create for the advantage of that employer; but should that protection be given gratis or exacted as the price of a job? If it is of value should it not be paid for, either by some assurance of stability of position or, at least, by some more valuable consideration than a month's notice?

Incidents such as a recent one wherein a large corporation has sought by the threat of legal prosecution to prevent a research engineer, formerly in its employ and recently released for economy's sake, from following his calling in his own chosen field demand attention that will forever prevent a repetition of the attempt. In the instance cited a signed contract is now invoked and exhibited which, strictly interpreted, would make the effort successful. Just how binding are unjust provisions of an employment contract? An executed instrument that specifies duties after employment has ceased may be the means of blacklist and boycott, unless the unfortunate signer seeks a different field. Unfitted, possibly, for anything else; his whole life training rendered useless; a corporation that battens on brains can tell him he may starve—if that is the only alternative.

The average man in need of employment is in no position to dictate or object to terms in the contract offered him. In a sense he is coerced by circumstances into signing, and the measure of his necessity is the degree of coercion practiced. Just how binding, morally or legally, is an instrument in which the element of coercion enters?

But a contract must allow the right to discharge. In technical employment, if the employee is guilty of violating the confidence reposed in him, the right to discharge is not sufficient. It should be strengthened, and by mutual recognition, by the assurance of prosecution and punishment. Where no culpability enters in, however, a mutual agreement should proclaim and recognize a mutual responsibility. Necessities which lead to severing the ties of such an agreement should terminate the responsibility as well. When released through no fault of their own, technical men should be protected from every danger of blacklist, boycott or attempted curtailment of their usefulness to themselves or society through the operation of contracts signed while seeking employment. A court precedent should establish that a contract terminated in one particular is thereby terminated in every other.

Are there other injuries being worked today through hold-over duties and obligations of terminated contracts? A federal investigation of the employment contracts offered technical men by those corporations entering into interstate commerce might throw interesting light on the subject.

Information for Business Guidance

A FRIEND of ours raises the question whether the average business man who directs the affairs of commercial enterprises has a clear concept of all the information necessary for guidance in making business decisions. He doubts not that business men, as a rule, gather a vast amount of information, but he has serious misgivings as to whether they recognize the essentials and do not burden and confuse their minds with matters that have no real bearing on their problems.

We know quite well that the typical business man is strong on efficiency. He is great for requiring his superintendents and foremen to introduce efficient methods in the factory. He seeks efficiency in the physical manipulation of his affairs, requiring, for instance, that the papers coming to his desk be placed on a certain spot, and providing a series of baskets for the outgoing stuff. Nothing must come to his desk that does not belong there. The underling is reprimanded if he brings something to him that should be handled by SMITH or JONES, and is reprimanded likewise if he places before SMITH or JONES a matter that should be settled by the boss himself.

It is a question of efficiency in mental operations. Does our business man take equal pains to see that information essential to good business judgment is placed in an orderly manner in his mind, while unnecessary matters are kept out so that they do not clutter his mental desk? That is quite doubtful. Men of affairs are often moved by example rather than by study of underlying conditions. The point is well illustrated by boards of directors. There are directors who might perhaps be called peripatetic for want of a better term. They belong to numerous boards. When they see a certain action taken at one board meeting, whether in the direction of retrenchment or expansion, they are likely to favor similar action at the meeting of the next corporation whose fortunes they help to direct, and by and by things are going again or stopped again as the case may be.

A crucial test is now being made that will show whether business men really seek and use the kind of information that should guide them in the conduct of business. Under the direction of Secretary HOOVER the Department of Commerce has undertaken to publish in compact and simple form all the pertinent facts that can be gathered as to business trends and conditions. The reports have been issued for some time and are being improved and extended as opportunity affords. The reaction of the business world to these publications is now awaited. The plan is well conceived. The information is not complete, but it is so much more comprehensive than the information the individual has hitherto been able to get that it greatly increases his field of knowledge. What is the reaction in the chemical and related industries to the *Survey of Current Business?* We shall be glad to receive expressions of opinion either for personal information or for publication.

Use of Graphs In Plant Operation

SCIENTIFIC men and technologists are cognizant of the great value attached to the use of the graph in visualizing figures, since it is one of the basic studies in technical curricula. Relatively few of these men promoted to responsible charge of plants have thought to apply the graph to the everyday details of plant management and control.

Study of an article presented on another page under the heading "Graphic Record of Sulphuric-Acid Plant Operation" should open up a line of thought which may well lead to the education of superintendents and foremen in the use of the graph and its subsequent installation as part of the daily record.

Certainly the average individual engaged in running the process has a native intelligence enabling him to grasp the meaning and application of the ordinary chart.

Graph usage is simple and should be made a tool of the operator as well as the student.

Chemical Storage Of Power

THE discussion of Muscle Shoals as a power project and broad industrial chemical opportunity has developed a thought rather new to chemical engineers—namely, that the storage of power in peak flow periods should be done by chemical means. This idea certainly has interesting possibilities, and these should receive careful study on the basis of engineering facts, for if the opportunity really exists which some credit to this scheme, it will mean marvelous new things in many localities.

The Tennessee River at low water could produce relatively little power (estimated for Dam No. 2 at less than 50,000 hp.) as compared with the maximum at flood periods which would supply well up into the millions of horsepower if all the water power could be utilized. Obviously investment for the period of maximum water flow is altogether out of the question. Also a minimum power development of 50,000 hp. would be inefficiently low. Therefore by storage of water it is possible to insure substantially 100,000 hp. continuously through 12 months, considering the Wilson dam alone. By storage in suitable impounding reservoirs on the upper river or by installation of other power dams above the No. 2 or Wilson dam, the flow would be still further regulated and a continuous horsepower correspondingly higher would be available.

At Dam No. 2 it is proposed that the installed horsepower be 600,000. Probably 250,000 hp. can be made continuously available at this point by supplementing the power from the dam during periods of low water with steam power from the plants connected with Nitrate Plant No. 2. However, it is reported that Mr. FORD intends still further to supplement power for continuous processing throughout the year by a third means, which might well be called the "chemical" storage of power.

One proposal is that during periods of high water some of the electrical energy be used for making metallic sodium. This metallic sodium would then be put in storage under oil to be used as a reagent during periods of low water flow. As such reagent, it would enable an operator to carry out processes of high energy demand such as the manufacture of aluminum, magnesium or other similar light metals from their oxides. Thus a chemical process would be substituted at low water periods for an electrochemical method which doubtless would prevail during periods of maximum power.

At first thought it does not appear that the investment necessary for this manufacture and storage of sodium would be as economical as corresponding investment in storage dams on the upper river, which would permit uniform delivery of power from the Wilson dam because of uniform flow of water. However, it would be imprudent to draw any such conclusion without a very careful electrical and chemical study of the problem from an engineering point of view. Things quite as novel as the use of sodium for a reagent have been made successful in times past and if this proposal proves to have substantial foundation in engineering fact, it will contribute much to the success not only of Muscle Shoals but also of other developments where irregular runoff results in large seasonal fluctuation in power.

Green Fields and Pastures New

DR. LOUIS BERMAN, who is an associate in biological chemistry at Columbia University, has written a book on the "Glands Regulating Personality," which some day we may review at length. In the meantime it points to the gate of one of the most fascinating but involved and as yet untilled fields of organic chemistry. By merely glancing in, however, we find almost irresistible invitations for research.

These ductless glands in every one of us are substantially the same—but only substantially so. They differ in particular, just as our fingerprints differ. And so their products, which are substantially the same, differ in mass and in mixture. These products are carried in the blood and delivered where they are needed. The secretions are called hormones, which indicates that they arouse or set in motion; and it has been said of them that they are "chemical messengers, sent from one organ to another through the public highway, which is the blood." Again, the stream of blood has been likened to a moving platform on which the various hormones embark and from which they alight where the signal or a field of force attracts them, or where a barrier opposes their further progress.

Still greatly to be studied are the functions of the hormones or secretions from ductless glands. The glands are located all over the body—in the head, in the throat, in the chest, on the kidneys and in the abdomen. Some stimulus excites a gland to activity and soon its secretion is at work, arousing curiosity or fear or anger or affection. These emotions are chemical!

If study goes far enough in this subject, it may throw great light on the treatment of insanity, for it stands to reason that with many sufferers it is the excess of some particular emotion, due to a gland working only a little out of its proper proportion, that causes all the trouble. Only lately at Sing Sing prison an operation was performed along these lines on a habitual criminal, by transplanting glandular tissue from an executed man into him. He shows signs of becoming normal under the better balance of hormones, but of course some cheerful idiot whose glandular secretions have mixed themselves up into soup claimed to have discovered that a law forbids any such "interference" with what is blasphemously called "the work of GOD."

When blood analysis shows what hormones are lacking and what are in excess, and when enzymes are so understood that we shall know the stimulus for each ductless gland, there may be far less misery in the world.

Readers' Views and Comments

Trade Association Activities and the Industrial Press

To the Editor of Chemical & Metallurgical Engineering

SIR:—As you pointed out in an editorial a few weeks ago, the activities of trade associations are now limited as a result of the decision of the United States Supreme Court in the case of the American Hardwood Manufacturers' Association. It appears that the maintenance of open-price information must be discontinued unless such information can be supplied by some means other than through the confidential reports of the trade association secretaries.

Doesn't this condition offer an unusual opportunity for co-operation between the trade associations and the industrial press? The industrial journals now carry, in addition to the purely technical information, price lists, condensed financial statements of the leading companies, discussions of employment problems, etc. Is it not a logical step forward for them to print production figures, sales statistics, average costs and other data now collected by the secretaries of the various trade associations? Let the trade association secretary be given a page or two for the presentation of his statistics in one or more of the leading industrial or technical journals serving his particular industry. The secretary should have no connection with the editorial staff of the journal. He should present his data without comment or discussion and his contributions should be printed as so much current industrial news. The editors of the magazine, however, would have a perfect right to comment on the data presented and to interpret them for the good of the industry.

In the Hardwood Manufacturers decision the Supreme Court commented on the association's "plan" of daily, weekly and monthly reports as follows:

> It is futile to argue that the purpose of the "plan" was simply to furnish those engaged in this industry the equivalent of such information as is contained in the newspapers and government publications with respect to the market for commodities sold on boards of trade or stock exchanges. One distinguishing and sufficient difference is that the published reports go to both seller and buyer, but these reports go to the seller only; and another is that there is no skilled interpreter of the published reports, such as we have in this case, to insistently recommend harmony of action likely to prove profitable in proportion as it is unitedly pursued.

The presentation of these trade statistics in an industrial journal would make them available to both buyer and seller, and therefore no legal complications should be produced. In this connection Gilbert H. Montague of the New York bar has made the following illuminating statement:[1]

> It is clear that comment and advice based upon trade statistics is dangerous when indulged in by the trade associations themselves, yet the same advice and comment may be quite harmless when given independently by a publication that is not a member of the association and which is accessible to buyer and seller alike. The editor of a trade publication can usually make such comment as he pleases for the benefit of the industry as a whole, and a discussion of demand and production which would bring down the whole force of the Department of Justice if emanating from a trade association secretary might be wholly innocent if published independently in the editorial columns of a trade or technical publication.

The average progressive manufacturer has come to see the advantages of the trade association and he appreciates the benefits of membership in it. He does, however, guard very carefully what he considers the vital statistics of his particular business. He probably would hesitate to send in his sales figures, costs, etc., to the assistant editor of an industrial magazine. He might also be opposed to sending such data to some unknown clerk in the Department of Commerce or to any other government agency. But the secretary of the trade association is in a different position. The manufacturer has a voice in appointing him and he pays a part of his salary. He has confidence in him. He knows that the data concerning his own business will go only to the secretary, and that they will be averaged or totaled with the corresponding data of his competitors. It seems likely, therefore, that the publication of these statistics under the conditions outlined above would receive the support of the manufacturers. Why doesn't the Synthetic Organic Chemical Manufacturers' Association try it?

I. E. KNAPP.

Jackson Laboratory,
E. I. du Pont de Nemours & Co.,
Carneys Point, N. J.

[1] *Printers' Ink*, Jan. 19, 1922, p. 63

The Manhood of Humanity

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of Jan. 4 is a long review by Ellwood Hendrick of Count Korzybski's "The Manhood of Humanity; the Science and Art of Human Engineering." Mr. Hendrick spoke favorably of the book and seemed impressed by its arguments. Having a respect for Mr. Hendrick's opinions, I was surprised that he took the book so seriously, just as I had been surprised that Prof. Keyser of Columbia University recently devoted a laudatory address to it. When I tried to read the book and comprehend the valuable theories it was said to contain, I concluded either that the book had been grossly overpraised or that I am especially dense at understanding such things. Today I noticed an unfavorable review of the book by Robert H. Lowie in *The New Republic* of Feb. 8, and it seems to me that his condemnations are justified. He points out that the so-called epoch-making discovery of man as a "time-binder" is not new at all; that the mathematical basis of the theory is inconsequential; and that the naïve assumption that human nature will reform itself when thus shown the mathematical error of its ways is laughable. With all respect to Mr. Hendrick, Prof. Keyser and the others who have praised the book, I agree with Mr. Lowie that Count Korzybski's solution of "human engineering" is not worth reading or thinking about.

New York University. P. B. MCDONALD.

Some New Petroleum Products

In the article, "Some New Petroleum Products," by J. H. James, published in our issue of Feb. 1, 1922, the lines at the top of page 212 should read "Rate of water feed to vaporizer, 0.6 liter per hour" instead of "6 liters per hour" as erroneously printed.

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—There is an element of truth in the editorial, "When Does an Employment Contract Terminate?" which you have sent to me for my comment. The difficulty exists more in a system that permits the wrongs as suggested, and more with greedy and unscrupulous officials of corporations and others, than with laws failing to protect professional men. As is suggested, court precedents may be needed more fully to safeguard their interests, since the law is a growing thing capable of being adapted to new conditions. Perhaps with the development of our modern industrialism with its innumerable ramifications and requirements for its own existence, as where it depends on secret processes, conditions surrounding employment contracts may demand court rulings, at least as to what would be presumed to be against public policy in such contracts. But here immediately we get into deep water.

One may imagine a case where a professional chemist is engaged in a factory founded on a secret process and bound by contract to keep the secret. He may give up the pursuit of all other lines so long that his usefulness in any other field or factory is permanently impaired. Yet he may be let out of his employment and by his agreement be restrained from engaging in the work he best knows or from imparting the information gained in the specialized line. Can we justly say that this is the fault of law or of our system, and if the fault of either, may it be corrected by statute or court decisions?

The right to contract for one's services is part of that pursuit of life, liberty and happiness proclaimed in the Declaration of Independence and guaranteed by the Constitution. To restrict the right to contract fully encroaches on this right, which inures to the benefit of both parties to the agreement. The right to break a contract is also a fundamental right. Nor may a court require one to perform a contract where it is for personal services, but a court of equity may restrain one from rendering like services to others under certain limitations.

In leaving open the right to contract freely, equity will protect the parties against fraud, coercion and undue influence as far as that is possible and where proper will relieve against such wrongs. If through stress of circumstances and conditions a person is unduly influenced to enter into a contract of service to his damage, equity will relieve him.

Peonage is involuntary servitude and is not permitted under o .r laws. One may contract to render service in payment of an obligation, but he may leave his employment at any time he chooses. No law or court may force him to render the service agreed upon. By contract one may be restricted in his field of operation or work, but it is against public policy for one to agree wholly to refrain from following a vocation, going into business, etc. One may not bargain away his right to earn his living. In theory at least he may not bargain away his ability or diminish his ability to earn a living. Such would be against public policy, and any contract based thereon would be unenforceable. Should an employer know that his employee was in necessitous circumstances influencing his entering into a contract, and such employer took advantage of these facts to the detriment of the employee, equity would relieve the employee and discharge the contract. Obviously charging the employer with such knowledge is difficult to prove, since the employee studiously endeavors to hide his necessitous condition. We regard it good business as well as perfectly permissible for an employer to attempt to keep secret his secret processes, to keep specialized knowledge and discoveries from his competitors, and therefore to put provisions in the employment contract requiring the employee not to disclose information or not to engage with competitors, and the like. It is doubtful if such contracts can be enforced, at least in such a manner as to protect the employer as he intends.

If large technical corporations extort, as the price of employment, contracts from their employees forever limiting a man's usefulness outside their own factory walls, the writer is of opinion that such contracts are unenforceable and valueless to the employer except to "scare" the employee. Of course, the corporation with its money has the advantage in being able to litigate, and such might in many instances result in a denial of justice to one unable to litigate. Because of this denial of justice a federal investigation might be a worthy thing, as suggested, though a relieving statute might not and probably would not be deemed advisable.

No contract is binding on the injured party where coercion enters in. But the coercion must come from the other party to the contract. Coercion is the result of fear of some harm from threatened force. Undue influence is the more proper term to be employed in the sense as discussed here. Even undue influence must be used, or advantage taken of one's condition, by the employer party to the contract.

Chicago, Ill. WELLINGTON GUSTIN.

Recent Progress in Electrical Precipitation

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am surprised as well as embarrassed that you have thrust honor upon me for having developed the mathematical equation given in the article by Evald Anderson on "Recent Progress in Electrical Precipitation," CHEMICAL & METALLURGICAL ENGINEERING, Jan. 25, 1922, p. 152. The truth is that I had nothing to do with the development of this equation, which we feel represents a distinct advance in the art, it having been done by A. A. Schmidt, who is in charge of our engineering work.

WALTER A. SCHMIDT.
Western Precipitation Co.,
Los Angeles, Cal.

On the Theory of Hardening of Metals

Prof. Honda has called attention to unfortunate errors in his paper published in CHEMICAL & METALLURGICAL ENGINEERING for Nov. 30, 1921 (vol. 25, p. 1003). Conclusions noted under the caption "Results of Investigation of Duralumin" should read:

2. The above effect of quenching is due to the dissolution of copper and magnesium compounds in the aluminum, the process of solution or separation being very slow. Thus duralumin is in a somewhat hardened state even if it is cooled very slowly from 500 deg. C.; a perfect annealing is obtained only by heating the alloy at 350 deg. C. for 1 hour or more.

3. Up to about 6 per cent Cu, alloys of Al and Cu show by quenching an immediate hardening, but very little effect on aging. Hence the immediate hardness is partly due to the dissolution of $CuAl_2$ in Al.

5. The aging after quenching is attributed to the dissolution of Mg_2Si in the $CuAl_2$ solid solution in Al. It is not due to metallic magnesium, because a mere increase of Mg does not result in an increase of aging effect, but an increase of both Mg and Si in the proportion of the compound Mg_2Si magnifies the same effect.

The Chemical Industry of Russia

By V. Leitis

PRIOR to the war, the chemical industry of Russia, and even her chemical trade as well, were in German hands. Every important German chemical concern had its branch in Russia, where—aided by the Russian protective tariff—it prepared fertilizers and all possible drugs and medicines, except the patented ones, which were made in Germany to keep the formulas secret.

German Influence

The Russian educational institutions were not able to develop chemists in sufficient numbers, and many came from Germany. As a result, almost every chemical plant—even the purely Russian ones—and every laboratory in Russia had German chemists. On the other hand, to keep Russians away from German secrets, those Russians who graduated from German chemical schools were not accepted as employees in Germany. The Aktien Gesellschaft für Anilinfabrikation, Badische Anilin- und Soda-fabrik, Farbenfabriken vorm. Friedr. Bayer & Co. were among the leading chemical firms in Russia. In regard to their size, it may be mentioned that in 1913 the Bayer company alone employed about 330 chemists and 280 engineers and mechanics. Under such competition, Russia was not able to develop its own chemical industry. As a result, Russia not only used chemical products made in Russia by Germans, but also imported heavily from Germany. Thus, in 1914 Russia imported from Germany the following quantities of fertilizer materials:

	Tons		Tons
Superphosphates	300,000	Chilean nitrate of soda	48,000
Thomas slag	177,000	Kainite, guano, etc	32,000
Total			557,000

It should be remembered that Russia is rather rich in phosphates which could be converted into superphosphates. Some Russian factories were engaged in this line, producing about 100,000 tons of superphosphates annually, but they were handicapped by German competition and better German selling methods. Furthermore, they did not enjoy as easy bank credit as the Germans, owing to the great German influence in Russian commercial banks.

The production of soda was entirely in Russian hands (Loobimoff & Co.), likewise a great part of the sulphuric acid industry, although some works located in Riga (present Latvia) which used imported ore were owned by Germans.

Development During Early Part of War

The war stopped the activities of Germans in Russia, the imports ceased, and of necessity Russia was compelled to create a chemical industry of her own. Russian chemists were invited and gradually the industry grew stronger until 1918, when Bolshevists came into power, and by nationalization and other communistic means checked the growth of this young industry.

At the end of 1919, there were in Russia the following chemical works:

	No.		No.
Salt and acid	35	Potash	45
Soda	3	Quicksilver	1
Dyes	3	Mineral wax	1
Compressed gas	14	Phosphates	9
Prussiate	2		
Total			113

All these plants were of small size, their equipment being antiquated, worn out and broken to such a degree that the Bolshevists could put into operation only eighteen of them, employing 7,225 workmen.

The output of these plants in 1920 to 1921 was extremely low when compared with pre-war figures, as shown in Table I.

TABLE I—PRODUCTION OF CHEMICALS IN RUSSIA

Products	1920, Tons	1921, 6 Months, Tons	1913, Tons
Sulphuric acid	13,827	1,287	200,000
Oleum	4,845	..	10,970
Nitric acid	430	66	24,355
Hydrochloric acid	15,843	33	65,483
Copper sulphate	91	114	No figures at hand
Superphosphates	5,833	..	100,000
Bichromate of ammonia	58	22	No figures at hand
Salts:			
Sulphate	14,013	..	.....
Chlorate	292	..	.....
Carbonate	11,050	..	.....
Chromates	1,110	..	.....
Sodium sulphite	807	..	.....
Bleaching powder	3,000	..	.....
Other salts products	850	..	.....
Total	72,049	1,522	

Effects of Bolshevist Rule

The present inefficiency of the Russian chemical industry can be explained by the communistic régime: crippled transportation, inefficient management, underfed and underpaid workers, lack of fuel and raw material. To be progressive, this industry needs the coperation of scientists, and if we examine the conditions in Russia we shall find everything there in favor of the uneducated man, with nothing for the intellectual class. The "intelligentia" has been pursued and despised by the Bolshevists and rule of the uneducated class has been established. The intellectual class was driven to compulsory physical work, street cleaning, wood cutting, even work in coal mines, but the scientific work could not be made compulsory. It was a highly mistaken idea to imagine that the proletariat alone would be able to manage the business of the state, putting the intellectual class aside. Since 1919, the Bolshevists have tried to remedy this fault by granting some privileges to the scientific and intellectual professions, but unfortunately too late—the country has already been ruined.

The harm done to agriculture is readily appreciated if we consider the total production and import of fertilizers in pre-war times (over 700,000 tons) and compare this figure with the 5,833 tons produced in 1920 (there was no import of fertilizers because of lack of money). In 1921 no fertilizers were produced.

For the production of dyes, 325 workers were employed, and the output, according to Bolshevist reports, was sufficient to supply only the needs of the state printery, where the Bolshevist paper money was printed.

The same condition affected the production of drugs and pharmaceuticals. In 1919-20, the thirty-two existing drug factories employed only 1,551 operators, the output being as follows:

	1913, Kg.	1919, Kg.	1920, Kg.
Chemical preparations	2,000,000	75,117	71,576
Drugs	3,000,000	283,264	401,176
Disinfectants	1,000,000	.....	226,529
Total	6,000,000	368,381	699,281

Regarding the future of the Russian chemical industry, foreign influence will undoubtedly prevail. If anything is being produced at the present time, it is done so regardless of cost, since payment is made with the worthless Bolshevist paper money under the management of the state. Such a situation cannot last indefinitely.

Riga, Latvia.

Grain Growth and Recrystallization in Metals. I—Definitions

Technical Definition of Recrystallization, and a List of Recrystallization Temperatures for Common Metals—Various Methods for Measuring Grain Size, Shape and Volume—Elongated Grains May Not Always Contain Strained Metal, Even When Apparently Stable

By ZAY JEFFRIES and R. S. ARCHER
Research Bureau, Aluminum Co. of America

CRYSTALLINE structure of metals was discussed in a previous article.[1] The present articles will deal more specifically with the sizes and shapes of grains produced on the solidification of metals, on grain growth in the solid state and on recrystallization.

When a metal freezes the sizes and shapes of the crystalline units or grains vary in accordance with the conditions obtaining at the time of crystallization. In general there is no distinction made between crystallization and solidification, since the latter is due to the former. As a rule rapid solidification produces smaller grains than slow solidification. The grain size of cast metals, provided they have not been plastically deformed, cannot be changed by heating below the melting point. This is true no matter what the grain size in the cast metal.[2] When a cast metal is plastically deformed at a temperature high enough so that no "strain hardening" results, microscopic examination shows that new and usually smaller grains have been produced. Working a metal at such temperatures is termed "hot-working." Plastic deformation has thus caused the grains to undergo some change which usually produces several grains from each of the original ones. Supposing the metal under consideration is copper and assuming that the temperature of working is 600 deg. C., severe working will produce a marked "refining" of the structure—that is, the grains will have increased greatly in number and will have decreased proportionately in size. If the metal is now heated to say 800 deg. C., it will be observed that grain growth has taken place and that there are fewer and larger grains. The melting point of copper is 1,084 deg. C.; this grain growth occurs therefore while the metal is in the solid state. In what is termed "normal grain growth" the higher the temperature and the longer the time at heat the larger will be the grain size. In some cases grain growth is very rapid at a given temperature for a short time, after which longer exposure seems to produce no further change. This is a condition of metastable equilibrium. An increase of temperature usually produces further grain growth in these cases.

Definition of Recrystallization

When a metal is plastically deformed at a temperature so low that "strain hardening" results, it is said to be "cold-worked." Microscopic examination shows that the grains have been deformed in about the same manner and magnitude as was the piece of metal taken as a whole. Except in the soft metals like lead, tin and zinc, these distorted grains do not change at room temperature. On heating, however, a temperature is reached, different for different metals and for various degrees of cold work, at which the distorted grain structure is replaced by new grains usually approximating an equiaxed shape. By "equiaxed grain" is meant one whose diameter is approximately the same in all directions. Hardness tests show that most of the "strain-hardening" effect is lost with this change in structure. This change is usually referred to as "recrystallization," and the lowest temperature at which new grains visible under the microscope appear may be called the "recrystallization temperature." Recrystallization temperatures for certain metals after severe cold plastic deformation are given in Table I.

TABLE I.—RECRYSTALLIZATION TEMPERATURES

Metal	Approximate Lowest Recrystallization Temperature Deg. C.	Metal	Approximate Lowest Recrystallization Temperature Deg. C.
Iron	450	Magnesium	150
Nickel	600	Tantalum	1,000
Gold	200	Tungsten	1,200
Silver	200	Molybdenum	900
Copper	200	Zinc	Room temp.
Aluminum	150	Lead	Below room temp.
Platinum	450	Tin	Below room temp.
		Cadmium	About room temp.

We intend to present a definite conception of the mechanism of recrystallization which will define "recrystallization" in a fundamental manner. The values given in the table must be considered as approximations and are selected with reference to the lowest temperatures after severe cold work, which will produce new grains *visible under a high-powered microscope.* The recrystallization temperature is lower the greater the amount of cold work, the lower the temperature of working, the purer the metal, the smaller the grains before deformation and the longer the time of exposure at temperature. It is only a matter of usage that the temperature of the beginning of recrystallization should be selected with reference to the appearance of grains which can be seen with a microscope; other measurements such as tensile strength, electric conductivity or hardness give more sensitive indications of the first changes of structure. It is true, however, that when new grains can be seen, the change toward the properties of the annealed metal is marked. Technically, "recrystallization" is the structural change produced in a cold-worked metal on changing from the strain-hardened state to the annealed state. Although there are an infinite number of stages, curves relating certain physical properties to temperatures of heating a cold-worked metal will often show sharp changes within a small temperature range and a gradual change both above and below this

[1] "The Crystalline Structure of Metals," Jeffries and Archer, CHEM. & MET. ENG., May 4, 1921, pp. 771-779.

[2] Iron is an exception to this general rule in that it undergoes an allotropic change at 900 deg. C. accompanied by a complete change in crystal structure with the formation of new grains. Grain growth also takes place in some cast alloys as a result of phase changes.

range. Such curves are given in Fig. 1, showing the tensile strength, elongation and electrical conductivity changes in cold-worked copper heated at various temperatures. A sharp break in all of the curves corresponds to a structural change, the elongated (strain-hardened) grains having been replaced by small equiaxed grains. The sharpness of the changes in Fig. 1 shows the justification for a term such as "recrystallization" to designate the temperature range within which they occur.

If a strain-hardened metal is heated to a temperature just below that of recrystallization, no visible grain growth takes place. On heating to any higher temperature, grain growth takes place, the higher temperatures and extended exposures producing the larger grains.

When metal powders are briquetted and heated to temperatures somewhat below their melting points, grain growth takes place. In the case of tungsten, or molybdenum or nickel powder, the density of the briquet may be only 60 per cent of that of the "solid" metal, but after heating to a high temperature but below the melting point, the density becomes about the same as in the cast or worked metals. On heating these briquets, the grain size normally[3] increases both with the temperature and with time of exposure.

Electrodeposited metals are crystalline. The grain size may be large or small, but heating such a metal may cause grain growth below the melting point.

Iron is unique in its grain growth characteristics because of the allotropic change in a temperature region permitting grain growth. If iron is cast, it first forms grains of gamma iron crystallizing with a face-centered cubic lattice. On cooling, gamma iron changes completely into a body-centered lattice at about 900 deg. C., and this transformation gives rise to entirely new grains. If the iron is kept below 900 deg. C., it behaves much like any other metal within a similar temperature range. It can be cold-worked and hot-worked and the grain growth characteristics can be studied at temperatures up to 900 deg. C. On heating above about 900 deg. C., however, the structure again changes completely into new grains of gamma iron. Every time iron is caused to change from one crystal lattice to the other a new set of grains is produced. Pure gamma iron cannot be "cold-worked," because at the lowest temperatures at which it is stable it cannot be "strain-hardened."

Average Grain Size

Before proceeding with a more detailed account of grain growth phenomena, it will be well to explain what is meant by some of the terms used.

Grains are three-dimensional bodies roughly polyhedral in shape. Our observation of them, especially for the purpose of determining grain size, is usually on a polished plane section. The quantity actually measured is therefore not the volume of the grain, but some linear dimension or area. Furthermore, the grains in a given piece of metal of even the most uniform structure always vary rather widely in size. Rosenhain has pointed out that for practical purposes it is perhaps the size of the largest grains which is of most importance, and some specifications have been written upon this basis, rejecting material which contains grains exceeding a certain stated diameter or area. It is of course probable that the observed plane section of any particular grain does not represent its *maximum* cross-sectional area, but it is also probable that the maximum grain area observed on a polished section containing a large number of grains *does* represent fairly closely the maximum size of the grains.

It is more common to measure the *average* grain size over the observed area. The various methods of doing this will not be discussed, but a preferred method (which has been described fully by one of the authors in this journal[4]) will be outlined for purposes of illustration. The specimen is photographed at a known magnification, or if a photograph is not desired, the image on the ground glass of the camera may be used. A circle is drawn on the ground glass or on the micrograph representing a certain area on the surface of the specimen, selected so as to include a fairly large number of grains, preferably over fifty. A count is then made of the number of grains totally inclosed and also of the number intersected by the circumference of the circle. Twinned portions of grains are not counted as separate grains. The sum of the number totally inclosed plus half the number intersected gives the equivalent number of whole grains within the area of the circle from which the average number of grains per unit area or the average area per grain may be readily calculated. It should be emphasized again that this quantity does not represent the maximum cross-sectional area of the average grain but the average cross-sectional area such as would be cut by a plane taken at random.

A value which we will call the average grain diameter is obtained by taking the square root of the average grain area. This diameter has no exact physical meaning. It represents what would be the length of side of

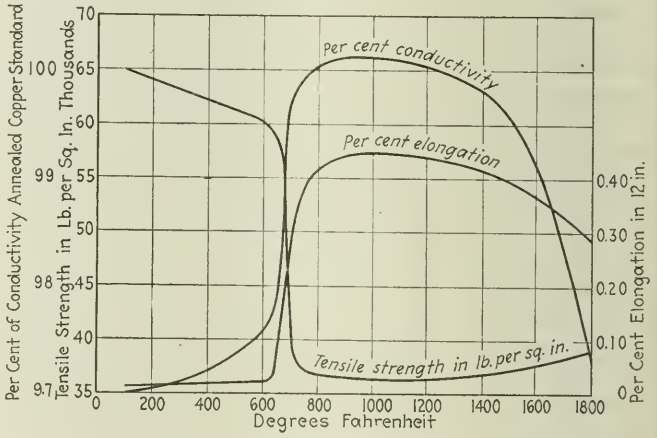


FIG. 1—VARIATION OF PHYSICAL PROPERTIES OF COPPER WIRE WITH VARIATIONS IN ANNEALING TEMPERATURE. (Bardwell, *Trans.*, A.I.M.E., vol. 49, p. 758)

the grains if they were all square. Actually the average grain diameter, determined in this manner, is sufficiently close for all practical purposes to the average intercept cut by a straight line through a large number of grains.[5]

When it is desired to make computations on the basis of volume, the hypothetical square grain may be extended to a cubical grain. The average grain volume is then equal to the cube of the average grain diameter.

It will be seen from the above that grain size meas-

[3] Deviations from this rule will be considered later.

[4] "Grain Size Measurements in Metals," Jeffries, Met. & Chem. Eng., 1918, vol. 18, p. 185.

[5] It is perhaps most scientific to express grain size in terms of the number of grains per unit area, since this is the quantity directly measured. The authors prefer, however, for general purposes to express grain size in terms of the average grain diameter in inches, with the object of giving as concrete a conception as possible of the actual magnitudes involved.

urements are only approximate. Some have objected to this inaccuracy and attempted by mathematical analysis to arrive at more exact expressions. The objection and attempt are unjustified in view of the real significance of the figures. The properties of metals are not affected to any marked extent by a variation in grain size of 25 per cent or even 100 per cent. Indeed such variations commonly occur from point to point in a supposedly uniform metal. The methods in common use for measuring and expressing grain size are therefore amply exact for the purpose.

Grain growth may occur without affecting the grain size as expressed by average grain area or diameter. During the first stages of growth the total number of grains within a given area does not change and hence the average grain size remains constant. It is not until some of the grains are completely absorbed that the measured grain size indicates the change. Some other means must be used for detecting *slight* grain growth. For most practical purposes, however, we are concerned with grain growth of such magnitude that it is well shown by changes in the measured average grain size.

Elongated Grains

When the grains depart widely and consistently from an equiaxial shape, as in cold-worked metal, it is often better to determine grain size by the intercept method—that is, by counting the grains intersected by a given length of straight line. It will be understood that the grains of a cold-worked metal are broken up into fragments which are in many respects equivalent to individual grains, but that we are here referring to the counting of the original grains. The average grain diameter may be determined in this way both in the direction of working and at right angles to this direction. A complete description of the grains requires measurements in three directions, corresponding to co-ordinate axes, and made on two surfaces usually at right angles to each other. The ratios of the average grain diameters thus determined indicates the shape of the grains and the amount of deformation that the metal has undergone.

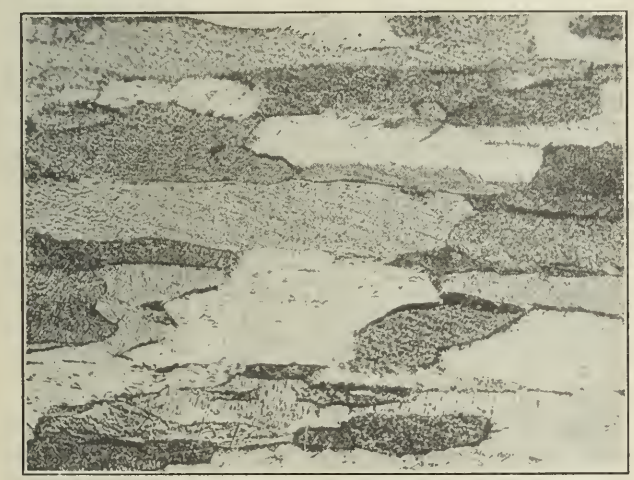


FIG. 2—UNSTRAINED GRAINS SIMULATING COLD-WORKED METAL IN DRAWN TUNGSTEN WIRE 0.020 IN. DIAMETER. × 250 (SYKES)

The term "worked metal" will be used in this article to denote metal which has been subjected to mechanical working of any kind, hot or cold, by rolling, forging, pressing, swaging, drawing or otherwise.

The word "strain" is used very commonly in connection with grain growth in a sense not altogether obvious. From the physical or mathematical viewpoint any deformation is a strain, including the elastic deformation represented by the first portion of a "stress-strain" diagram. But an elastic deformation does not constitute a strain, according to usage in connection with grain growth. Strain is sometimes used to denote stress, and at least carries an implication of this meaning. "Strain" as used in these pages does not necessarily involve stress. We may define a *strained metal* or grain as one which has been permanently deformed in such manner as to harden it. A hot-worked metal is not strained. The strain of a cold-worked metal is removed by annealing.

The hardness produced by work is called strain hardness or work hardness.

Unstrained grains are normally equiaxed in shape, but exceptions are very common. When a metal containing material which mechanically obstructs grain growth is subjected to considerable working, either hot or cold, it is often found to exhibit grains which are consistently elongated in the direction of the working, even after thorough annealing. An example of this type of structure in tungsten is shown in Fig. 2. These grains are unstrained, though not equiaxed. A distorted grain shape suggestive of cold-working is not therefore to be regarded as proof of strain.

When a metal solidifies in a chill mold it is often found that long grains grow out at right angles to the walls of the mold. These grains are referred to as "columnar," and they are of course unstrained. If the mold is circular or nearly so in cross-section, the grains converge toward the center, and may then be referred to as "radial grains."

(Part II, on Experimental Data and General Laws, will be published in a subsequent issue.)

Use of Rubber in Paper Manufacture Proves Advantageous

Experiments on the quality of paper in the manufacture of which small amounts of rubber latex are added to the fiber seem to demonstrate that the product is superior to the same material made without rubber. Vice-Consul Wade Blackard of Singapore reports the results of tests in the Feb. 13 issue of *Commerce Reports*.

It is claimed for the process that it will not only reduce the cost of paper manufacturing materially and simplify paper-making methods, but that it will greatly improve the quality of the product.

Experiments were made to show that with an ordinary fiber made into a paper containing one-tenth of 1 per cent of rubber the product had a folding number of 5,000 to 6,000 and a tensile strength two or three times that of the same material made without rubber. But with a rubber content of about seventy-five one-hundredths of 1 per cent the folding number reached 14,500, while the same paper made in the usual manner had a folding number of 30.

Another fiber beaten for half the usual time made into a paper containing 1 per cent of rubber had a folding number of 72,500 and a tensile strength of 87 lb. for a strip 1 in. wide, equal to 6,600 lb. per sq.in., or about twice the strength of a well-vulcanized rubber compound, such as is used in tires, for example. The bursting strength was about 40 lb. for a thickness of one-tenth of a millimeter.

Pottery Manufacture in the East Liverpool District

Plant Operations in the Manufacture of Semi-Vitreous China at Plant No. 5 of the Homer Laughlin China Co.—Raw Materials—Producing the Slip—Magnetic Separation—Filtering—Forming—Making the Glaze—Burning—Important Economic Factors

By CHESTER H. JONES

EAST LIVERPOOL, Ohio, located on the north bank of the Ohio River and connected with Newell and Chester, W. Va., on the opposite side, by steel bridges, makes one community dependent on the pottery industry and is the center of the manufacture of tableware in the United States. It is comparable in this respect with Stoke-on-Trent, in England, a town long the center of production for English china. The location of pottery manufacture at East Liverpool is purely traditional, for no native clays are used in the whiteware plants.

In 1839 James Bennet, an English potter, found a good clay here for making yellow and Rockingham ware. The general manufacture of whiteware began in 1879 and was followed by the use of underglaze decoration. The development of semi-vitreous china came about 1890 with better clays, different mixes and harder firing. The present product is an outgrowth of the white-granite ware and is known variously as semi-vitreous china, semi-vitreous porcelain, semi-porcelain and porcelain granite.

The plants and workmen were available for white ware manufacture, and conversion from yellow ware required only a change of raw materials. These were brought together from many scattered points, causing this location to develop into the largest center for the industry. Whiteware is the type of tableware having a fairly porous body covered with a brilliant transparent glaze. It has the general body composition of 52 per cent clay, 34 per cent flint (ground quartz) and 14 per cent feldspar.

The clay content is kaolin and ball clay. The former, being non-plastic, burns white, the latter, being very plastic and tenacious, fires to a cream or buff color. Kaolin gives whiteness and ball clay plasticity and bonding strength. Flint reduces drying shrinkage and gives rigidity during firing. It further promotes the escape of steam and gases during the period preceding vitrification. Feldspar fluxes at the higher kiln temperatures to a glass which dissolves some of the quartz and clay, cementing it into one mass. The amount of feldspar used in white ware does not completely eliminate pore space, which is the principal distinction between white earthenware and porcelain.

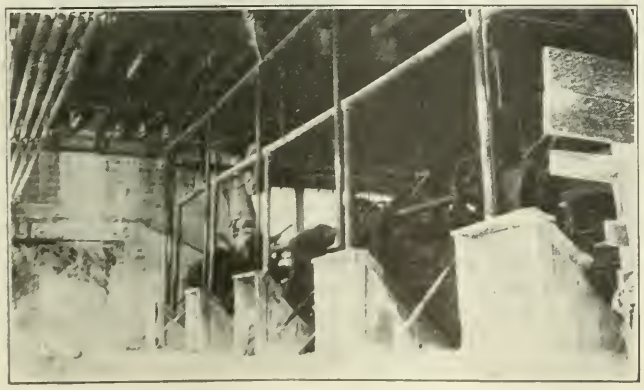


FIG. 1—VIEW ALONG TOP OF BLUNGERS

The chief producers in the district are Knowles, Taylor & Knowles, M. C. Nichol Pottery Co., Thompson Pottery Co., West End Pottery Co., Taylor, Smith & Taylor, A. M. Knowles, Vodrey and the Homer Laughlin China Co. Of these the last named is perhaps the best for description of the process.

The Homer Laughlin China Co. was started by Homer Laughlin, an English potter, in 1871. He erected and operated a two-kiln white ware plant and for many years was loath to expand for fear of sacrificing quality in quantity production. The company, with main offices in Newell, W. Va., now operates five plants, Nos. 4 and 5 being located in Newell and Nos. 1, 2 and 3 in East Liverpool. The total number of kilns in these five plants is seventy-eight. The yearly capacity is 2,000 glost kilns, or seven carloads, of china per day. This is approximately one-fifth of the amount of tableware manufactured in the United States. In 1920 the actual production of the five plants was 1,237 bisque kilns and 1,935 glost kilns, with an average natural gas consumption of 273,000 cu.ft. per bisque and 242,000 cu.ft. per glost kiln.

In 1914 Plant No. 5 was completed, and since it is the most recent of the group arranged for straight line flow of material from raw clay bins to packing and shipping department, a detailed account of the operations will be given in the following paragraphs.

Preparation of the Body

Constituents or raw materials used in making the body are all shipped into the district and include: English kaolin; English ball clay; Florida kaolin; North Carolina kaolin; feldspar; flint.

These are unloaded from railway boxcars to separate bins, whence they are drawn in required proportions to industrial car scales. This batch scale car is pushed by hand along the track directly to the rear of the battery of five blungers. Fig. 1 is a view along the top of the blungers. The car enters from the raw materials building through the double door on the left of the view and the batch is shoveled through the wooden charge openings appearing on the top of each blunger. Water is introduced through the pipes entering the top near each material charge opening.

The blunger tanks as well as the agitators or cisterns for holding slip are constructed from brick and concrete. The agitating mechanism consists of five single vertical shafts with paddles for each blunger connected by bevel gears to the continuous horizontal shaft running along the battery. Each gear on this shaft runs

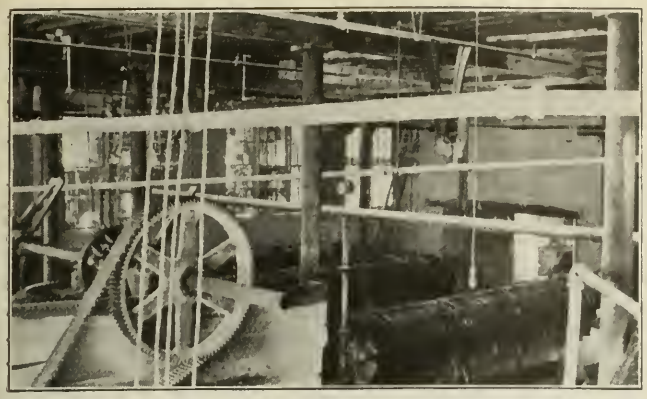


FIG. 2—FILTER PRESSES

as an idler until thrown in by separate clutch, thus permitting the individual operation of any blunger. Clutch operating handles are seen adjacent to the feed openings and convenient to the charging floor operators.

The main shaft is driven from electric motor by silent chain, as shown to the left in Fig. 2. This view also shows three of the five filter presses arranged on the main floor in front of and below the blungers with details of overhead water main leading to blungers and slip piping to the filter presses.

Treating the Slip

When the mixture of body materials and water has been whipped to the required consistency in the blunger to form a creamy slip, it is drawn from the bottom to a common header trough running along the front of the battery between blungers and filter presses and flows into an agitated cistern below the floor. Like all other storage tanks for clay slip, the liquid must be kept continually in motion by slowly revolving paddles mounted on a vertical shaft. Otherwise the solids would settle out of solution, rendering the pumping system immovable. The mechanism for driving the agitator below floor appears beneath the cage in the foreground of Fig. 3, and consists of bevel gearing with suspended agitator shaft driven by belt from overhead shaft.

From this agitator the slip is pumped by double-piston heavy-duty slip pump to the two large brick agitators above floor level, as shown in the background of Fig. 4. From each of these the flow continues to the revolving lawns in the foreground, where it passes through 12XX silk equal to a 150-mesh brass screen. Both lawns discharge directly into the Type U Dings Magnetic Separator, which is the low box appearing in the right front of the picture.

The slip enters the magnetic separator through pipes

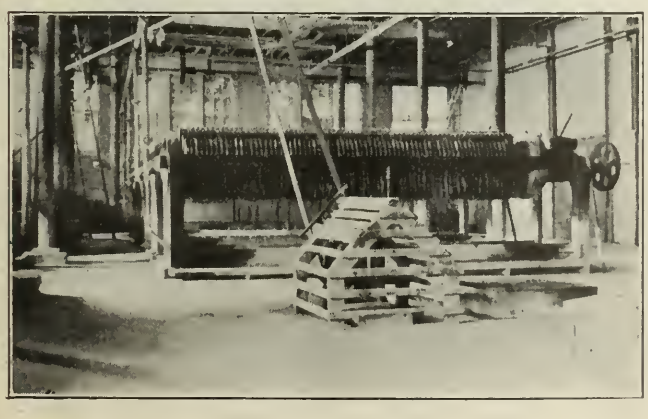


FIG. 3—ANOTHER VIEW OF PRESSES

in the rear end. The removable iron riffle bed is magnetized by 220-v. current from below, and as the liquid travels over the tortuous path all particles of solution are brought in contact, causing any native or abraded iron particles to adhere. At the discharge end of the separator the flow passes over a swinging cradle held stationary in place by an electromagnetic coil connected in series with the main magnetizing circuit and so arranged that should the power go off it will swing out of place by its own weight and cause the solution to fall in a launder for recirculation through the storage cisterns above. This insures that all clay passing through the separator will be cleaned of iron by the current.

Deposits of primary kaolins very low in iron opened up in the United States are so far quite rare. England is more fortunate in this respect, which accounts for the American potter's preference for the imported Eng-

FIG. 4—BRICK AGITATORS AND REVOLVING LAWNS. MAGNETIC SEPARATOR IN FOREGROUND.

lish clays. On the other hand, plastic ball clays of very good quality have been located in both Tennessee and Kentucky.

Filtering

The iron-free slip passes directly from the separator to a pair of agitators below floor level, whence it is pumped by Patterson heavy-duty pumps operating at 80-lb. pressure into the battery of five filter presses shown in Figs. 2 and 3. Cakes of plastic material are put through an English Boulton pug mill in the adjoining room. The filter cloths are thoroughly washed at frequent periods to prevent premature decay through bacterial action. This is done in a wooden box supporting a squirrel-cage rotor in which the cloths are revolved as the fresh water plays through the apparatus. Creosote is added as a preservative during this washing process.

From this point the pugged clay takes two courses through the plant. Part is used directly in the forming or jiggering department, the remainder goes to make up the colloidal solution or casting slip. Molds for use on the jiggers and for the casting process are produced

FIG. 5—SECTION OF JIGGER ROOM.

on the same floor as the preparation room just described. Large quantities of plaster of paris are consumed in a very complete mold production room.

Jiggering

Fig. 5 is a view of one small section of a large jigger room. The tables are arranged in one long row with the light from outside windows giving perfect illumination. Instead of placing the tables directly against the wall, as is commonly practiced, the space in front, as shown in the picture, permits the delivery of clay to the front of each bench by hand truck without interfering with the jigger operator.

The jigger shown in the foreground is for use in throwing a variety of the deeper pieces, a long up and down travel being obtained by motion of the collar on the column. To the left rear is an ordinary jigger for throwing plates, etc. As each piece is formed it is removed, together with the bottom mold, from the jigger and placed on the ferris-wheel driers seen directly back of the operators' benches.

Fig. 6 is a close-up view of the loading side of one of these driers. The outfit consists of a large room with board walls which is heated by steampipes. The revolving ferris-wheel arrangement of shelves filling this space is moved by the operator, who turns the crank communicating with the worm and gear attached to the main shaft as often as he desires to bring empty shelves in front of the opening for loading. Piece and mold are thus gradually passed over the top to the opposite side, where they are removed after remaining for 8 to 12 hours in the drying atmosphere. The molds are returned by hand to the shelves shown on the left, Fig. 6, where convenient for the jiggerman to use again.

FIG. 6—DRIER

After trimming off the rough edges from the dried pieces, they are transferred to the green ware room, where all ware is sorted and counted.

Casting Department

Casting slip is prepared near the pugging room on the first floor. Fig. 7 shows the apparatus used for this work, a machine made by Gosling & Gatensburg, Hanley, England, which has proved very satisfactory for the purpose. As will be noted, it consists of a cast-iron cistern placed with the top near the floor level, with a small blunger on the right set directly on top of the cover. The belt-driven cross-shaft above drives both the blunger shaft and agitator shaft through bevel gears. The batch of pugged clay, sodium silicate and sodium carbonate is put in the blunger through the top cover. These latter reagents operate to make a heavy but fluid suspension with reduced water content.[1] When thoroughly agitated the batch is drawn to the lower and larger agitator beneath, whence it is later pumped for use to tanks on the floor above. Two troughs or launders are seen emptying into the top of the agitator, Fig. 7. These convey waste material and slops from the casting floor to this cistern, thus making a considerable saving of otherwise wasted slip.

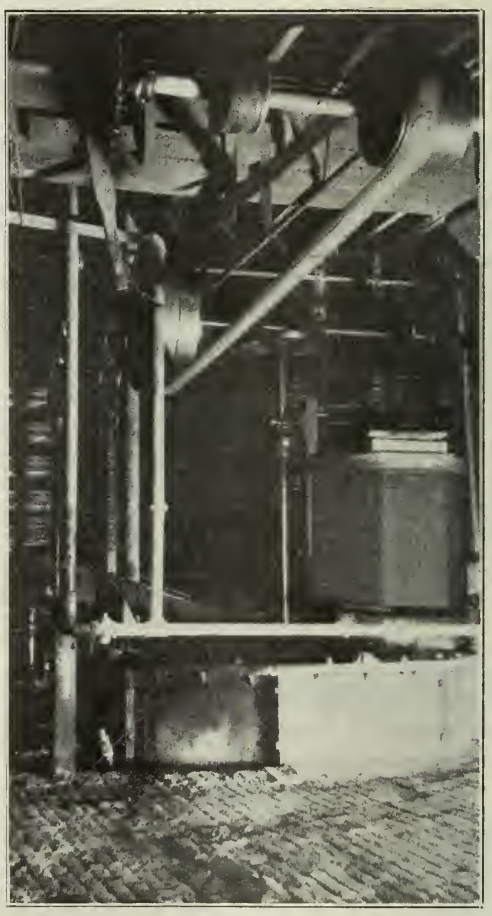


FIG. 7—APPARATUS FOR PREPARING CASTING SLIP

[1]See Bureau of Standards Technologic Paper 51 and University of Illinois Bulletin 17, both by A. V. Bleininger.

Fig. 8 is a view of a small section of the casting room. On the upper right hand appears one of the tanks which receives the slip from the apparatus described above, together with the piping system for serving material to the operators. In the foreground are typical plaster of paris molds used for casting all sorts of ware such as vegetable dishes, sugar bowls and even cups and large pitchers complete with handles. The casting of ware with handles is a distinct advance over the old operation in which cast handles are attached by hand after the main body of the piece has been thrown on the jigger.

Clay slip is drawn into the molds through the valve on the hose outlet, one of which appears lying on the molds in the foreground. After standing a few minutes, the excess slip is poured out, the mold is parted and the cast piece is trimmed and ready for transportation to the green room.

Making the Glaze

The glaze is prepared from frit or glassy constituent, boric acid, borax and other mill additions. The frit is prepared from the following typical formula:

	Lb.
Boric acid	100
Borax	50
China clay	25
Flint (natural)	180
Lime	8
Flint from sagger linings	80

This is placed in saggers in the kilns and melted to a glass. The company has recently erected a gas-fired reverberatory furnace to replace the practice of using

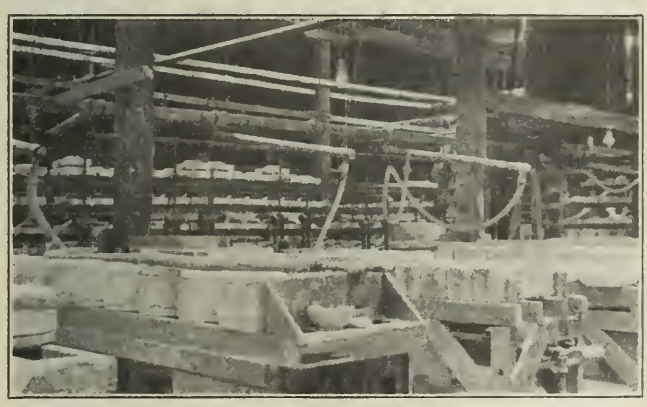


FIG. 8—SECTION OF CASTING ROOM

saggers. This glass or frit is removed to the glaze room, where it is ground in the chaser mill. During the grinding, china clay, flint, whiting, zinc oxide and feldspar are added, the whole being thoroughly mixed and ground in the dry state. The composition of this mixture must be such as to produce a glaze which will fit the bisque body according to the degree of burning of the body. It is a matter of obtaining proper coefficient of shrinkage of the glaze.

Fig. 9 is an interior of the glaze room. To the right is the track scale into which the mill additions are weighed and transported to the chaser mill, the latter not shown. The mixture from the chaser mill is carried to the four 1,200-lb. Patterson pebble mills on the left, where it is ground wet to a creamy consistency. These mills are emptied to boxes beneath. These, in turn, discharge to a common launder leading to the hexagonal rotary lawn appearing beneath the pebble mill in Fig. 10. This lawn is covered with No. 14 lawn silk. The lawn box empties to an agitator tank beneath the floor,

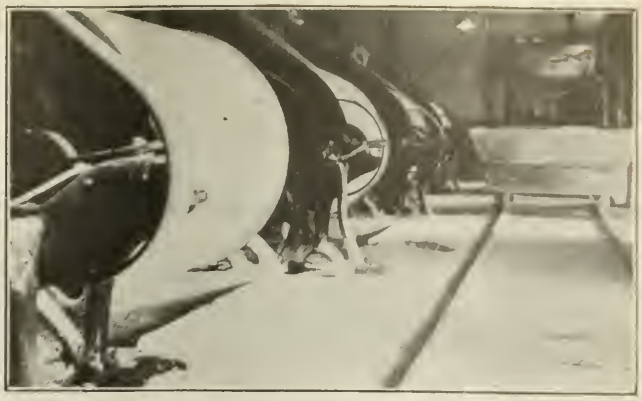


FIG. 9—GLAZE ROOM

whence the glaze is pumped by the small outfit, shown on the left of the view, to the dipping department.

The glaze tanks in the dipping room are all provided with agitators. Glaze is drawn off in ordinary galvanized washtubs, the ware which has received the bisque burn is dipped therein by hand and subsequently dried over steam pipes. It is then returned to the main kiln room, where both the glost and bisque burning is carried on. Ware from the green room here receives the bisque burn and is passed on as mentioned to the glaze room. The bisque is stamped with the trademark, plant and lot number just before dipping in the glaze.

Sagger Production

The sagger department is located in the basement. The mixture used consists of 50 per cent grog from broken saggers, with the balance a mixture of two clays. One is open firing and refractory, while the other clay is dense firing, though somewhat less refractory. Both are American clays.

Both hand molding and machine are employed in the forming. In the latter case a motor-driven Crossley sagger machine is used to develop about 1,000-lb. pressure per square inch. The sagger glaze mix consists of:

	Lb.
Whiting	30
Plaster	5
Feldspar	250
Flint	75
China clay	70
White lead	120
Red lead	20

Burning

Gas is burned at 45c. per 1,000 cu.ft. While this is expensive, there is a production saving of 15 per cent more ware as compared with coal firing. In the winter coal is used on the bisque kilns and some glost kilns and

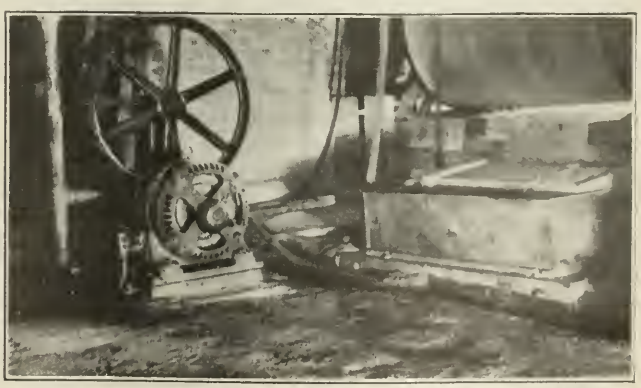


FIG. 10—HEXAGONAL ROTARY LAWN FOR GLAZE

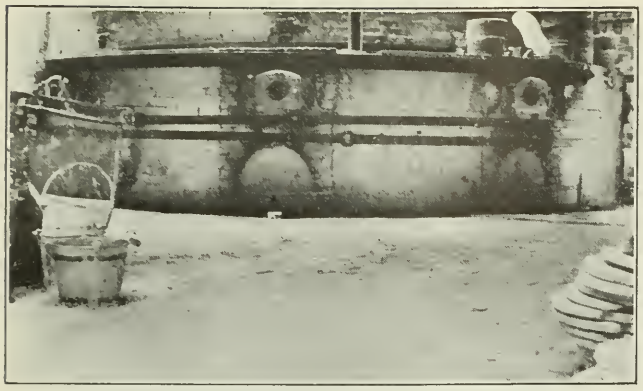


FIG. 11—UP-DRAFT PERIODIC KILN

for the purpose coal grates on wheels are inserted under fireboxes.

The main kiln room has seven bisque and nine glost kilns. They are 18 ft. in diameter, up-draft periodic type. Fig. 11 shows two of the fireboxes on a kiln with gas pipe feeding through the ash door opening. Cones and draw trials are used to determine and regulate ordinary firing conditions. Veritas disks are used when trouble occurs and occasionally Albany and body trials are employed. The bisque is burned to cone 8 and the glaze to cone 6.

Lowden overhead tram system is employed for handling saggers, coal and ware to and from kilns. A complete coal-handling system is installed. Standard gage railroad hopper cars dump to bin beneath track. Outlet permits coal to drop to pit at one side of track. An electrically driven hoist with grab bucket takes coal from this pit and deposits it either on the storage pile beneath overhead trestle or to overhead bin, whence it is transported to the kiln room.

Decorating Department

There are three general methods of decorating the ware after the glaze is burned on. Line decoration involves the spinning of the piece on a small horizontal wheel while the brush is held against the surface. Stamp decorating employs a rubber stamp with pad and is confined principally to the application of gold designs. Decalcomania is a transfer paper with the design printed thereon from lithograph stones. The inks are mineral colors. The design adheres to the varnish, previously applied on the proper portion of the ware, when the paper is washed away. All these operations are carried on by hand. The production of decalcomania paper has been improved by double and triple printing on lithograph presses which piles up the ink, giving a relief effect when burned onto the ware. Each pottery purchases exclusive designs by the sheet from the decalcomania manufacturer. About fifty open patterns are kept in stock. The artistic development of the decalcomania within the last 5 years has been very great.

There are four gas-fired, square, muffle type decorating kilns, each having two chambers. Coal is fired on grates along each side. The temperature reached corresponds to cones 018 and 019. Where gold and color is used in the decoration the ware must be twice fired. Inspection and packing in sets complete the production feature.

Economic Factors Important in Pottery Manufacture

The American pottery industry is today in a far more advantageous position than before the war, but it is still subject to several important factors. One of these is the necessity of importing English kaolins and ball clays, which, contrary to the broad statements of chemists not thoroughly familiar with the industry, are essential to the production of tableware. Potters would be glad to use domestic materials if it were possible to do so and are even now introducing as much North Carolina and Florida kaolin as they dare to use. The position as regards ball clays is more favorable and it should be possible in time to eliminate a large part of the imported clays. Some of the Tennessee and Kentucky clays are already being used and recent developments in Missouri afford additional hope.

The great need is, however, for primary kaolins found in sufficient quantities and of good quality. The North Carolina kaolins at the best are extremely valuable materials, but unfortunately they are subject to variations due to their fluctuating mica content, which renders them more or less unreliable. Furthermore, the quantities available are not sufficient to supply the whole trade. The plastic kaolins of Florida and Georgia can be used in smaller proportions, but these offer real difficulties because of their fine-grained, partly colloidal nature.

It is to be hoped that the search for suitable kaolins will be continued until ultimately it will be possible to depend entirely upon domestic raw materials. As regards the flint and feldspar, we have an ample supply of these rocks.

Labor

The second important factor in the pottery industry is the labor question. Organized labor prevails and piece work is the rule. This system has both its advantages and disadvantages. It cannot be denied that labor has been unreasonable in the past, but this is true of all other industries. On the other hand, the Brotherhood provides the potteries with trained men who have served their apprenticeships and are skilled workers. This organization has also shown wise moderation during the recent wage settlement and the trouble that existed has been caused by "locals" not affiliated with the Brotherhood. The future development and growth of the industry will undoubtedly depend upon closer co-operation between the manufacturers and the craftsmen.

Educational Needs

One of the needs of the situation is an opportunity for the pottery workers to be trained in properly equipped schools in the technical fundamentals of the trade. Such a beginning has been made at the Trenton School of Industrial Arts and it will be necessary to found similar institutions at several of the clay-working centers. It is essential that an opportunity to improve himself be offered the ambitious workman. It cannot be expected that a large proportion of the potters would avail themselves of such training, but those who do will constitute the nucleus from which foremen and superintendents can be chosen. This has been realized for some time in Europe, where trade schools open to workers have been in existence for many years, and attention need be called only to the schools at Stoke-on-Trent in England, Levres in France, Bunzlau and Hoehr in Germany and Teplitz in Bohemia.

The writer is indebted to W. E. Wells, Jr., general manager, and A. V. Bleininger, chief technologist, for courtesies extended during visit to the plant and information furnished for the preparation of this article.

Chemical Warfare and the Arms Treaty

Abolition of Gas Warfare by Proposed Treaty Is Shown to Be Impractical and Not in Harmony With the Best Technical Opinion—Alternative Procedure Suggested to U. S. Senate and a Review of the Facts Upon Which It Is Based

By R. S. McBRIDE

IN THE TREATY on submarines and chemical warfare, the representatives of the five principal world powers have returned a signed indictment of the use in war of noxious gases and chemicals. Now it remains for the Senate of the United States to try the case of the indicted criminal, gas.

In this article there will be no attempt to propose just what the Senate of the United States should do with this particular treaty. The effort will be rather to set forth certain *established* facts and other *alleged* facts which should be taken into account by the Senate if this treaty is to receive proper consideration from the standpoint of the needs of the American people.

The following is the only section of the submarine treaty (so called because all other sections treat of submarines) which deals with the question of the use of gas. It is section 5:

> The use in war of asphyxiating, poisonous or other gases, and all analogous liquids, materials or devices having justly been condemned by the public opinion of the civilized world and a prohibition of such use having been declared in treaties to which a majority of the civilized powers are parties, the signatory powers, to the end that this prohibition shall be universally accepted as a part of international law binding alike the conscience and practice of nations, declare their assent to such prohibition, agree to be bound thereby as between themselves, and invite all other civilized nations to adhere thereto.

What Led to This Treaty Proposal

Strong public opinion against the use of gas in warfare developed spontaneously after the famous chlorine attack made by the Germans on the Canadian troops at Ypres. This sentiment grew steadily during the remaining period of the war and still remains a powerful factor throughout the country. As a consequence a few hundred thousands of the communications which came to Washington from individuals, associations and others during the late Arms Conference urged the abolition of the use of gas in war.

A technical sub-committee of the Arms Conference was appointed to represent the five principal powers affected. This committee consisted of seven members, two each from the United States and France, and one each from Great Britain, Italy and Japan. The advisory committee of the American delegation, consisting of a group of private citizens and public officials selected more or less as spokesmen of American public opinion, also gave consideration to the question of gas. It was on the basis of the reports of these two committees and of a third document submitted by the General Board of the U. S. Navy that the American delegation based its conclusion that gas warfare should be prohibited.

The full texts of these several documents have already been made public, but it is believed that their important bearing on the present situation warrants a brief review of their salient conclusions. It will be recalled that the representatives of the five signatory powers who acted as technical experts in the consideration of gas warfare were of the opinion that it was impractical to prohibit chemical warfare. The committee reported, among other things, that neither the research nor the production of warfare gases could be prohibited, restricted or supervised and that therefore "no nation dare risk entering into an agreement which an unscrupulous enemy might break if he found his opponents unprepared to use gases both offensively and defensively."

The American delegation and the Arms Conference itself, however, did not accept this technical interpretation of the situation. In this respect it departed materially from the policy which it apparently followed throughout all of the rest of its deliberations. In all other cases it appears that the Conference reached its conclusions on technical subjects after weighing carefully but finally approving the consensus of technical opinion. It certainly did so in the case of the conclusions reached with respect to submarines, aircraft and the exact disposition of naval vessels.

The Advisory Committee and Navy Reports

A sub-committee of the advisory committee, under the chairmanship of General Pershing, also labored over the matter, and its report was presented *in extenso* to the Arms Conference by Secretary Hughes. After reciting general statements as to the development of gas warfare, the committee concluded that "whatever may be the arguments of technical experts, the American representatives would not be doing their duty in expressing the conscience of the American people were they to fail in insisting upon the total abolition of chemical warfare, whether in the Army or the Navy, whether against combatant or non-combatant."

As a result of its deliberations, the American delegation adopted in substance this advisory committee report despite the fact that the advisory committee was far from unanimous in recommending it to the delegation. It is reported that the split on this particular resolution was, in fact, one of the most serious points of friction in the entire proceedings from the standpoint of the American advisers.

At this point there was injected into the discussion, "for the information of this committee," a report by the General Board of the U. S. Navy, which said categorically "Yes" in answer to the question, "Should gas warfare be prohibited?"

The comment of the General Board of the U. S. Navy cannot be regarded as a technical discussion of the question, but it appears to have had considerable influence with the delegation, possibly because it stressed the frightfulness of the use of gas against non-combatants.

The American delegation after considering these re-

ports laid before the Arms Conference a resolution which was presented by Mr. Root. This resolution strictly forbade in any way use of asphyxiating, poisonous or other gases, and all analogous liquids or poisonous devices. It was in substance identical with the final form of the treaty provisions quoted above. This resolution was adopted by the Conference unanimously and became the basis for its final recommendations which now are before Congress.

An Alternative Procedure Now Suggested

Those who have studied the subject carefully, particularly those who have had long experience and know gas warfare, believe that the conclusions of the Arms Conference were in error in their interpretation of the function of gas as a military weapon. They all admit that there are highly improper uses of gas, just as there are recognized misapplications of the submarine and aircraft. However, basing their conclusions upon certain facts, or alleged facts, they insist that the proper procedure would have been to define as clearly as may be the misapplication of gas, and provide penalty for such misapplication, rather than to have attempted to prohibit its use. In other words, they would place gas in the same category with submarines and provide correspondingly. One alternative which has been proposed uses the substance of the treaty above discussed and by re-wording it but slightly accomplishes this result in the following language. (The italicized words in paragraphs 1 and 2 and all of paragraph 3 are the new portions):

> The *wrongful* use in war of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices having been justly condemned by the general conscience of the civilized world.
>
> The signatory powers, to the end that the prohibition of this *wrongful* use shall be universally accepted as a part of the international law binding alike the conscience and practice of nations, declare *that the use of these materials in any form against cities or against bodies of non-combatants of a belligerent or neutral country is a violation of the laws of war, and they* agree to be bound thereby as between themselves, and invite all other civilized nations to adhere thereto.
>
> The signatory powers do further declare that any person in the service of any power who shall use these materials in any form against cities or bodies of non-combatants shall be deemed to have violated the laws of war and shall be subject to trial and punishment as in the case of persons violating the rules adopted for the regulation of submarine warfare.

Six Pertinent Facts

In urging the adoption of this alternate form of treaty obligations certain important facts and opinions have been enunciated. It appears that the Senate of the United States should, and it doubtless will, carefully consider these points. They may be briefly summarized as follows:

(1) Gas as a military agency can be developed by research and its manufacture continued in secret indefinitely, if any nation wishes, despite any number of international agreements to the contrary. In this respect it differs fundamentally from battleships and fortifications, which cannot be so secretly constructed and preserved.

(2) Gas in its application in war can be as accurately controlled as to its objective as can high explosive, shrapnel or small arms missiles. It is urged that there is absolutely no justification for the claim that it necessarily is used against non-combatants as well as combatants if used at all.

(3) Gas is demonstrated to be the most effective and probably the most economical weapon; and it is claimed by those who have thoroughly studied the subject that it is fully as humane a weapon as any other. Assuming a demonstration of these three important points, gas would certainly qualify as one of the most acceptable potential weapons of modern war, even assuming that that war is to be a "civilized" one.

(4) The Chemical Warfare Service as a military agency cannot limit itself to offensive military preparedness, for it is essential to have at all times defensive measures provided for the protection of our troops in case an unscrupulous potential enemy might violate an international agreement.

(5) Effective preparation for defense against gas warfare demands thorough study of offensive measures that may be met. Moreover, the surest guarantee that offense measures will not be used contrary to agreement is the fear of retaliation on the part of the better prepared enemy. Thus it is argued that means for offensive warfare of this type must always be maintained not only on an experimental scale, but upon a scale capable of expansion to large units very quickly.

(6) The Chemical Warfare Service, furnishing as it does an important link in the chain of chemical industries, contributes to peace-time welfare of the community through this and other means quite sufficiently to justify its cost even though its military value as a measure of defense were entirely ignored.

Demonstration of these six points in convincing detail is out of place here. Some of them, as pointed out below, are easily demonstrable. Others have been less clearly established. Nevertheless they are set forth and insisted upon by those who should know and who probably can at the proper time bring forth evidence for their conclusive support. At this time, therefore, it is urged only that these facts and opinions be not ignored, but that effort be made to bring out all the points pertinent to them before this nation shall have irretrievably committed itself to a policy upon which there is still ample ground to justify difference of opinion.

Controllability of Gas

It requires no elaborate argument to demonstrate the unquestioned correctness of the first point made—namely, that research and development, even manufacture, of gas offense material can be continued in secret if desired. This research and development, in fact this manufacture, is going on as a part of regular chemical industry and will continue as such without regard to the military significance of treaty obligations. It is quite as hopeless to attempt pre-control by agreement of these things as it would be to attempt pre-control of the judgment of the commander of a submarine. The integrity of those in charge must be trusted to determine what use will be made of such facilities or of such submarine. Only the honorable character of these persons will determine what the application will be. Their existence cannot conceivably be prevented.

The controllability from the standpoint of who is harmed by use of gas is a question not quite so clearly established. Experiences of non-combatant populations subjected to gas are reported from the late war. That such experiences were not uncommon need not be questioned, but there is no question that non-combatants were similarly harmed by the misapplication of bombs and other explosives dropped from airplanes or by missiles of all types from small arms to the largest of high-explosive shell. Technical experts seem unanimous

in their statement that gas *can* be applied as accurately to an objective as can any other weapon.

An unscrupulous enemy might apply it to non-combatant as well as combatant. In fact, the advisory committee seems to fear this frightful and unrestrained use of gas, if it is permitted at all, more than any other feature. But there is no reason why there should be such application than there is that an enemy should sink passenger vessels unwarned or hospital ships traveling solely on errands of mercy. The choice is strictly his.

Effective, Economical and Humane

The large percentage of casualties experienced in the last war from gas is a complete demonstration that gas is one of the most effective weapons of modern war. The experience of the late war was also a complete demonstration that from the standpoint of money cost it is one of the most economical agencies of offense.

It is estimated that proper defensive measures for protection of America could be at least fifty to one hundred million dollars per year less if it were permitted that our Army and Navy use gas as one of the agencies against the combatants of an attacking enemy. It is insisted by those who have studied the subject that this tremendous annual saving could be accomplished even though the total expenditure for all Army and Navy agencies were only to be one-half to one-third of the present total, which is between one-half and three-quarters of a billion dollars per year. Unless the enemy can gain absolute control of the air, thus blinding our military forces in this element, and then be free to attack as he wills from the air, the defensive measures which can be accomplished by gas used upon landing places give tremendous advantage to a defensive force. The advantage is so great, indeed, that it is urged that other expenditures of all types could be materially reduced without it any way curtailing the effectiveness of the defense provided.

The third claim regarding gas as a weapon—that it is as humane as any other—is also demonstrated. It is shown that the percentage of recovery of gas casualties has been very much higher than the percentage of complete recovery from any other cause of casualties. Medical investigation seems to have established the fact that there is no justification for the assertion that tuberculosis, pneumonia and the other diseases claimed as after effects of gassing were so caused. It is also insisted that the suffering caused at time of casualty is no greater when a man has been subjected to gas than if he has been *equally* disabled by bayonet, shrapnel or high explosive.

Since it is upon the basis of humanity and humanitarian considerations that the decisions of the Arms Conference were reached, it would seem essential that this point should be thoroughly studied in the light of the latest and the best information which can be brought before the Senate of the United States.

Continuance of C.W.S.

The British representatives in addressing the Arms Conference were so outspoken in their interpretation of the proposed treaty that it seems there need be no doubt in the minds of the American people on the same point —namely, that the treaty does *not* mean any interruption of measures of preparedness from the standpoint of defense. It seems reasonable to assume, therefore, that the question of continuance of the Chemical Warfare Service as a branch of the Army is not raised by the discussion of this clause of the treaty. In any event, C.W.S. can be defended very convincingly as a defensive unit and as a unit of peace-time value quite worth its cost.

What Shall Be Done About It?

The Senate of the United States is already considering these treaties. The Senate is a deliberative body reaching conclusions after thorough consideration and serious debate pro and con. It would not be fitting or proper that the chemical industries of the country, which have the most intelligent appreciation of the present situation, should take the initiative and attempt to dominate this situation, even on the ground of the superior knowledge of the question. The matter is one of public policy and public opinion, rather than of science and technology.

Despite this limitation which expediency places upon the chemical industry at this time in this matter, the industry can and should insist that the Senate carefully bring out all facts bearing upon the usefulness, the "frightfulness" and the humanitarian aspects of gas warfare.

If the Senate will carefully and thoroughly delve into the subject, there is no question that it will reach a sound and proper conclusion. Whether this conclusion will be to ask the President to negotiate a slight amendment of this section of the treaty, whether it will be to accept the treaty with clear understanding in their own minds as to what limitations must inevitably be placed upon its meaning, or whether the flaws alleged to exist will be deemed sufficient to cause rejection of the treaty as a whole and insistence that this section must be omitted before ratification, only time can tell.

If, as is urged by some, the conclusions of the Arms Conference were based upon a misunderstanding of the facts, then the Senate can well take some course leading to appropriate amendments of the Conference recommendations. However, to urge this now would be quite unseemly, for some of the greatest minds that present-day statesmanship can furnish have studied these questions and reached deliberative conclusions. All that can or need be asked is that the review of the situation by the Senate be thorough and impartial.

Investigation of Abandoned Magnesite Beds

Previous to 1860, most of the epsom salts used in the United States was made from magnesite mined in Pennsylvania. The demand for magnesite on the Atlantic seaboard resulted in an investigation by the U. S. Geological Survey as to the possibility of again working the Pennsylvania deposits profitably.

The work done, which consisted of re-excavating the pits, quarries, open cuts and a shaft that had become filled with dirt, showed that the magnesite occurs in a fine network or stockwork of small veins, most of them less than an inch thick. Two veins were uncovered, one about 14 in. wide and the other about 12 in. wide. A thorough exploration, including the reopening and drainage of a shaft with underground drifts, failed to disclose any larger veins, but it is reported that a body of magnesite about 30 in. wide was found in the shaft at the crossing of two principal veins.

The development work completed last fall shows that the quantity of magnesite available close to the surface is very small and that many tons of waste would have to be handled to produce a single ton of ore, and production on a commercial scale was therefore not attempted.

Centrifugal Casting

An Art Known for Over a Century—Requires Careful Adjustment of the Cooling Rate, Which Is Controlled by the Temperature of the Mold and of the Liquid Metal—Recently Adapted to Steel and Monel Metal

By L. CAMMEN

IN THE present paper it is intended to describe the process of centrifugal casting of hollow metal objects. Actually, however, centrifugal casting has been successfully applied to the production of non-metallic tubes, such as concrete pipe (Hume process). It has also been used for the production of solid castings, by locating the molds around the rim of a spinning wheel. By this method dense aluminum castings have been obtained, as well as concrete blocks and precast shapes.

The Art Is Old

The art of centrifugal casting of hollow metal objects is quite old, and has been practiced on a commercial scale in England since the beginning of the last century, the earliest patents dating as far back as 1809. About the year 1852, Shanks, in London, made cast-iron gas pipe, 12 ft. long, 3 in. in diameter, by pouring molten metal into a spinning wrought-iron mold. He also applied his process to the manufacture of iron sheets for roofing, by casting cylinders, 9 in. long, 6 in. diameter and about 0.01 in. wall thickness. These cylinders were then carefully annealed, cut open and flattened out. The process was kept secret, and these sheets found a ready market for a long time, until rolled-steel sheets became available.

As noted in the *Mechanic's Magazine* for December, 1864, Whitley and Bower, in England, applied the process of centrifugal casting to the manufacture of cast-iron wheel tires. Their machine is shown in Fig. 1,[1] where *A* is a metal, clay-coated mold rotating about a vertical axis *B*. The metal is supplied through spout *C*, while *D* and *E* are the fast and loose pulleys by means of which the rotary motion is imparted to the mold. In its essential features the Whitley machine does not differ from the majority of those used today, at times under the veil of the deepest secrecy, in this country and elsewhere.

That the art of making centrifugal castings was known in the United States at an early date—that is to say, early in our industrial history—is shown very clearly by an illustrated description in one of the first issues of the *Scientific American*. Fig. 2 reproduces this page and the description, which exhibits the state of the art so well that comment is superfluous.

Sir Henry Bessemer, the inventor of the bessemer process of steel manufacture, devoted a good deal of his attention to the subject of centrifugal casting of steel, without, however, publishing full details of his trials. M. Tresca, in a paper before the Institution of Mechanical Engineers (1867, pp. 149-50), states, however, that "the most remarkable instance that he had met with of freedom from air bubbles was in the case of a bessemer rail manufactured at the Imphy Iron Works, near Nevers, in the Department of Nièvre; and he had ascertained that the method adopted at these works was to pour the molten metal into a revolving vessel driven at a considerable speed, so as to clear the steel of air by rapid rotation. This method appeared very effective in practice, in freeing the steel from the minute air bubbles which it contained on leaving the converting vessel or the melting pot."

In 1882 Webb, speaking before the Iron and Steel Institute (*Journal*, 1882, p. 522), stated that at his works in Crewe he was casting steel wheels and making them sound by casting them on turntables. Not only this, but he used a variable speed and feed in doing so. His remarks show that at that time the mechanics of the centrifugal casting process was already perfectly well understood, a supposition further supported by the fact that Ledebur's "Handbook of Iron and Steel Founding," published in 1892, devotes a chapter to centrifugal casting, covering all the fundamental elements of this art.

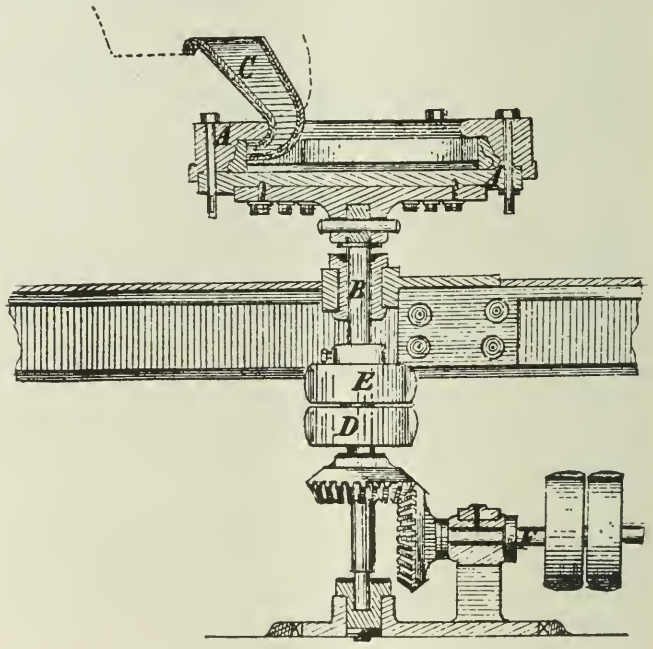


FIG. 1—WHITLEY AND BOWER (1864) MACHINE FOR CENTRIFUGALLY CASTING TIRES FOR WHEELS

A study of these references and the numerous patents issued on centrifugal casting in this country and in Europe would indicate that practically all the essential features were covered by patents issued prior to the beginning of the twentieth century, so that with the exception of minor details and one or two features in special casting processes there is no reason why any good engineer could not design a successful casting machine without running into legal complications. A

[1] Reproduced from *Dingler's Polytechnic Journal*, vol. 153, p. 451.

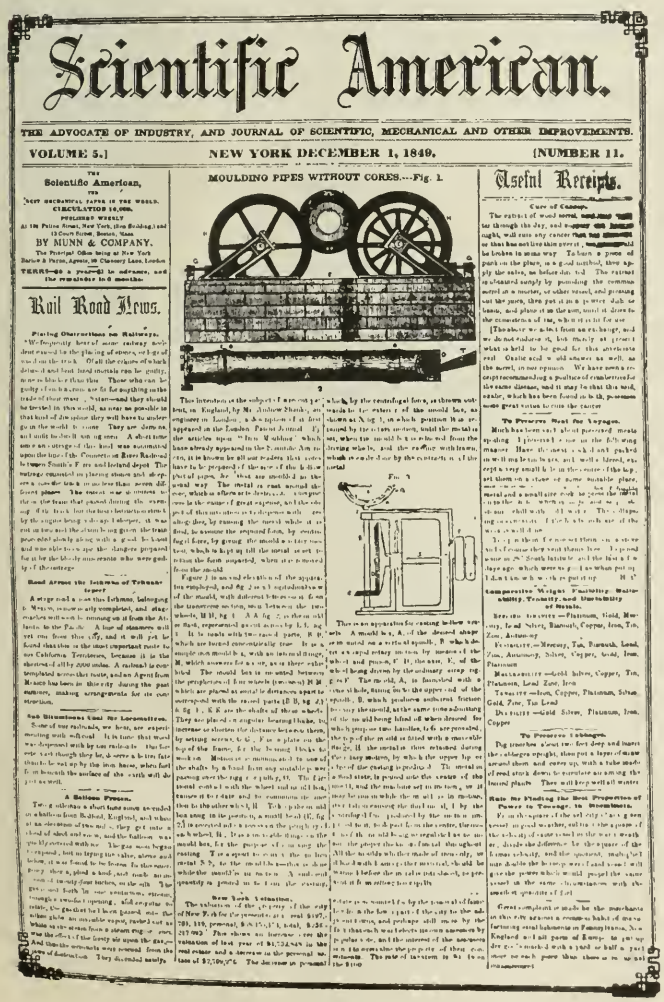
familiarity with the patent situation is, however, desirable in order to avoid involuntary infringement by using some minor detail (such as, for instance, a particular type of pouring spout) that has been covered by a patent.

Field of Application

It is only within the last few years that the field of application of centrifugal casting has begun to be realized. As a matter of fact, it is very extensive indeed and falls into several regions. In the first place, centrifugal casting is a cheap method of producing goods of certain shapes—namely, those having a hollow interior, symmetrical about an axis passing through the body of the casting, whether concentrically or eccentrically. The advantage of such methods lies in the fact that with proper equipment a very large number of units can be produced with comparatively little labor and without the use of cores. During the war several concerns employed this method—for example, for the production of piston rings for automobile engines—and even now establishments like the Ford Motor Co. employ it regularly with considerable success. An American manufacturer of bearings uses the centrifugal method to line the tube with the bearing metal. The Sandusky Foundry & Machine Co., Sandusky, Ohio, employs such casting to produce big paper mill rolls and propeller sleeves which would be much more expensive and probably less satisfactory if cast in a stationary mold. The same method with slight modifications has been applied to the manufacture of hollow tubes of variable cross-section, which could not be cast at all in a stationary mold and would be very expensive to produce by machining.

However, the above is not the most important field of application of centrifugal casting, the value of which lies primarily in the fact that by its means shapes can be produced which it would be next to impossible to produce by casting in stationary molds. Thus the Stokes Castings Co., Ltd., Mansfield, England, has produced by this method cast-iron liners for aluminum cylinders for airplane engines of such a small thickness and high grade of metal as could not be duplicated by any other process except by machining, and at a price only a small fraction of what a machined tube would have cost.

As a matter of fact, centrifugal casting in many cases produces a metal essentially different from the one produced by casting in a stationary mold, whether sand or chill, and approximates more the character of a forging. Thus tests made on centrifugal steel castings by Dr. G. K. Burgess, of the U. S. Bureau of Standards, have shown that centrifugal castings properly heat-treated can pass with a safe margin all requirements of the Ordnance Department specifications for gun forgings, which is certainly a very remarkable thing. Those who deal with thin-wall Monel metal castings know how extremely difficult it is to obtain solid metal free from blowholes and miniature "pipes" or cavities caused by unequal contraction. And yet Monel metal tubes 2 to 3 ft. in length and $\frac{3}{8}$ in. in wall thickness have been produced centrifugally of such uniformity of metal as to permit drawing them into perfect seamless tubes.


Scientific American.

THE ADVOCATE OF INDUSTRY, AND JOURNAL OF SCIENTIFIC, MECHANICAL AND OTHER IMPROVEMENTS.

VOLUME 5.] NEW YORK DECEMBER 1, 1849. [NUMBER 11.

MOULDING PIPES WITHOUT CORES.—Fig. 1.

Useful Receipts.

Rail Road News.

FIG. 2—A PAGE OF THE "SCIENTIFIC AMERICAN" OF 1849

Centrifugal Casting vs. Piercing

Hitherto the principal tonnage of seamless tubing has been made by the Mannesman piercing process and its variations. Essentially this process consists in imparting such a twisting motion to a steel billet as to break down its central fibers, a motion set up by means of obliquely placed rolls or disks. This works very well with high-grade mild steel or Muntz metal, but does not work well with metals which are either extremely tough or very brittle. Thus all efforts to produce pierced Monel metal or Admiralty brass billets have so far been unsuccessful commercially. Because of this limitation of the Mannesman process there are a considerable number of metals and alloys not used today for the production of seamless tubing. Notwithstanding the large demand for high-carbon chromium (1.25 C, 1.5 Cr) steel for ball-bearing races and the fact that it would be obviously desirable to make these races out of seamless tubing, they are made out of a solid bar, either by direct machining or by the trepanning process, at a considerable increase in cost over what it would have cost to make them out of tubing. The reason for it is that high-carbon chromium steel of the above analysis cannot be pierced by the Mannesman process easily enough to permit of its commercial production. Not only that, but Mannesman's process is limited to the production of comparatively small sizes, not in excess of, say, 6 in. in diameter (although tubes as large as 9 in. have been produced more or less experimentally). It is obvious that as we go up in sizes both the piercing mills and the drawing benches used in this process increase in size and cost with great rapidity.

The centrifugal process permits one to cast, at a comparatively moderate cost, seamless tubes in sizes

practically without limit. For example, there is no reason except our still insufficient knowledge of the details of the process why tubes 10 ft. in diameter and, say, ¼ in. wall could not be made thus.

It has particular application to the production of condenser tubing from Admiralty brass (10 per cent Cu, 29 per cent Zn, 1 per cent Sn). Hollow billets from this mixture cannot be made by the Mannesman process and therefore have to be cast in sand using a core soft enough to permit the metal to contract. Not only does this necessitate the use of excessively thick walls (⅝ in.) in order to produce a good casting, but such thick walls also require an excessive number of draws in the bench, with a corresponding increase in the cost of the final product. Furthermore, one can never be certain of the behavior of a soft core and no two castings are absolutely alike, some of them containing blowholes, cavities or hard metal. Moreover, in sand casting there is no positive way to eliminate slag inclusions or bits of sand from the mold or core being captured by the metal. Every blowhole, cavity or slag inclusion means a weakness or failure of the tubing, and none of them can be discovered as a rule until a number of draws have been made on the tube and a considerable amount of money and labor spent. Centrifugal casting in a mold with properly controlled temperature permits one to produce practically perfect Admiralty brass tubes in thicknesses of ⅜ in. and down to 1/16 in. with a higher degree of certainty than from sand-cast tubes. Moreover, such tubes have been found to be practically free from occluded slag or hard spots.

Another remarkable feature of centrifugal casting is its ability to produce very close mixtures where sand casting results in a great deal of segregation. One of the most striking examples of it is in the casting of lead-copper alloys. When cast in a sand mold the copper segregates from the lead to such an extent that the two metals can be clearly distinguished in yellow and dark gray banding. When cast centrifugally at proper temperatures a uniform blackish gray alloy is produced and the particles of copper and lead cannot be seen by the naked eye (but are fairly clearly distinguishable under a microscope). On the other hand, when casting bronze in a spinning mold, there does occur a certain degree of segregation resulting in an increase of hardness with a corresponding percentage of tin toward the inner edge. It would appear, therefore, that the action of centrifugal force affects some metals more than others, which may be due either to the electrical potential between the two metals or to the method by which the metals in the alloy are combined—that is, whether they form a chemical compound, a solid solution or a mechanical mixture—and possibly by the proximity of the analysis to the eutectic. It may be mentioned in this connection that all attempts to separate silver out of a lead-silver alloy by centrifuging have failed, notwithstanding very high speeds employed.

Mechanics of Centrifugal Casting

In the first place, clear distinction should be made between castings made with a horizontal and a vertical axis, and also with the intermediate case of an inclined axis. In casting about a horizontal axis the metal is distributed symmetrically about the axis, and if the axis of rotation coincides with the axis of the spinning unit, a tube of uniform thickness is produced for the entire length of the mold. If a vertical axis is used, it is obvious that the external wall of the casting follows the shape of the mold, while the interior of the casting forms a paraboloid of revolution, the elements of which, in accordance with the formulas developed by Resal and Kirpicheff, depend on the speed of rotation, the specific gravity of the metal and the depth of the mold. In casting with an inclined axis, the same general principles apply with the further complication that the elements of the inside paraboloid of revolution are also affected by the angle of inclination of the axis to the true horizontal.

Two methods may be used in producing centrifugal castings. The one ordinarily used is to introduce

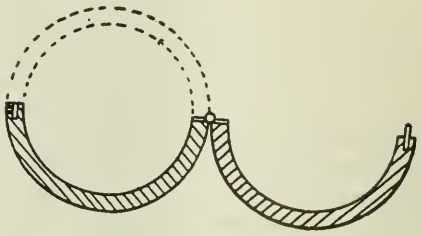


FIG. 3—SECTION OF MOLD SPLIT ALONG THE LONGITUDINAL AXIS (THE TWO PARTS MAY BE EITHER HINGED OR BOLTED)

molten metal into the moving mold. The other is to melt the metal in the mold in which the casting is made. While this is a convenient scheme to effect certain conditions—as when it is desired to keep the metal from coming in contact with air—it has been so far applied only on a limited scale.[2]

A mold for the manufacture of tubing and pipe may be either solid or split (Fig. 3). The latter is preferable when long pipes are cast, as it is then easier to shake out the pipe. Crucible graphite or zirconium

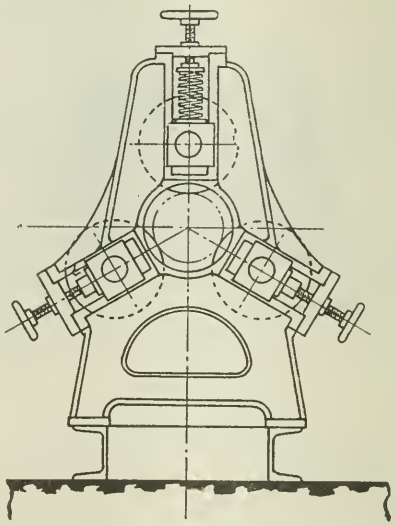


FIG. 4—SPINNING BENCH FOR USE WITH REMOVABLE MOLD

tubes may be used for molds for short castings, but when casting long pipe, metal molds are to be preferred, especially those made of such a heat-resisting and noncorrosive alloy as nichrome. Enough work has been already done on the production of cast tungsten to make it certain that a mold of this truly wonderful material will be available within a comparatively short time.

There are several ways of supporting the mold in the spinning bench (Fig. 4), the selection of which de-

[2]For its description see "Mold Serves as Electric Furnace," by E. C. Kreutzberg, *Iron Trade Review*, July 7, 1921.

pends mainly on the size of the unit. But there is one rule which must not be forgotten for an instant by the designer of a machine for centrifugal casting, and that is that it should be made substantial, strong and free from vibration, which means a well-balanced rotator on a solid foundation.

If molten metal is to be poured into the spinning mold, very careful consideration of the thermal conditions in the mold and of proper appliances for handling the hot metal will be required. It may be added that one of the most important reasons why centrifugal casting has not been used to the great extent which it deserves has been the failure to appreciate properly the necessity of keeping the mold at the *proper* temperature, be it high or low, and the consequent failure to produce sound articles.

Heating the mold may be done electrically if very cheap current is available. Otherwise the mold is heated in the same type of furnace as is now used for heating billets at tube mills, while small molds may be heated by placing them in the flue of a reverberatory furnace. For casting such metals as steel and Monel, the mold should be heated to about 2,200 deg. F., so as to reach the spinning bench with a temperature of about 2,000 deg. F.

Where a metal mold is used, it should be coated with a thin film of some material which prevents the metal of the casting from coming into direct contact with the metal of the mold. There are several materials that may be used for such coating, and their selection depends largely upon the metal to be cast. I may mention here electrically calcined magnesia with pitch as a binder; zirconia with either pitch or crucible clay as a binder; and plain pitch, which can be used only with non-ferrous materials except with alloys rich in nickel.

The life of the mold depends on its material and handling. Thus far nichrome appears the most long-lived material now available. Under conditions very similar to those under which these molds work, cast nichrome has shown a life of from 10,000 to 12,000 hours, the time required to make about 20,000 castings. Under certain conditions it may be found cheaper to use alloy iron molds with nichrome liners. If the outer shell of the mold is made of iron containing about 7 to 10 per cent Cr and 2 per cent Ni, the life of the mold will be as high as 1,000 castings. Selection of the type of mold is determined largely by considerations of cost and the heating furnace available.

Function of Riser or Sink-Head

We should consider first steel or Monel metal castings, since they present more difficult combinations of conditions than either brass or bronze. In making castings in a stationary mold, whether it be a simple ingot or a complicated casting from pattern, the foundryman has to provide for the escape of gas from the metal and for the piping produced by contractions in cooling. In a casting from a pattern, the gates or risers are so proportioned as to avoid defects from these causes. In ingot casting, special methods such as dozzling are used to keep the top of the ingot hot as long as possible and thus provide opportunity for the escape of gases, and furnish hot metal to fill in the contraction cavities, the topmost part of the ingot thus performing the functions of the risers in sand molds. In both cases the foundryman is prepared to discard as defective a certain part of the casting (the ingot head, gates and risers) and his skill lies partly in reducing the quantity of defective parts as far as possible, and especially in directing the process so as to get all the defective metal into the parts which he can discard without spoiling the casting.

In centrifugal casting, however, there is no riser or anything corresponding to the ingot top, the cooling proceeding essentially at a uniform rate all along the length of the tubular shape. It is obvious, especially in tubes of small diameter and considerable length, such as 6 in. outside diameter and 16 ft. long, that the loss of heat inward must be extremely small, because the entire inner air cylinder is surrounded by metal at approximately the same temperature. Heat is therefore lost outward to the mold and through it to the air. As a result of this, the part of the casting in immediate contact with the mold chills first. At first sight, especially to those familiar with such centrifugal processes as cream separation, it would appear that the pure metal, being heavier than either slag or oxidized metal, should be thrown to the outside, while all impurities and metal containing dissolved gases would be forced to the inside. This does actually happen, providing only sufficient time is available. But this separation takes place at a fairly slow rate because of the great viscosity of molten steel. If enough time is available between the instant of casting and that of complete freezing of the metal, the impurities and gases *will* be thrown out to the inside of the casting, otherwise they will be caught in the tube wall and make the tube worthless. This is one of the reasons of the many past failures to produce thin-wall steel tubing by centrifugal casting. On the other hand, very excellent steel tubes (both plain carbon and nickel alloy) have been produced with diameters ranging from 10 in. up and wall thicknesses up to 3½ in. In the latter case there is so much metal in comparison with the area in contact with the mold that enough time is available to produce a good segregation of impurities inward before the inner wall freezes.

Thermal Conditions in the Mold

It would appear, therefore, that the secret of producing tubing of thin-metal (under ½ in.) lies in establishing conditions under which the cooling of the molten metal would proceed at a fairly slow rate. In the Cammen process this has been accomplished by preheating the mold to a temperature fairly close to the melting point of the metal itself, as, for example, to 2,000 deg. F. for steel and Monel metal castings. Under these conditions a ⅜-in. wall takes about 60 seconds to harden entirely, which is sufficient to produce clean metal.

Brass casting shows the same phenomena, though, of course, to a somewhat lesser degree, because of the lower melting point of the metals and the ability to superheat them to a somewhat greater extent than is possible with steel. Nevertheless, even there the chilling of the metal is one of the most serious difficulties that has to be overcome by the manufacturer of centrifugal castings. Attempts have been made by several manufacturers to introduce the entire metal of the casting at once, which involves the use of elaborate and so far only moderately successful pouring devices.

The problem of the centrifugal tube maker, working in bronze is somewhat complicated by the fact that he is between the devil and the deep sea, and cannot even directly resort to the Cammen expedient which proved satisfactory with steel and Monel metal—that is, the use of the hot mold. If he chills the bronze very

rapidly, he generally gets an excellent metal, but is apt to run into trouble because of the presence of blowholes due to occluded gases. Unless the metal is poured into the mold at such a rate as to form a complete section when casting heavy tubes by this process, the first metal poured chills, and then when new metal is added it does not weld completely to the previous batch, the result being a composite tube or one with split areas in its interior. These defective tubes give considerable trouble, especially under a hydrostatic test. This is probably the main reason why manufacturers of centrifugally cast bronze tubes refuse to sell rough castings; not being certain of their product, they prefer to eliminate defective tubes in their own plants rather than have their customers do it. On the other hand, if the maker chills the metal very slowly, using a hot mold, he gets rid of the danger of blowholes, but the bronze is coarse grained and will not satisfactorily pass the hydrostatic test. In the Cammen process this dilemma has been solved by the employment of a somewhat complicated but effective system. The bronze is poured against a hot mold (electrically heated to a temperature about 100 deg. below the melting point of the particular bronze), but as soon as the pouring has been completed a stream of water is passed over the mold, which chills it as rapidly as may be desired. In this way the temperature conditions during cooling can be controlled to accord with the best practice for the given metal.

Cast-Iron Pipe

Cast iron is in many respects different from that of the other metals, in that numerous tests have shown that the best results are obtained when cast iron is cast against a chill mold. Methods for making cast-iron pipe in rotating permanent molds have been developed by a French-Brazilian engineer, Dimitri Sensaud de Lavaud, whose work has been of pioneering importance. The method developed by de Lavaud is novel and ingenious. He uses a cast-iron mold, water cooled on the outside, and a pouring spout extending to the farther end of the mold and moving at a predetermined rate of speed outward. As the metal is poured, it chills almost instantly and by the time the spout is withdrawn the entire tube is formed. As the metal is cast against a chill, it is a quite brittle white iron, but after a proper anneal it becomes tough. Because of its great uniformity, centrifugally cast pipe may be a good deal thinner for the same strength than pipe cast in sand molds, the ratio being approximately 15 to 23 lb. per ft. in favor of the centrifugally cast pipe.

Stokes Castings, Ltd., developed another ingenious method of rapidly chilling the cast iron for making piston rings and liners for aluminum cylinders of airplane engines. This concern uses a mold composed of a cast-iron liner with a heavy aluminum jacket, the selection of aluminum being apparently due to the fact that it has a specific heat more than four times that of cast iron and also a higher coefficient of radiation.

Steel Pipe and Centrifugal Casting

The field of national importance which is apt to be profoundly affected by the development of centrifugal casting is that of steel pipe, whether welded or seamless.

In the last 10 years or so there has been a remarkable extension in the applications of pipe. It is now used as a starting point in the production of a great many types of mechanical elements, such as shafts and columns. While similar members made of bar stock are usually produced in alloy steels, such as nickel, chromium-nickel, chromium-nickel-vanadium and tungsten, the same members when made of piping are of plain carbon steel. The reason for this is that piping is available only in simple steels. Although alloy steel tubing can be produced by the Mannesman process in a more or less experimental manner, and in fact has been produced on a comparatively small scale by the National Tube Co. in this country and Accles, Pollock & Co. in England, it has not yet really become a commercial product, and has seldom been specified by designing engineers. The initial difficulty in the production of this tubing lies in the piercing process. But hollow billets can be easily produced by centrifugal casting at a cost which compares not unfavorably with that of piercing, and the subsequent drawing from a hollow billet is easier than from a pierced billet, since the former is made of metal which has not been strained beyond its elastic limit.

A still more important future development will be centrifugally cast pipe in sizes from 6 in. up. While such sizes can and actually have been made in seamless tube, the machinery and processes employed for these sizes are so expensive as to make it impossible to compete with welded pipe except in very special instances. Because of this, welded pipe from about 6 in. up, and riveted pipe in still larger sizes, is practically standard. Casting in a hot spinning mold permits the production of pipe in all sizes at a cost estimated to be in the neighborhood of $40 per ton for standard thicknesses, and down to $35 or possibly less for extra strong and double extra strong. That seamless pipe at this price is preferable to welded pipe for the majority of applications need hardly be proved. If it is remembered that the cost of a plant per ton of produce to make centrifugally cast pipe is very much lower than that of either seamless or welded pipe, it will be clear what effect the new process may have on an industry now producing close to 3½ million tons of steel goods.

New York City.

Prices of Portland Cement in 1921

Preliminary estimates made by the United States Geological Survey from reports of representative producers of portland cement show that the average factory price per barrel of portland cement, excluding cost of container, in the United States in 1921 was approximately $1.87. The prices by districts were as follows:

District	Average Factory Price per Bbl.
Eastern Pennsylvania and New Jersey	$1.72
New York	1.90
Michigan and northeastern Indiana	1.85
Illinois and remainder of Indiana	1.68
Western Pennsylvania and Ohio	1.73
Maryland, Kentucky, Virginia and West Virginia	1.83
Alabama, Tennessee and Georgia	1.94
Iowa, Minnesota and Missouri	1.77
Kansas, Nebraska, Oklahoma and Texas	2.15
Colorado and Utah	2.33
California	2.35
Washington, Montana and Oregon	2.51

New High Explosive Reported

A new high explosive called brazilite is reported to have been discovered in Brazil. In experiments this explosive resisted without deflagration all mechanical and chemical tests. Assistant Trade Commissioner Bernard H. Noll in the Feb. 6, 1922, issue of *Commerce Reports* states that it is claimed that the explosive does not give off gases prejudicial to the operator. During the experiments 5,650 g. was placed in a bored hole 4 m. 65 cm. in depth, and this charge, when detonated, displaced 200 cu.m. of granite.

The German and American Synthetic-Ammonia Plants*—III

Description of Processes and Apparatus Used at Oppau, Germany, and Sheffield, Ala., for the Removal of Carbon Dioxide and Carbon Monoxide and the Additional Purification of the Gases Required for the Ammonia Synthesis

By R. S. TOUR

THE first undesirable constituent to be removed from the converted gas is the carbon dioxide, which is eliminated by water scrubbing of the gas under pressure. The pressure used at Oppau is but 25 atmospheres for the water scrubbing, although 200 atmospheres is the pressure used throughout the rest of the process. The compression is accomplished by 12 five-stage compressors (3-9-25-70-200 atmos.). After the third stage the gas is withdrawn and scrubbed, and then returned to the fourth and fifth stages. The compressors require about 1,000 hp. each, and are separately driven by direct-connected producer-gas engines. The compressors are of standard design with equal capacities in all stages, but since water scrubbing after the third stage removes about 35 per cent of the gas (CO_2 and some H_2 and N_2) there are provided 5 additional three-stage (25 atmos.) compressors to handle the larger capacity necessary in the power stages before water scrubbing.

Carbon Dioxide Removal at Oppau

There are 12 water-scrubbing towers, 4 ft. in outside diameter and 40 ft. tall, made in two 20-ft. sections, bolted together in the middle. All operate in parallel, taking compressed gas from a manifold fed by the 17 compressors previously described. The gas passes up through the tower packing, consisting of Raschig stoneware rings (3 in. by 3 in.) while water flows downward through the packing to a reservoir at the base of the tower. The exit gas from each scrubber passes through a mist trap or catch-pot before passing on to the fourth stage of the 12 high-pressure compressors. The mist trap is bottle-shaped, 5 or 6 ft. long, with the gas inlet tube extending some distance down into the bottle. (See Fig. 6.)

At normal capacity, about 3,000,000 cubic feet per day of scrubbing water is pumped to the 12 towers by 6 centrifugal pumps direct connected to motors (180 kw., 1,480 r.p.m.). On the same shaft is connected a Pelton-type water wheel through which the exit water from the towers discharges and returns about 60 per cent of the input water; the motors furnish the difference. Each pump and water-wheel set serves two towers, although there is a manifold cross-connecting all sets. The water feed to the Pelton wheel is controlled manually with the aid of a sight gage which indicates the level of water in the tower. Automatic float chambers for maintaining the proper water level and rate of discharge have recently been developed. The carbon-dioxide gas released in the water wheels passes to a holder for use in the ammonia utilization processes.

The gases liberated from the discharge water represent nearly all of the carbon dioxide in the original gas; the scrubbed gas carries less than one per cent. All of the hydrogen sulphide and similar constituents are also removed. The solubility of the other gases is not negligible and experience at Oppau indicates that 7 to 8 volumes of hydrogen and nitrogen are dissolved while removing the 28 to 29 volumes of carbon dioxide. This absorption of hydrogen and nitrogen is about twice that called for by the available data on relative solubilities, but is in accordance with experience at Sheffield. It is interesting to note that the loss of hydrogen and nitrogen in the water is rather independent of the pressure at which the scrubbing is done, since the ratio of solubilities of the gases is not greatly affected by pressure.

Carbon-Dioxide Removal at Sheffield

Carbon dioxide was absorbed at Sheffield at 100 atmospheres pressure, which was the pressure maintained throughout the rest of the process. The compression was accomplished in the operating unit by one (and one spare) 4-stage compressor (4-12-35-100 atmos.) with 700 cu.ft. per minute low pressure displacement. After allowing for water vapor in the gas, normal gas losses in scrubbing and purification, later "purge" of gas in the circulating system, and unavoidable but expected leakage, this displacement has a capacity of but 5 tons of ammonia per day. The compressors were belt driven by 300 hp. motors and operated very satisfactorily.

The original plan and installation was for water scrubbing the gas in three stages, the gas passing up through each of the three towers consecutively while fresh water was pumped to the top of each tower, fed downward through the packing, and was discharged into a common manifold. Such an arrangement for 3-stage scrubbing is fundamentally inefficient. It is evident that the water in the first tower will dissolve

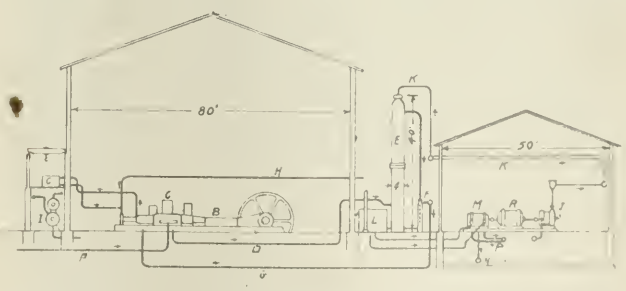


FIG. 6. COMPRESSORS AND WATER SCRUBBER AT OPPAU

A—Compressor intake.
B—5-stage compressor.
C—Intercoolers.
D—Compressor exit 3rd stage.
E—Water scrubbers.
F—Mist trap.
G—Return of gas to 4th stage.
H—Gas exit 5th stage.
I—Boilers on gas engine exhaust.
J—Centrifugal pump.
K—Water inlet to scrubbers.
L—Reservoir on water exit.
M—Pelton wheel power recovery.
N—Water discharge from Pelton.
P—Released CO_2 exit.
R—Motor for pumps.

*For Parts I and II see CHEMICAL & METALLURGICAL ENGINEERING, vol. 26, Nos. 6 and 7, pp. 245 and 307, Feb. 8 and 15, 1922.

carbon dioxide with a maximum solubility corresponding to the initial partial pressure. The unit absorption capacity of the water in the second tower will then be decreased due to the decreased partial pressure of carbon dioxide and finally in the third tower the solubility coefficient will be very low. In other words, at a given total pressure the quantity of water necessary to dissolve a given weight of carbon dioxide increases with any decrease in the percentage of carbon dioxide. Thus, if instead of absorbing the carbon dioxide in three stages, it were all absorbed in one tower of sufficient capacity, all of the water would be used under optimum conditions. The latter operation may require but half the water of the former, and in addition will proportionately decrease the loss of the valuable gases by solution in this water. The attempted operation at Sheffield also involved many mechanical difficulties in the control of the parallel water supply and discharge from each of the towers. After two months of experimentation two of the towers were superimposed, making one tower 2 ft. in inside diameter and 30 ft. high. One-stage scrubbing in this tower led to very satisfactory results, leaving less than one-tenth of 1 per cent of carbon dioxide in the gas. The exit gas passed through a catch pot to separate suspended water before passing to the next step of the process. (See Fig. 7.)

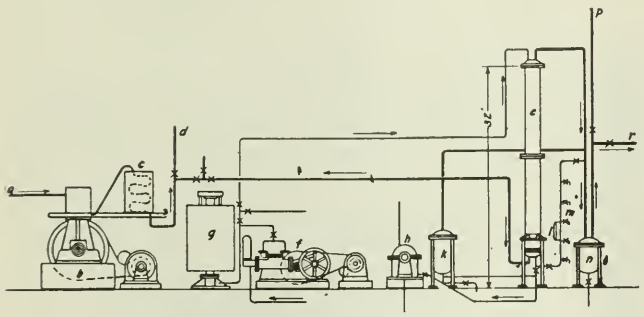


FIG. 7. COMPRESSORS AND WATER SCRUBBER AT SHEFFIELD

a—Compressor intake.
b—4-stage compressor.
c—Cooler.
d—Gas vent from system.
e—Water-scrubber tower.
f—Hydraulic pumps.
g—Accumulator.
h—Pelton wheel.
k—Float chamber.
l—Klinger gages.
m—Tell-tales.
n—Catch pot.
p—Gas vent from system.
r—Gas exit to caustic system.

The packing in the towers is of prime importance for efficient scrubbing, since it is essential that it affords much contact surface, causes turbulent flow of the gas, does not pack or mesh together to cause channeling of the fluids, and, finally, is resistant physically and chemically to the action of pressure and corrosion. At Sheffield, spiral tile were first tried, then pipe nipples, large hard pebbles, and special coke, but these were all found unsatisfactory. Finally small castings of special, though simple shape, were developed and proved successful.

The water was fed to the tower by one (and one spare) reciprocating motor-driven pump of 20 cu.ft. per minute displacement. The water discharge from the tower was through a Pelton water wheel driving a generator which fed into the power line. The water wheel operated on water at 1,500 lb. pressure and carrying about 20 volumes of dissolved gas. It was the source, therefore of much trouble; at its best it returned but 25 per cent of the power in the water. The carbon dioxide released was discharged to the roof, and the water passed to the sewer. No utilization of the carbon dioxide was considered.

The question as to what pressure should be used for water scrubbing is one to be decided according to the conditions at the plant concerned. The quantity of water handled, of course, decreases with increase of pressure, since the solubility of carbon dioxide increases. The power required to pump the water is, however, not much affected, since as the quantity decreases its pressure head increases. Power recovery from the discharge water is much improved at the lower pressures, the main difficulty at very high pressure being due to the high nozzle velocities and the large quantities of gas expanding out of solution in the nozzle. Further, all the power required to compress the carbon dioxide to the scrubber pressure is a loss which is reduced by decreased pressure. High pressure scrubbing decreases the size of the apparatus, since the volumes of gas and water are decreased proportionately while the velocity of absorption is increased. The advantage of smaller apparatus is, however, somewhat offset by the necessary increased strength of the vessels and joints. These considerations in general point to a comparatively low scrubbing pressure (i.e., 200 to 500 lb. per sq.in.).

Carbon-Monoxide Removal at Oppau

As previously stated, the exit gas from the 12 water scrubbers returns to the 12 high-pressure gas compressors and is compressed to 200 atmospheres. The balance of the process beyond this point operates at this pressure. The next step consists of scrubbing the gas with a copper solution; the gas passes through scrubbers similar in operation to the water scrubbers, but using ammoniacal cuprous formate solution (containing perhaps some carbonate) at ordinary temperatures as the dissolving medium. Refrigeration of the solution and absorption of the carbon monoxide at low temperatures has apparently been tried at Oppau and abandoned. There are 15 towers, arranged in two sets (of 7 and 8 each), and situated in one row along the outside of the compressor building. (See Fig. 8.) Any tower can be cut out and it is probable that one item in each set is a spare. The towers are steel forgings about 40 ft. high and 1½ ft. in inside diameter, with walls 5 in. thick. They are heterogenously packed with iron Raschig rings (1 by 2 in. in diameter). A mist trap, similar in construction to that used in the water scrubbers, is employed at the exit of each tower.

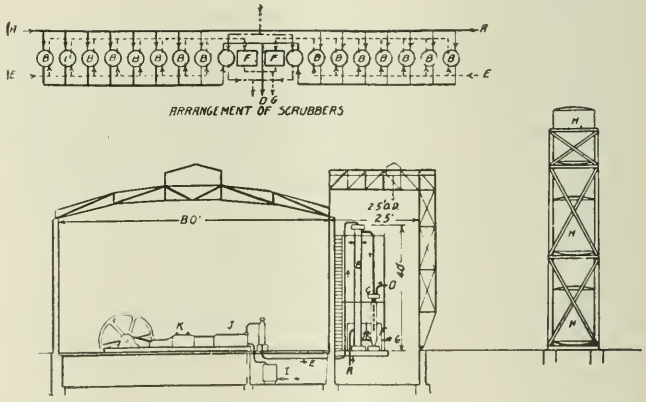


FIG. 8. COPPER SOLUTION SCRUBBERS AND PUMPS AT OPPAU

A—Gas inlet to scrubber.
B—Scrubbers for Cu solution. (See arrangement above.)
C—Mist trap.
D—Purified gas exit.
E—Cu solution exit from pump.
F—Pressure release tanks.
G—Cu solution to regenerators.
H—Regenerating tanks.
I—Cu solution inlet to pumps.
J—Cu solution pumps.
K—Steam engine cylinders.

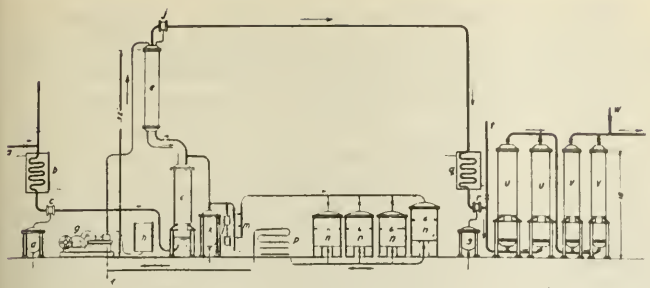


FIG. 9. COPPER SOLUTION SCRUBBERS AND DRIERS AT SHEFFIELD

a—Gas inlet from caustic system.
b—Cooler.
c—Separator.
d—Receiver.
e—Copper scrubbers.
f—Copper solution intake to pumps.
g—Copper solution pumps.
h—Accumulator.
j—Separator.
k—Float chamber.
l—Klinger gages.
m—Tell-tales.
n—Regenerating and storage tanks.
p—Cooling coils for copper solution.
q—Cooler.
r—Separator.
s—Receiver.
t—Gas vent from system.
u—Driers.
v—Purifiers.
w—Gas vent from system.
x—Gas exit to circulating system.

Control of the Copper-Solution Scrubbers

All of the towers operate in parallel, the flow being manually controlled with the aid of sight gages. The gas inlets and exits of the scrubbers are cross-connected by a manifold and the operating valves are controlled from the inside of the building adjoining, the stems of the valves extending through the walls. There are friction orifices at the entrance of each tower for measuring the flow of gas, and the pressure differences are observed by means of a pressure balance of special construction. The device consists of a mercury U-tube of high pressure pipe, bent to a semicircle. This circle is suspended at its center on a knife edge with pressure connections of spiral flexible metal tubing leading from the center. A tendency to change the level of the mercury swings the U-tube and an adjustable counterweight about the knife edge. A pointer attached to the apparatus operates on a calibrated scale or a recording device.

The cuprous formate solution is pumped into the top of the scrubbers by 15 tandem-steam-driven pumps cross-connected in pairs (two pumps per flywheel). The solution passes from the bottom of the scrubbers to pressure release vessels, of which there are two, one for each set of towers. The spent solution, after release of the pressure, passes on to a large regenerating system where its carbon monoxide is removed by heating the solution under vacuum in regenerating vats, which are 20 ft. high and 16 ft. in diameter. The composition of the solution is readjusted before it is again used. The effluent gases from the generating system contain perhaps 50 per cent of carbon monoxide, the remainder being largely nitrogen, hydrogen, and ammonia. This mixture during the war was purified by additional ammoniacal copper solution and then piped to Ludwigshafen for the manufacture of phosgene, which was one of the most important of the poison gases.

Scrubbing the gas with the ammoniacal cuprous solution removes, by reaction with the reduced copper, any free oxygen that may be present; by combination with the free ammonia it removes the residual carbon dioxide as well as traces of other acidic gases that may have passed through the water scrubbers; and it absorbs nearly all of the 2 per cent of carbon monoxide in the gas. In normal operation about 35,000 cu.ft. per day of copper solution are passed through the towers, removing the carbon monoxide of the gas down to a few hundredths of one per cent. There is dissolved perhaps one per cent of the nitrogen and the hydrogen, which is liberated with the carbon monoxide on the regeneration of the solution. The absorption capacity of the solution for carbon monoxide is about 20 cu.ft. (60 deg. F. 30 in. Hg) per cu.ft. of solution, and regular operation approximates full saturation. There was, therefore, available at Oppau about 650,000 cu.ft. of carbon monoxide per day.

The question naturally arises why the copper scrubbing should be done at 200 instead of 25 atmospheres pressure. The mechanical construction would certainly be simpler for the latter. This case is different from that of the water scrubber. The power loss due to dissolved gas is slight and the energy requirement for the solution is small, so no attempt is made to recover the power. Further, the completeness and efficiency of purification is greatly improved by pressure and this is of paramount importance here. It must be remembered that the manufacturing and regenerating cost of the copper solution makes it desirable to use it in minimum quantities.

Carbon-Monoxide Removal at Sheffield

The original plan at Sheffield was to remove most of the carbon monoxide by scrubbing with hot concentrated caustic solution (according to the reaction: $NaOH + CO = NaCOOH$) preliminary to the scrubbing with the cuprous solution. The equipment for hot-caustic scrubbing was necessarily very elaborate. A gas-fired tubular heater was installed for heating the gas before it came in contact with the hot caustic. The hot gas passed on to the "lift line," where, acting as an air-lift pump, it carried hot-caustic solution to the top of the scrubber down which the gas and caustic passed over cast-iron packing. The scrubber tower was kept hot by a hot-air jacket supplied by a special gas-fired furnace. The liquid and gas, descending to the bottom of the scrubber, separated in a caustic-solution reservoir; the gas passed out through water-cooled coils for condensing the moisture, which drained back to the caustic reservoir. The solution in the reservoir returned by gravity to the inlet of the lift line to repeat its cycle, but on the way passed through a gas-fired tubular furnace for reheating. For continuous operation partly spent solution was to be drawn from the reservoir, and fresh solution was to feed into the system through still another gas-fired furnace.

Since the hot-caustic scrubbing was finally abandoned it will not be necessary to discuss the principles involved. The intermittent trial runs proved that 75 per cent of the carbon monoxide could be removed by hot caustic. Cuprous-scrubbing is still required for the residual carbon monoxide, and the only net saving by hot caustic is the 75 per cent decrease in the circulation quantity of copper solution. It is doubtful whether hot-caustic scrubbing is economical even if its mechanical difficulties were overcome. The difficulties with the installation at Sheffield finally proved themselves insurmountable and after three months of untiring attempts, hot-caustic scrubbing was abandoned and the carbon monoxide allowed to pass on to the cuprous system for entire removal there. The caustic circulating and lift system, however, remained in service and although a cold solution was used it served to remove residual carbon dioxide, hydrogen sulphide, etc., after the water scrubbers.

Sheffield used cuprous ammonium carbonate instead of the formate for the absorption of carbon monoxide. There seems to be very little difference between the two as to absorptive power for carbon monoxide, but there is considerable advantage in using the formate when stability of the solution is taken into consideration. The carbonate as used at Sheffield gave much trouble in preparation, precipitated metallic copper while in use, broke down considerably on regeneration, and in general proved unsatisfactory.

Control of Cuprous Scrubbing at Sheffield

The original installation for cuprous scrubbing in Unit No. 1 consisted of one tower 2 ft. in inside diameter and 15 ft. tall. The solution was supplied to the top of the tower by a small piston pump drawing from the storage vats and feeding through a "reducing chamber" filled with metallic copper in order to make sure that all the copper in the solution was in a reduced state. It was soon found that the solution required no reduction in operation, the carbon monoxide in solution acting as a reducing agent on regeneration even after the solution had picked up considerable quantities of oxygen during scrubbing. Further, it was found that one tower afforded insufficient scrubbing and two were used, these being placed one above the other, though not directly superposed and so piped together as to operate as one long tower. (See Fig. 9.) The building and location of equipment did not permit setting up a single long tower. The gas passed upward through the towers and through a separator and catch-pot to entrap suspended liquid. The solution passed down the towers and out at the bottom, the discharge being controlled manually with the aid of sight gages, showing the level of liquid in the bottom of the tower. Automatic float chambers installed at Sheffield for controlling the discharge failed to function properly and no alternative from manual control was possible. In the redesign of the plant, an electrical device has been developed which tests indicate should operate very satisfactorily for the automatic control of the various liquid discharges throughout the process.

The copper solution was discharged directly through a line into the regenerating and storage tanks, where it was heated to 70 deg. C. at atmospheric pressure by steam coils and allowed to cool by radiation; no heat interchanger system was installed. Great care was taken in regeneration to avoid contamination of the solution by oxygen of the air. Heating this solution at atmospheric pressure was very destructive and required continuous readjustment of composition (especially the addition of ammonia).

Effect of Refrigeration

In view of the fact that refrigration of the gas for removal of moisture was to follow the copper system at Sheffield, a beneficial change was made during operation to bring part of the refrigeration into effect together with the copper scrubbing. The gas before entering the copper scrubber passed through coils cooled by refrigerated brine. The copper solution on the way to the pumps was also cooled by brine. Although refrigeration does not greatly increase the absorption capacity of the solution at saturation, it does decidedly decrease the carbon monoxide vapor pressure of the solution when it is but partially saturated. Thus, refrigeration does not materially decrease the quantity of solution to be used, but does improve the purity of the gas at the exit of the copper towers where it is in contact with fresh solution.

The gas at Sheffield entered the copper scrubbers with about 4 per cent of carbon monoxide while the exit showed but a few hundredths of one per cent. The methods of analysis for such small concentrations of carbon monoxide in hydrogen were very unsatisfactory and led to considerable uncertainty in operation. The absorption capacity of the solution as used was about 15 cu.ft. of carbon monoxide per cubic foot and 90 per cent saturation was easily obtained (calculated from the quantities of solution used and the volumes of gas scrubbed). The gas entering the scrubbers sometimes contained as much as 0.1 per cent of oxygen which was completely removed by the copper solution and taken care of by reduction during regeneration.

Additional Purification at Oppau

Following the copper scrubbers there are two caustic scrubbers, one in series for each set of parallel copper scrubbing towers. These two towers with mist traps are in the same row and identical in construction with the copper towers. About 3,500 cu.ft. of 30 deg. Bé. solution is circulated per day through the two scrubbers by means of two vertical duplex pumps with 40 hp. motors. It would seem that the caustic scrubber ordinarily aids little in purification but acts as a safety in the line in case the water scrubbers or copper scrubbers do not function properly. Partially spent caustic solution after release of pressure is handled by centrifugal pumps discharging to the final absorption tower of the nitric acid system.

This completes the purification steps in use at the Oppau plant. No precautions are taken to remove moisture, since, as we shall see, the ammonia synthesis system to which the gas passes directly from the caustic scrubbers utilizes water as the scrubbing medium to remove the ammonia from the gas. No steps are taken for removing the very small percentages of carbon monoxide and ammonia that are retained in the gas after leaving the scrubbers.

Additional Purification at Sheffield

It was necessary to dessicate the gas thoroughly at Sheffield in order to protect the particular type of ammonia catalyst selected for use there. This was accomplished by refrigeration followed by soda lime drying. For the former the gas passed through two sets of coils each submerged in a bath of refrigerated brine circulated by a small pump from an ammonia refrigerating system. In later operation, as previously noted, one of the brine coolers was reconnected to precede the copper system. The brine coolers worked very satisfactorily, the only care necessary being to avoid too low a temperature which might freeze the condensed moisture within the coils. The gas passed from the coolers through separators and then upwards through a tower, 15 ft. high and 2 ft. in inside diameter, filled with coarse soda lime. There were two such towers, one being a spare to be repacked while the other was in use.

A tower filled with a special purification material developed as a specific protection against poisons especially dangerous to the catalyst, followed the soda-lime towers. This completed the purification at Sheffield and the gas passed directly to the circulating system for ammonia synthesis.

The fourth installment of this article, in which the actual ammonia synthesis is described, will be published in a subsequent issue.

Study of Gas From Destructive Distillation of a Mixture of Water-Gas Tar and Coal*

By Ralph L. Brown

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THE chemical properties of the unsaturated members of the aliphatic series of hydrocarbons are such as to render them ready starting points or basic materials for the synthesis of hundreds of important organic chemicals. The tremendous quantities of these unsaturated compounds that are produced daily in the various coal-carbonization and oil-refining processes and the fact that at present they have little value other than for fuel render a survey of the identity and extent of occurrence of these compounds important from the viewpoint of economic utilization and conservation of our natural resources. The increased need of liquid fuel and the relatively early exhaustion of petroleum resources will eventually require every utilization of liquid fuel products obtainable directly or indirectly from coal. Accordingly the Bureau of Mines has taken advantage of an opportunity[1] for making an examination of the gaseous unsaturated hydrocarbons found in the gas obtained when a mixture of water-gas tar and coal[2] is distilled in a gas-making retort. The results obtained are set forth briefly in the subsequent paragraphs.

Method of Procedure

The method[3] employed in general was to collect the unsaturated compounds in the form of their dibromide derivatives at the plant and to isolate the individual members of the mixture in the laboratory. During the collection the gas was drawn from the system after the tar and ammonia removal had been effected. It was then led in turn through NaOH solution and over solid NaOH for the removal of H_2S, through a large cartridge of activated gas-mask charcoal to remove oils and vapors, through a meter for rate and volume measurements and finally through a train for the absorption of unsaturated compounds. The train consisted of a series of three bottles containing a layer of bromine covered by a little water. Three such trains were used in parallel and were kept in a bath whose temperature was maintained at approximately 5 deg. C. Full cognizance was taken of the work of Read and Williams,[4] in which it was reported that when ethylene was passed into bromine water, approximately one-half the bromine, and consequently a proportional quantity of the ethylene absorbed, go to form the bromhydrin, while less than the remaining one-half forms ethylene dibromide. It has, however, been found experimentally as indicated by the theory that if the entering gas first comes into contact with the bromine as in bubbling through it, the amount of bromhydrin formed is negligible for the purpose in hand. The possibility of bromhydrin formation may be also avoided by omitting the water from the first bottle containing bromine. Most of the absorption of the unsaturated compounds occurs in the first bottle.

The total volume of gas passed was 40 cu.ft., and the average rate of flow through the apparatus was 7.2 liters per hour. The crude bromides produced and collected were washed with Na_2CO_3 solution and water and dried with $CaCl_2$.

Fractionation

A quantity of these crude bromine derivatives was fractionated under diminished pressure in an atmosphere of nitrogen. The distillation flask was heated by immersion in a liquid temperature bath, and the receiver was immersed in a freezing mixture. There was obtained, from 543 g. of crude material, three portions of the following characteristics:

Portion I—430 g., equivalent to 79 per cent, boiling below 60 deg. at 12 mm.

Portion II—14.5 g., or 2.7 per cent, boiling between 60 deg. at 12 mm. and 125 deg. at 35 mm. The evolution of HBr due to decomposition with consequent rise of pressure was evident and the distillation was stopped.

Portion III—94 g., or 17 per cent, of black tarry residue.

The fractionation of portion I after being thoroughly dried was first begun at atmospheric pressure, but evidences of decomposition appeared and it was continued under diminished pressure. The crude fractions corresponding roughly to the dibromides of ethylene, propylene and combined homologs were then fractionated in order at atmospheric pressure, using an 8-in. column. The final fractions were (*a*) 15 g. of boiling range 79 to 83 deg.; (*b*) 228 g. of boiling range 125 to 135 deg.; (*c*) 96.5 g. of boiling range 135 to 145 deg.; (*d*) 25.0 g. of boiling range 145 to 165 deg.; (*e*) 14.6 g. of boiling range 165 to 180 deg., and (*f*) a solid residue of 10.5 g., the loss of 40.4 g. of substance.

Physical Properties of Fractions

These fractions were then examined as to their physical properties. Fraction *a* boiling between 79 and 83 deg. was found to have at 20 deg. a specific gravity of 0.8858 (pure benzene $D\ 20/4 = 0.8799$), to contain only traces of bromine and to possess the characteristic odor of benzene. This fraction was therefore considered as benzene.

TABLE I

Material	Boiling Point, Deg. C.	Sp. Gr. at 20 Deg. C.	Bromine in Per Cent	Carbon in Per Cent	Hydrogen in Per Cent	Total
Ethylene dibromide....	131	2.178	85.07	12.78	2.16	100.11
Fraction *b*.....	125–135	1.982	81.10	16.70	2.71	100.5
Propylene dibromide...	141.6	1.933	79.17	17.84	2.99	100.0
Fraction *c*.....	135–145	1.942	79.40	17.83	2.89	100.1
Butylene dibromides...	148–166–158	1.79-1.82	74.03	22.24	3.73	100.0
Fraction *d*.....	145–165	1.760	71.77	24.76	3.61	100.14
Amylene dibromides...	170–190	1.60-1.70	69.51	.....	....	.....
Fraction *e*.....	165–180	1.629	63.3	.....	....	.....

The next four fractions—namely, *b*, *c*, *d* and *e*—were examined by determining the specific gravity, analyzing for bromine,[5] carbon and hydrogen. The results of these determinations are given in Table I, in which are placed,

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*Report of Investigations, U. S. Bureau of Mines.

[1]The Trent Process Corporation, Washington, D. C., was at that time carrying on, at the Georgetown Gas Works, distillations of "amalgams" prepared from various coals and oils by the Trent process for cleaning coals, and it was through the courtesy of the officials of that organization that the collection of the material for this examination was made possible.

[2]Kanawha gas coal (70 per cent) and water-gas tar (30 per cent) from the Washington Gas Light plant were used in the "amalgam" distilled at that time.

[3]See Norton and Andrews, *Am. Chem. J.*, vol. 8, p. 1; Zanetti, *J. Ind. Eng. Chem.*, vol. 8, pp. 676 and 679, 474; Sennatt and Slater, *Gas. Journ.*, 1920, p. 695, and others.

[4]*J. Chem. Soc.*, vol. 111, p. 240 (1917). Also Read and Hook, *ibid.*, vol. 117, p. 1214 (1920).

[5]Method of Carius was used.

for purpose of comparison, those same constants for the pure dibromides of ethylene, propylene, butylenes and amylenes.

Discussion of Results

In the case of fraction *b*, a first consideration of the specific gravity and the analyses seemed to indicate that this fraction was badly contaminated with propylene dibromide. However, repeated efforts to eliminate the latter by fractional distillation led to the conclusion that the impurity—material other than ethylene dibromide—must be a compound of lower bromine content and higher carbon and hydrogen content than ethylene dibromide, and yet with a boiling point quite close to that of the latter compound. Assuming the bromine content of this fraction to be present entirely as ethylene dibromide, the improbability of the impurity being a simple hydrocarbon is seen from the total nonconformity of the calculated specific gravity of such a mixture with the measured value of the fraction. A survey of the monobromine derivatives of the aliphatic and aromatic series of hydrocarbons led to the belief that monobrompentane (which has a boiling point 129 deg., D 20/4 = 1.2234, bromine content of 52.9 per cent, carbon content 39.7 per cent and hydrogen content of 7.35 per cent) might be the impurity provided it is formed under the conditions which obtained. Assuming monobrompentane to be the only impurity of consequence, simple algebraic calculations, based on the bromine and carbon content of brompentane and ethylene dibromide on the one hand and the values found by analysis for the fraction *b* on the other, indicated the same relative proportions in which the two compounds could be present. An approximate average of the two values showed 87.5 parts of ethylene dibromide and 12.5 of brompentane, and on that basis the calculated values for the hydrogen content and specific gravity agree with those found for the fraction. The values follow:

	Bromine Per Cent	Carbon Per Cent	Hydrogen Per Cent	D20/4
Calculated	81.05	16.2	2.81	1.984
Found for fraction b	81.10	16.7	2.71	1.982

More positive evidence of the presence and identity of the impurity was sought by causing a quantity of this fraction *b* to react, in one experiment with a zinc-copper couple,[6] and in a second with an Al-Hg "Metallpaar," and[7] the resulting gas and vapor passed through a coil cooled to —10 deg., to remove alcohol and unreacted fraction *b* by condensation, and then through a coil cooled to —70 to —80 and finally into bromine cooled to 5 deg. In a catch bulb on the second coil a small quantity of liquid was obtained to which a little ice water was added and the bulb shaken. An upper layer of oil separated, which, when tested by the Menzies method for determining boiling points of small amounts, boiled from 32 to 35 deg. The ethylene dibromide recovered from the bromine in this experiment was found to be practically pure. Further work on the identification of the impurity under question being impossible through a lack of more of fraction *b*, the latter was considered to be 87.5 per cent of ethylene dibromide and about 12.5 per cent of material which the evidence seems to indicate to be a bromine derivative of pentane.[8]

[6] Gladstone and Tribe, *J. Chem. Soc.*, vol. 45, p. 154 (1884), *Ber.*, vol. 6, pp. 202, 454 and 1153 (1873).
[7] Wislicenus, *J. prakt. chem.*, vol. 54, p. 52 (1896).
[8] The constants and properties of $CH_3CH_2CH_2CBr:CH_2$ would permit it to be considered here in the same proportion. However, the agreement between the calculated specific gravity for such a mixture (1.942) and that found (1.982) is not so close.

In fraction *c*, in view of the conformity of its specific gravity, boiling range and composition with that of propylene dibromide, the fraction was considered to consist practically entirely of that compound.

In fraction *d* it is seen that other material than butylene dibromide (of which there are three isomers theoretically possible) must be present. As in fraction *b*, saturated hydrocarbons may be eliminated and among the monobromine derivatives that might be possible impurities, monobrombenzene and monobromhexane are the most likely. Calculations based on carbon and bromine content showed that approximately ten parts of either compound with 90 parts of butylene dibromide would give a mixture with properties similar to those of fraction *d*. On the other hand, a consideration of the specific gravity of the same two mixtures demands that the greater part of this impurity be monobrombenzene to have the same specific gravity as measured for fraction *d* (calculated 1.764, measured 1.760). In view of the fact that paradibrombenzene was isolated and identified in *e* and in portion II and that fraction *d* amounted to only 25 g. in all, it was considered that fraction *d* consisted of butylene dibromides containing 10 per cent of monobrombenzene.

TABLE II—HYDROCARBONS COLLECTED AS BROMIDE DERIVATIVES (469.5 g.)

		Grams
I.	Benzene	15.0
	Ethylene dibromide	200.0
	Monobrompentane	28.0
	Propylene dibromide	96.5
	Butylene dibromides	22.5
	Monobrombenzene	2.5
	Amylene dibromides	14.5
	Paradibrombenzene	3.0
II.	Paradibrombenzene	3.0
	Liquid dibrombenzenes	12.0
III.	Tetrabrombutane	25.5
	Liquid residue	62.0
	Carbon	6.5
	Total working loss	52.0

In view of the divergence of the constants of the isomeric amylene dibromides and the small total amount of fraction *e*, the latter was taken as an approximate measure of the amylenes and any further unsaturated compounds in the gas.

At the close of the fractionation in vacuo of portion I, there formed, as a sublimate of the residue *f*, monoclinic tablets perfect in form, entirely colorless, melting without recrystallization at 87 deg. From the final combined residue of portion I, paradibrombenzene was obtained and identified by its melting point (88 to 89 deg.) and its bromine content. Three grams was isolated by crystallization at low temperature.

From portion II, obtained in the first distillation, approximately 3 g. more of dibrombenzene was separated by crystallization. The residual mother liquor, 7.6 g., showed on analysis a bromine content of 69.99 per cent, whereas for dibrombenzene the theory demands 67.74 per cent. The specific gravity at 20 deg. was 1.954 and that for ortho- and meta-dibrombenzene is 1.977 and 1.965 respectively (at 18 deg.). This mother liquor was considered to be largely a mixture of dibrombenzene and no further attempts at isolation and identification of the constituents were made.

The residue (portion III) from the original distillation, as previously stated, was a black pitchy mass. The ethereal extract separated a dark liquid amounting to 87.5 g., which, on being well cooled, yielded 25.5 g. of tetrabrombutane (1, 2, 3, 4 derivative) which was identified by its melting point (115 to 116 deg.) and its bromine content. (Theory demands 85.53 per cent;

found, (*a*) 84.43 per cent, (*b*) 85.08 per cent.) The crystals were orthorhombic. No further products were isolated from the 62 g. of mother liquor. The ether extraction residue from III was 6.5 g. of carbon particles of less than micron size and resembling carbon black. They were a product of decomposition during distillation. The presence of the 1, 2, 3, 4 tetrabrombutane undoubtedly indicates the presence of 1–3 butadiene in the gas.

Thus the gas under examination contained in addition to condensable oils largely collected by the charcoal and those gases unaffected by the bromine (CO_2, 1.6 per cent; O_2, 0.5 per cent; CO, 5.3 per cent; H_2, 35.5 per cent; CH_4, 42.5 per cent; N_2, 6.6 per cent) the constituents—forming about 6 per cent of the total gas volume—which are grouped together in Table II in the form and quantity in which they were isolated.

The amounts of the unsaturated hydrocarbons in the gas calculated from the values just given are presented in Table III. In view of the present-day interest in one

TABLE III.

	Per 40 cu.ft. of gas			Per 1,000 cu.ft. of gas		
	Dibromides in Grams	Hydrocarbons In Grams	Theoretical Alcohol Equivalent In Grams	Hydrocarbons In Grams	Hydrocarbons In Cu.Ft. At 25 Deg.	Theoretical Alcohol Equivalent in Gallons
Ethylene	200.0	30.0	49.3	1230	23.10	0.415
Propylene	96.5	20.1	28.8	720	10.34	0.238
Butylene	22.5	5.85	7.7	193	2.25	0.063
Amylenes	14.5	4.42	5.6	139	1.36	0.045
Butadiene	25.5*	3.70	....	.....	.....	.....

*Represents that which was actually isolated as the tetra-brom derivative; the amount present would be larger.

utilization of olefine hydrocarbons from commercial-scale sources of production—namely, the production of their corresponding alcohols—the theoretical equivalents of the unsaturated hydrocarbons are included.

Summary

(1) The unsaturated hydrocarbons of the gas produced by distilling a water-gas tar and coal mixture in a gas retort were collected for study by removing them as their dibromide derivatives.

(2) The identity and approximate amounts of these unsaturated hydrocarbons have been determined.

(3) Most of the compounds contaminating the dibromides of these hydrocarbons have been identified.

Acknowledgment

The writer wishes to acknowledge the valuable suggestions and assistance of A. C. Fieldner, Supervising Chemist, and J. D. Davis, Assistant Supervising Chemist, of the Pittsburgh Station, and the courtesies of the officials of the Trent Process Corporation.

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Nitrogen in Oxyacetylene Welds

Analyses for nitrogen in oxyacetylene weld metal have been made by the Bureau of Standards on samples which are representative of two types of fracture—crystalline and fibrous. On the basis of combined nitrogen, there seems to be no distinction between the crystalline and fibrous weld metal. The limits of combined nitrogen found were approximately one-sixth the limiting values for nitrogen in electric arc deposited metal—that is, 0.015 to 0.027 per cent nitrogen in oxyacetylene welds, as compared with 0.10 to 0.15 per cent in the arc weld.

Graphic Record of Sulphuric-Acid Plant Operation

By E. B. Rupard

AT THE end of the fiscal year or other operating period it is customary to represent the efficiency of a sulphuric-acid plant by the average niter consumption, chamber space, production and other composite figures of the year's run. Although the actual efficiency is indicated, the figures cannot give an idea of the details of plant operation. If those interested in knowing how the yearly averages were obtained wish to follow the plant operation through the year, the daily, or at least weekly, plant records must be reviewed. This would be a tedious task and probably the conclusions would be vague because the average mind is unable to visualize operations from such a mass of data.

By plotting the plant's record from week to week the detailed results for the year are shown at a glance and a very accurate idea is gained of the manner in which the plant was handled. All variations from normal, as well as efficient running, are shown. If the plant is well managed, the niter and yield curves will show even trends, and on the other hand faulty operation will naturally cause wide variation with consequent poor results.

The acid maker should keep a daily record of any conditions at the plant that would affect the results, such as weather, mechanical trouble, change in methods or apparatus, etc., in order to assist in interpreting any variation from normal. If no outside cause is apparent, most likely the fault is with the management. Likewise where consistently efficient running is shown, it may be profitable to refer to the daily log to ascertain the favorable conditions at that time and if possible attempt to reproduce and maintain them. In this way the graph used with the daily record as reference may serve as a guide in operating the plant as well as a descriptive report on results.

Fig. 1 represents a year's run at a plant that evidently was efficiently managed at all times. During the first week after the plant was started, the niter consumption and chamber space were high, but the operation in the next few weeks showed a decided improvement and the plant was soon running smoothly and efficiently. No radical variations in yields or niter are shown and the chamber space was so adjusted to conditions that the maximum production was realized and an economical conversion and niter consumption maintained.

Fig. 2 covers the second year's run at the same plant with practically identical conditions, although evidently not as carefully managed as in the previous year. From January to July the plant exhibited remarkable efficiency, indicating what might be expected with proper conditions and care. The period between September and January showed wide niter variations and the low yields are most likely due to the lack of uniform operation. From June through August is a period of weekly niter variations; the plant was running on comparatively easy and uniform charges and outside conditions were favorable.

Basing judgment solely on the yearly averages of the two runs, the second year seems very nearly as good as the first. Analysis and study of the graphs, however, show that although the plant had the disadvantage of starting up, the first year was really a great deal better than the second. During the second

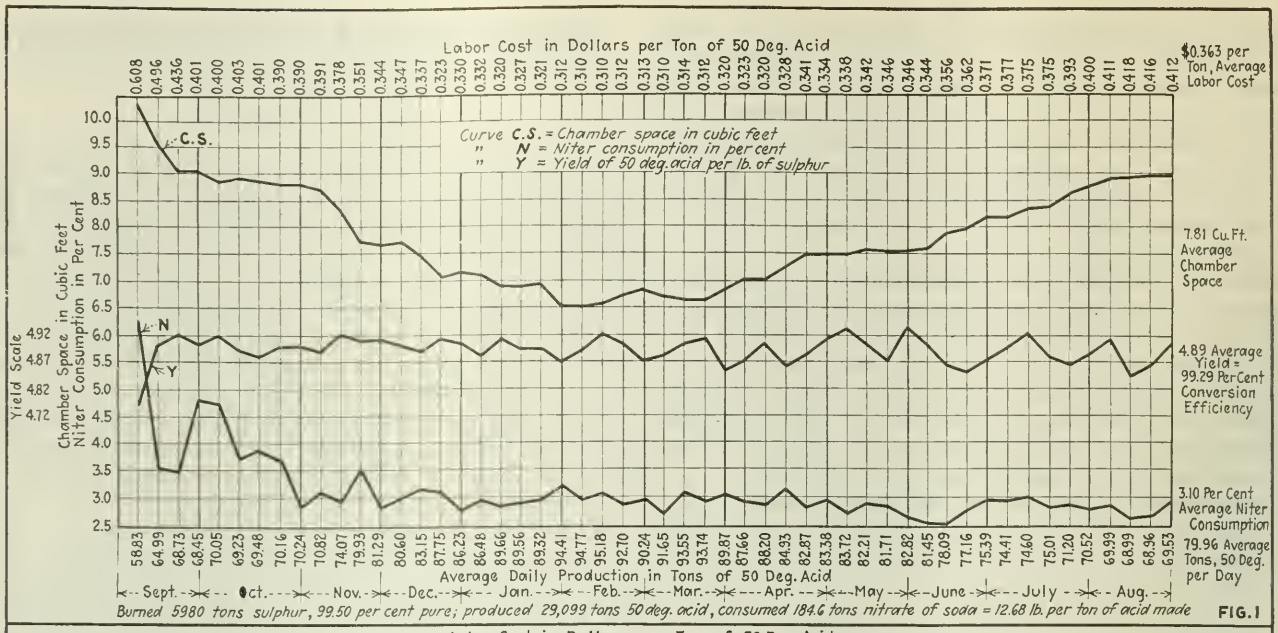
Labor Cost in Dollars per Ton of 50 Deg. Acid
$0.363 per Ton, Average Labor Cost
Curve C.S. = Chamber space in cubic feet
" N = Niter consumption in per cent
" Y = Yield of 50 deg. acid per lb. of sulphur
7.81 Cu. Ft. Average Chamber Space
4.89 Average Yield = 99.29 Per Cent Conversion Efficiency
3.10 Per Cent Average Niter Consumption
79.96 Average Tons, 50 Deg. per Day
Yield Scale
Chamber Space in Cubic Feet
Niter Consumption in Per Cent
Average Daily Production in Tons of 50 Deg. Acid
Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug.
Burned 5980 tons sulphur, 99.50 per cent pure; produced 29,099 tons 50 deg. acid, consumed 184.6 tons nitrate of soda = 12.68 lb. per ton of acid made

FIG. 1

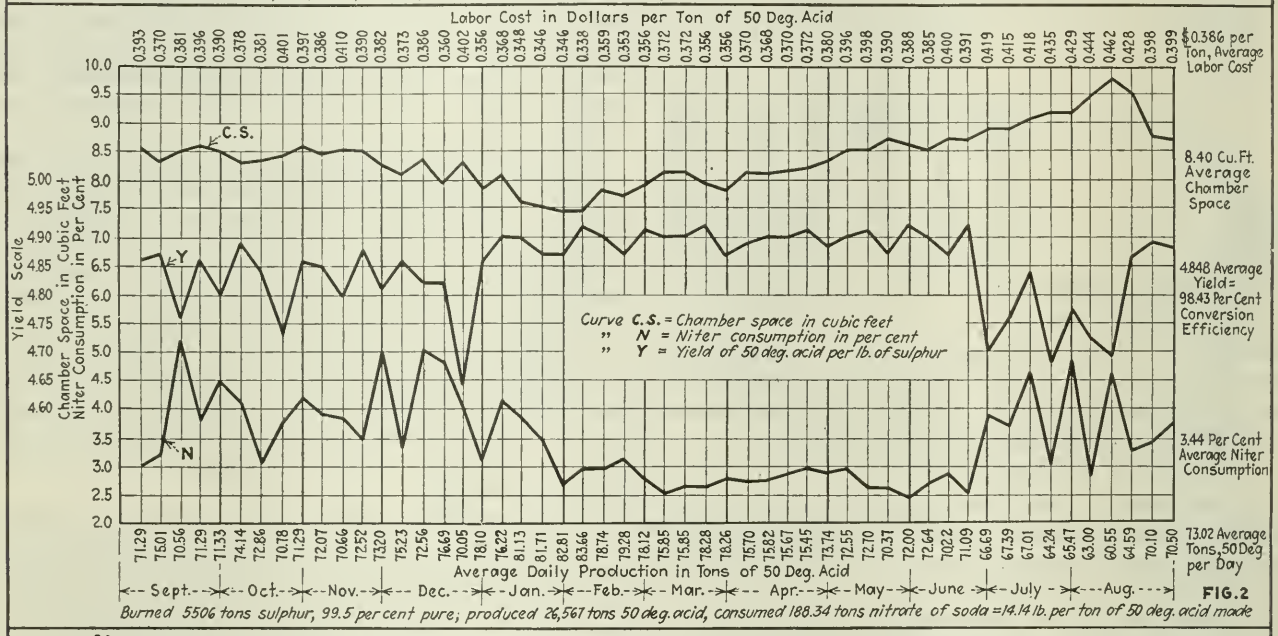
Labor Cost in Dollars per Ton of 50 Deg. Acid
$0.386 per Ton, Average Labor Cost
Curve C.S. = Chamber space in cubic feet
" N = Niter consumption in per cent
" Y = Yield of 50 deg. acid per lb. of sulphur
8.40 Cu. Ft. Average Chamber Space
4.848 Average Yield = 98.43 Per Cent Conversion Efficiency
3.44 Per Cent Average Niter Consumption
73.02 Average Tons, 50 Deg. per Day
Yield Scale
Chamber Space in Cubic Feet
Niter Consumption in Per Cent
Average Daily Production in Tons of 50 Deg. Acid
Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug.
Burned 5506 tons sulphur, 99.5 per cent pure; produced 26,567 tons 50 deg. acid, consumed 188.34 tons nitrate of soda = 14.14 lb. per ton of 50 deg. acid made

FIG. 2

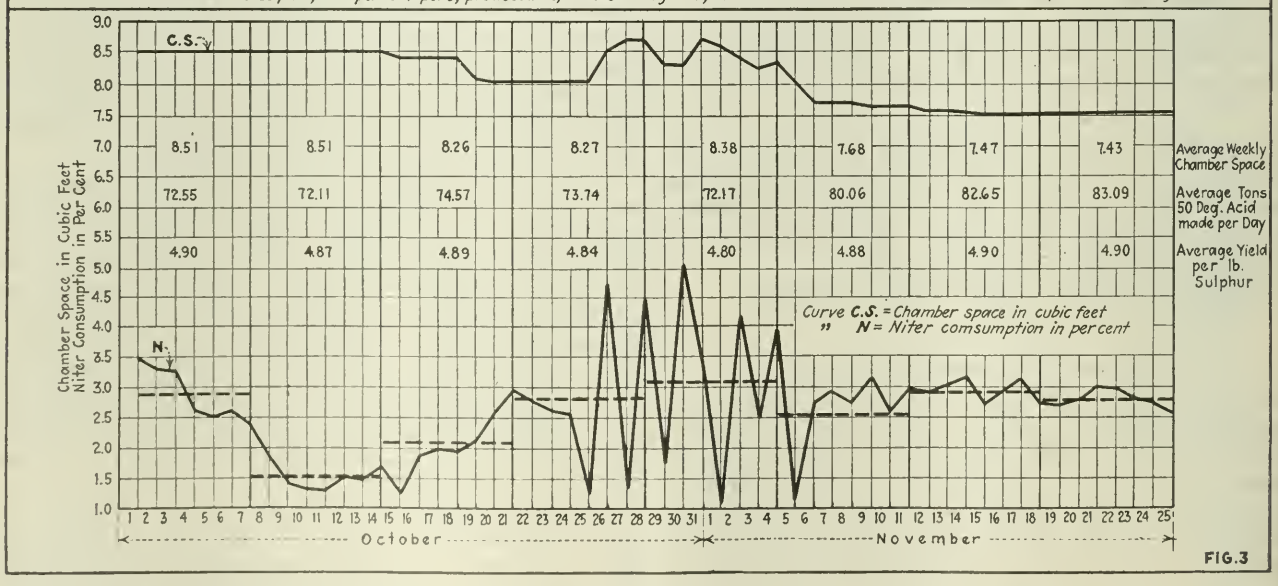
Average Weekly Chamber Space
Average Tons 50 Deg. Acid made per Day
Average Yield per lb. Sulphur
Curve C.S. = Chamber space in cubic feet
" N = Niter consumption in per cent
Chamber Space in Cubic Feet
Niter Consumption in Per Cent
October
November

FIG. 3

FIGS. 1 TO 3

Fig. 1—Weekly operating record for chamber-process sulphuric-acid plant during first year's operation.

Fig. 2—Weekly operating record for same plant during second year.

Fig. 3—Daily operating record for sulphuric-acid plant Oct. 1 to Nov. 25.

year 3.75 tons more of niter was used, manufacturing costs were $0.023 per ton higher (on the same labor rate), and had the yield of acid per pound of sulphur been 4.89, as in the first year, the production of 50 deg. acid the second year would have been 230 tons.

These items would alone amount to considerable, but the greatest saving the first year had over the second was the better use of the chamber space, producing 2,532 tons more of 50 deg. acid than the second year with only the additional cost of 474 tons of sulphur. The graph indicates how advantage was taken of conditions to utilize the chamber space for a greater production.

Fig. 3 is a daily graphic report of operations which may serve as a guide to the acid maker in detecting errors of management and avoiding their repetition by establishing conditions conducive to good running.

In this graph it will be noted that between Oct. 25 and Nov. 7 niter consumption showed the greatest daily variation. Probably in the operator's anxiety for low niter consumption he reduced the supply too much one day and had to "pot" excessively the next. A mean would have been more economical and better results would naturally have been obtained with a consistent, sufficient supply of niter. This condition was evidently found to be the trouble, as a mean seems to have been established and for the following weeks results were uniform.

The daily graphic record would likely call attention to faulty operation of this kind.

Automatic Load Regulator for Motor-Driven Pulp Grinders

By W. H. Artz
Manager Paper Mill Section,
Westinghouse Electric & Manufacturing Co.

IT IS a well-known fact that the load on motor-driven pulp grinders is very fluctuating, unless regulated. The percentage of load variation is greatest where each grinder is driven by an individual motor and usually least where four or more grinders are driven from a single motor, references in these cases being made to the usual type of three- or four-pocket grinders.

Where the magazine type of grinder is used, having only two pockets per stone, the percentage load variation of a single grinder with individual motor is even more severe than in the preceding cases. Even with two magazine grinders driven by a single motor, the load variations, when pockets are put on or taken off, are such as to cause very unsatisfactory operation if an automatic load regulator is not used.

With the best of care and the greatest degree of supervision of the operation of grinders and the filling of the pockets, it is impossible to maintain anything like a uniform load on the grinders. With the class of labor usually employed the load fluctuations generally vary from 25 to 50 per cent above and below the average load, and it is not uncommon to find, where power is being purchased on a peak load basis, that from 25 to 40 per cent more power is being paid for than is actually being used—i.e., power is being paid for on the basis of a peak perhaps 25 to 40 per cent higher than a curve representing the average load. It was largely to correct this condition and to effect other economies that the Westinghouse automatic load regulator for motor-driven pulp grinders was developed. An installation of this regulator is shown in Fig. 1.

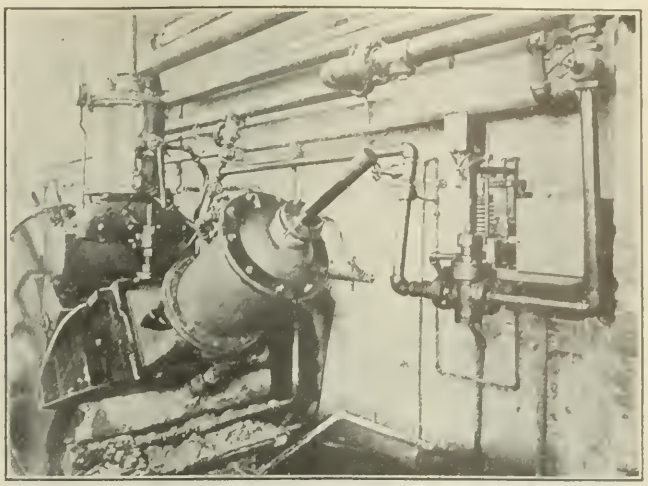

FIG. 1—LOAD REGULATOR ON THREE-POCKET MOTOR-DRIVEN PULP GRINDER AT DEFIANCE PAPER CO., NIAGARA FALLS, N. Y.

With the use of this regulator in connection with each grinder motor, all peaks of any consequence can be prevented, and if ordinary diligence is exercised in keeping the pockets filled, every valley in the load curve, shown in Fig. 2A, can be avoided, thus making practically a uniform straight load curve as the meter chart proves in Fig. 2B, representing constant horsepower input to the grinder motor. This can be accomplished automatically in spite of voltage variations that may take place on the power circuit or change in the power factor setting of the motor itself, and even in spite of the fact that several pockets may be opened at the same time. This precludes all possibility of excess loads and peaks, and assures maximum production and the most efficient and economical use of power.

Description of Apparatus

The Westinghouse automatic load regulator equipment consists of a control panel as illustrated in Fig. 3A, carrying relays, switches and rheostat, the necessary resistance and a motor-operated hydraulic element,

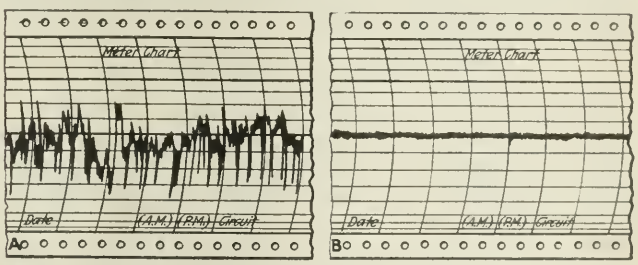

FIG. 2—LOAD CURVE OF PULP GRINDER
A—When not using regulator. *B*—With automatic regulator installed.

shown in Fig. 3B, controlling the water pressure in the pocket cylinders of the grinders being regulated.

The control panel has mounted on it a contact-making watt relay having both current and potential coils; a set of magnetic reversing switches for controlling the direction of rotation of the regulator motor; and a hand rheostat with necessary resistance for determining the load which the grinder motor is to carry.

Two current transformers are used in the grinder motor circuit, the secondaries of the former connecting to the contact-making watt relay. In places where 220-v. alternating current is not available, two small single-phase transformers are provided to furnish poly-

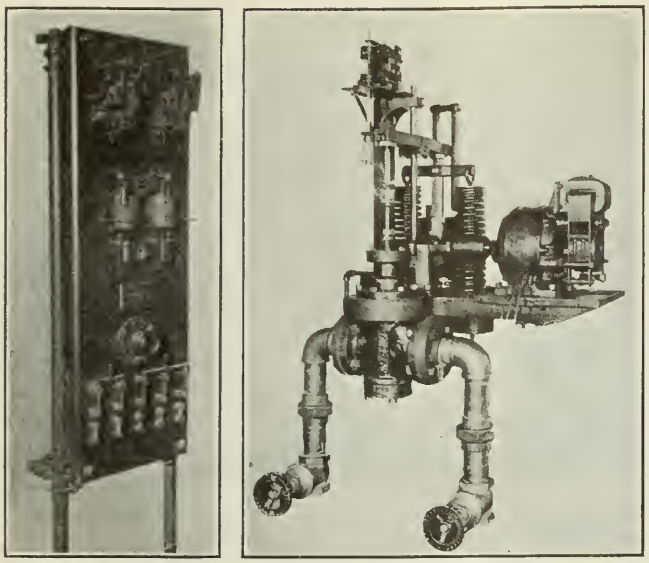

FIG. 3—AUTOMATIC LOAD REGULATOR
A (at left)—Control panel. *B* (at right)—Hydraulic element.

phase current for the regulator motor and for the potential coils of the contact-making watt relay.

The hydraulic element consists of a heavy cylinder type, balanced valve *B* (see Fig. 4) with bleeder element *D*, a small a.c. reversing induction motor *A* with magnetic brake, a moving lever system *L*, a reaction cylinder *M* and a cutout switch *C*. The valve, gears, motor and reaction cylinder are all rigidly mounted in compact form on a common bedplate. The balanced valve *B* controls the hydraulic pressure in the pocket cylinders. Connected directly to the stem of valve *B* is the piston of the bleeder element *D*. The small motor *A* actuated by the watt element raises or lowers the moving lever system *L*, to which is attached the stem of the balanced valve *B*, the piston of the reaction cylinder *M* being attached to the other end of the moving lever *L*. The reaction cylinder *M* is connected to the water-pressure line near the pocket cylinders. The cutout switch *C* limits the travel of the valve and completes the hydraulic element.

Description of Operation

The action of the regulator is as follows:

The sensitive beam of the contact-making watt relay is balanced between two contact points when the grinder motor is carrying the correct load. In case of any decrease in load, such as a pocket taken off for refilling, a change in magnetic pull is exerted on the watt relay and a contact is made, energizing the coil of one of the reversing switches. Thereupon the latter is closed, causing the small motor *A* to rotate in such a direction as to screw upward, through the medium of bevel gears, the vertical rod attached to the lever *L*. The lever *L* fulcrums at the point where it connects with the stem of the reaction cylinder *M*, and the upward movement at the opposite end of the lever increases the opening in the valve *B* and thereby greater water pressure increases the load on the grinder motor to normal or full field. This movement of the small motor *A* takes place very quickly—in fact, in a small fraction of a second—and by it the increase in pressure in the grinding cylinders corrects the load before an appreciable load decrease has occurred.

To prevent hunting, the reaction cylinder *M* is provided. Without the reaction cylinder, the small motor *A* operating through the lever system *L* would open the valve *B* too wide and overload the grinder motor before the watt element would act to stop the small motor *A* or reverse it. The piston in the reaction cylinder *M*, feeling at once the increase in pressure when the valve *B* is being opened, moves upward, which causes the opposite end of the lever *L* connected to the steam of valve *B* to move downward. Counteracting in a measure the movement of motor *A*, as above explained, produces the same effect as stopping the motor *A* before it has overtraveled and permits the lever *L* to assume gradually a position giving a valve opening which keeps the load constant on the grinder motor.

In case of an increase in load, such as a refilled pocket being returned to service, the operations of the regulator are similar to those described above, but in the reverse direction. The watt relay causes the small motor *A* through the lever system *L* to decrease the opening in the valve *B* and reduce the pressure on the pocket cylinders. After the above operation, the tendency is for the stored energy in the hydraulic system to keep the pressure on the pocket cylinders for a considerable time and consequently overload the pulp grinder motor until this pressure is reduced. This condition is overcome by the bleeder valve *D*, which is in the water line between the main valve *B* and the pocket cylinders. When the opening is decreased in the main valve *B*, the bleeder valve *D* opens a greater or lesser

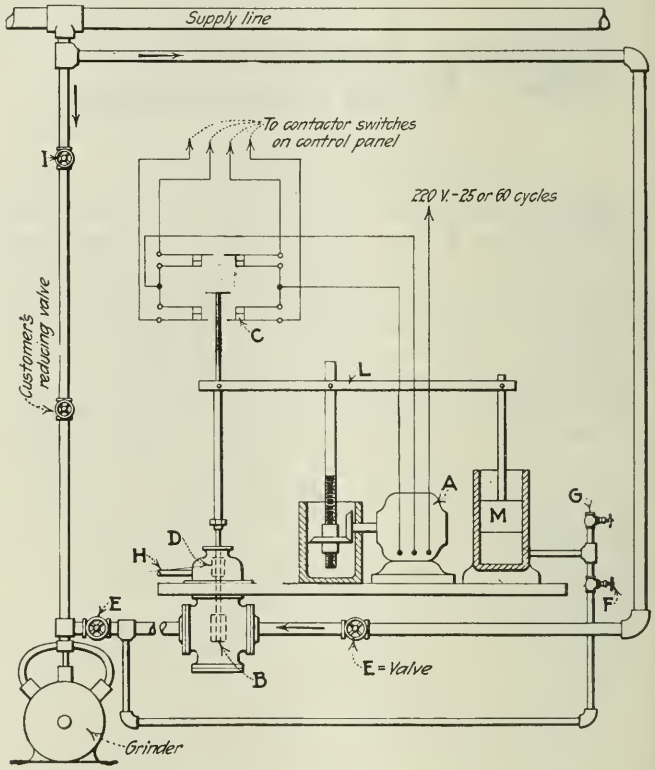

FIG. 4—SCHEMATIC LAYOUT OF HYDRAULIC ELEMENT

degree and relieves the stored pressure at once, thereby eliminating the tendency to overload the grinder motor. Then a further combined action of small motor *A* and the piston in the reaction cylinder *M* restores the valve *B* to the correct position indicated by the load on the grinder motor. A cut-out switch *C* is provided to stop automatically the motor *A* when the travel of the valve *B* has reached its mechanical limit in either direc-

tion—that is, when the valve *B* is wide open or entirely closed.

Advantages

The possibilities and advantages of the automatic load regulator, proved by actual pulp mill continuous operation, may be summarized as follows:

Constant uniform load can be maintained at all times, preventing all peaks and assuring that no more power will have to be paid for than is actually needed.

There will be no valleys in the load curve and maximum production will be obtained, the load being held at a constant uniform value, even though the operator does not keep the pockets filled as he should.

Greater production can be obtained from the motor and grinding equipment than would be possible under any other conditions, on account of the ability to operate the equipment continuously at maximum capacity, without danger of overloading or exceeding the permissible power demand.

The load on the motor can readily be temporarily reduced by turning the hand rheostat, in cases where the power supply is sometimes limited. Such load setting will be automatically maintained until a further change is made.

The regulator prevents the possibility of overloading the motor, which would trip the circuit breaker, shut down the equipment and interrupt production.

The life of the grinder equipment is prolonged by eliminating, by virtue of constant load conditions, the severe strains and wear and tear to every installation having no regulator.

It being a watt regulator—i.e., regulating for constant load rather than for constant current—constant load is maintained without appreciable variation, regardless of line voltage fluctuations or the power factor of the motor. This is of great value as every change in voltage or power factor would affect the load carried by the motor if the regulator were designed to regulate for constant current instead of constant load.

It being of the relay type rather than of the torque motor type, the valve operating motor has ample power under all conditions to give positive action, regardless of friction or foreign matter in the water.

The anti-hunting means, provided on both the electrical and hydraulic elements, give close regulation to any installation consisting of a motor and any number of grinders. It is worthy of note that good regulation can be obtained with a one-grinder equipment which is impossible with other types of regulators, due to the large load change when one of the pockets is cut out of service for refilling or repairs.

New Chemical Companies Organized

During the month of January, 32 new companies were organized with capital of $50,000 or more, to manufacture chemicals, chemical byproducts, drugs, etc., with aggregate capitalization of $37,650,000. This is a large increase over December, when 26 companies were incorporated, with a capital of $3,595,000, and also a decided advance as compared with January, 1921, which registered indicated capital of new companies of $22,295,000.

In the same month 92 new oil and petroleum companies were formed with individual capital of $50,000 and over, with aggregate capitalization of $100,250,000. This is considerably higher than the record for December, 1921, which showed 58 such new companies organized, with total indicated capital of $65,615,000.

Synopsis of Recent Chemical & Metallurgical Literature

Chromium-Molybdenum Steel.—C. N. Dawe, metallurgical engineer for the Studebaker Corporation, presented a paper on "Chromium-Molybdenum Steel Applications From the Consumer's Viewpoint" before the recent meeting of the Society of Automotive Engineers, in which he presented the results of 400 tests made in the laboratory of a large consumer of alloy steels. Over 2,000 tons of molybdenum steels of various analyses have been put through production in the form of rear-axle shafts, transmission gears and shafts, steering knuckles, steering-knuckle pins, ring gears and drive pinions—in fact, all parts for which alloy steel is specified. By a process of elimination it became clear that an analysis showing a carbon content below 0.30 and above 0.23 per cent, with a chromium content of 0.70 to 0.90 per cent and molybdenum 0.30 to 0.40 per cent, gives satisfactory results with water as a quenching medium, there being no cause for concern pertaining to the development of quenching cracks.

"The wide heat-treating range of a given steel is a property upon which great stress always seems to be laid, but in this present day of accurate metallurgical control we do not need a 100 to 200 deg. quenching range. What we as consumers are mostly interested in is to determine the lowest quenching temperature that can be used commercially and still obtain the maximum physical properties. With this in mind, three quenching temperatures ranging from 1,550 to 1,650 deg. F. were used in the case of the chromium-molydenum, chromium-vanadium and chromium steels, while 1,475 to 1,575 deg. F. were used with the chromium-nickel steel used for comparison purposes. Three drawing temperatures (1,000, 1,100 and 1,200 deg. F.) were used for each quenching temperature."

Physical properties obtained, true to expectations, were occasionally variable in all four types of steel, and his published results are therefore the results of very broad averages.

"Generally speaking, in performing tests of the above nature where we desire to note a comparison of the physical properties of certain steels in terms of the elastic limit, ultimate strength, reduction of area and percentage of elongation, sometimes we are confused because of the variations we obtain, and because it is practically impossible, over a large number of test-pieces, to hold any one or two factors constant so as to note the variation in the remaining factors. If we could heat-treat the test-pieces so that the elastic limit would be the same in all, the variation in the three other remaining factors would tell the story." Failing in this, a comparison by merit index[1] was made, which gave a higher figure for chromium-molybdenum steels than for its competitors. In view of the fact that this steel apparently can be produced in unlimited quantities with no danger of shortage of molybdenum, and because it has been produced and sold at a lower price than its closest competitor, chromium-vanadium steel, its adoption has been sanctioned. It forges entirely satisfactorily, with the particular advantage that the scale formed breaks away from the forgings very easily. With proper composition and for sizes within ordinary limits, it cold-shears as readily as the other grades of commercial alloy steels. It responds very readily to the heat-treating operations, the percentage of forgings falling outside of the required Brinell hardness being very small.

"With reference to its machine qualities, no figures can be given. However, we have satisfied ourselves by noting the machinability of the tonnage that has passed through our shops that chromium-molybdenum steel machines at least as well as the best there is. We have not heard of a

[1] $Merit\ Index = \frac{Elongation\ (Elastic\ Limit + Ultimate\ Strength)}{2{,}000\ (100 - Reduction\ in\ Area)}$

failure of any part made of this steel out of the 50,000 cars that have thus far been produced since its adoption."

Since the Studebaker Corporation is a very large user of carbonized parts, and published literature on molybdenum steels contained little such data, a heat of steel containing 0.13 C, 0.40 Mn, 0.61 Cr and 0.35 Mo was case-hardened. This analysis was abandoned for the reason that too high temperatures were required for double heat-treatment. Quenching directly from the carbonizing box and using a single lower heat for hardening did not produce the desired core fracture. Preliminary work on another analysis (0.19 C, 0.54 Mn, 0.70 Cr and 0.37 Mo) was very encouraging, and transmission parts for 5,000 cars were ordered. It was often noted that a test fracture under shock would not show a "tough core," but would have a crystalline or granular appearance, particularly objectionable in parts that are subjected to a straightening operation and in clash gears. In order to obtain better results, the part to be heat-treated had to be subjected to prolonged heating above the critical temperature of the core to bring about the proper condition before quenching and the lower heat for hardening had to be applied as quickly as possible to prevent the core from being subjected to lengthy heating at the lower temperature.

To obtain the best possible results with the case-hardened parts it was necessary, therefore, to quench from the carbonizing box into oil and follow this by the regular double heat-treatment and a final draw at 375 to 400 deg. F., timing each operation as carefully as possible. There are two particular advantages that should be noted, however, in that chromium-molybdenum steel will take on a given case-depth in 10 per cent less time than chromium-nickel steel; also, there will be a resultant average increase of 5 to 7 points scleroscopic hardness.

"Chromium-nickel steel apparently still holds the first place among commercial steels for case-hardening of important parts, but nickel-molybdenum steel (0.13 C, 0.38 Mn, 1.58 Ni, 0.20 Mo) will be a serious contender, principally because of its ability to harden in oil after carbonizing a rolled (not forged) piece. For instance, steering knuckles have always before been water-hardened, necessitating some rejections due to subsequent straightening. However, of one lot of 1,949 nickel-molybdenum pins carbonized and hardened in oil, not one was lost in straightening or because of softness after final grinding."

The Technical Hydrogenation of Hydrocarbon, Nitrobenzene and Coal.—The *Journal of the Society of Chemical Industry* (vol. 40, No. 23, p. 445R, of Dec. 15, 1921) contained an interesting article on the technical hydrogenation of hydrocarbon, nitrobenzene and coal. It leads to the conclusion that the field of hydrogenation has thus far been but little more than scratched and offers at the same time an engaging prospect for research.

The production of cyclohexane from benzene is not of leading technological importance, although the hydrocarbon has been used in the production of synthetic rubber. Naphthalene when purified has been successfully hydrogenated in Germany to tetrahydronaphthalene, and called "Tetralin" by the Gesellschaft mit beschränkter Haftung of that name at Rodleben, near Rosslau. They produce 120 tons daily. They make also decahydronaphthalene by permitting the absorption of hydrogen to continue further, and a mixture of the tetra and deca products is known on the market as "Tetralin Extra." The deca product, being a fully saturated hydrocarbon, is unattacked by sulphuric or sulphurous acid, and may be likened to paraffin hydrocarbons. The "tetralin," on the other hand, has one benzene nucleus not hydrogenated and suggests many derivatives for use in making dyes and fine chemicals. Besides the war-time use of tetralin as a substitute for turpentine its use is indicated as a motor fuel, as an illuminating oil, as an insecticide, as a solvent for rubber, hydrocarbons, fats, dyes, etherial oils, etc., and as a starting point for dyes.

It is proposed to undertake the hydrogenation of cracked petroleum oils, and thus to avoid important losses. Nitrobenzene is reduced under a Badische patent in which a mixture of CO and steam or water gas and steam react with a copper catalyst to produce aniline. Other methods have been proposed in addition, but an interesting feature of the former is the use of copper as originally proposed by Sabatier in the place of nickel, which would certainly produce cyclohexamine. Copper, on the other hand, is unable to induce hydrogenation of the benzene ring, although it readily acts in the reduction of the nitro group. The Badische process may in time replace the standard method of reducing nitrobenzene with iron borings.

The hydrogenation of alkaloids is another field of peculiar interest, in that it has been observed that in certain cases the toxicity of the original alkaloid is materially diminished by the process.

Of immense interest is the hydrogenation of coal, and here it appears that the Germans have made considerable advance, although they do not seem to have reached any striking success as yet. In the Bergius patent (Br. Pat. 4,574, 1914) it is stated that coal is treated in autoclaves at 400 deg. C. and under high pressure of hydrogen. (Berthollet obtained an artificial petroleum by the action of hydriodic acid on coal in sealed tubes.) Fischer and Schrader, in *Brennstoff Chemie* (1921, vol. 2, p. 161) describe the liquefaction of coal by means of sodium formate. Rhenish lignite yields 7 per cent of tar by destructive distillation, but if mixed with four times its weight of sodium formate the yield is 23 to 27 per cent, and greater if the pressure of gaseous decomposition and steam is kept constant. Thus 45 per cent of tar was obtained from a mixture of one part lignite and two parts sodium formate and 48 per cent from a mixture of one part fuel and eight parts of the salt. The increased production is attributed to the influence of nascent hydrogen from the decomposition of the sodium formate. Molecular hydrogen is said to have very little effect. Fischer and Schrader further say (*Brennstoff Chemie*, 1921, vol. 2, p. 257) that the presence of carbon monoxide at increased temperature such as 500 deg. C. and under pressure gives better yields than hydrogen as in the Bergius process, but that it is less successful than when sodium formate is employed.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Production of Ferrozirconium.—Ralph H. McKee, of New York City, patents a method for making ferrozirconium, substantially free of Al, not more than 3 per cent Si and containing 20 to 40 per cent Zr, and 0.5 per cent C, by fusing a mixture of 500 parts granular zircon with 300 parts cast iron, 250 parts CaO and 25 parts fluorspar in a resistance furnace. (1,401,265. Dec. 27, 1921.)

Zirconium Steel.—Ralph H. McKee, of New York City, claims to be able to make zirconium steels by merely adding zirconium oxide or silicate minerals to the molten iron or steel, without fluxes or other reagents. About one-quarter of the metal in the added mineral is reduced and enters the alloy; in this way irons containing as high as 20 per cent Zr may be made. (1,401,266 and 1,401,267. Dec. 27, 1921.)

Heat-Treatment of Aluminum Alloys.—Earl Blough, of Parnasus, Pa., finds that a great variety of Al:Cu alloys may have their tensile strength greatly increased by a proper double heat-treatment, combining a thorough anneal at about 520 deg. C. and a quench in boiling water, in which it is permitted to remain for several hours. The high temperature should be maintained for a sufficient time to relieve strains, allow recrystallization and uniform diffusion of soluble constituents. Accelerated aging of the quenched specimen is effected by the bath of boiling water. (1,394,534; assigned to Aluminum Co. of America. Oct. 25, 1921.)

Recovery of Chromium From Iron Ore.—F. A. Eustis of Milton, Mass., proposes to leach finely divided soft Cuban iron ores with weak HCl with or without H_2SO_4, extracting

therefrom Fe, Al, Ni and Mn, and leaving behind SiO_2 and the chromium minerals in such enriched form that the latter can be easily recovered by smelting, (1,403,237; partially assigned to C. P. Perin. Jan. 10, 1922.).

Molybdenum From Molybenite.—G. W. Sargent and J. W. Weitzenkorn, of Washington, Pa., have discovered an exothermic reaction between molybdenite and manganese oxide:

$$MoS_2 + 2MnO_2 + 4C = Mo + 2MnS + 4CO$$

The powdered reagents (with or without iron filings) are mixed, heated to 2,000 deg. F., whereupon a button of substantially pure Mo (or ferromolybdenum) forms, containing less than 0.10 per cent sulphur, overlain by a clean, fluid slag. If carbon is not added to the mix, the end product is a reducible Mn:Mo:S compound. Or the complete reaction may be effected during steel-making operations, with the resultant formation of excellent alloy steel. (1,401,924. Dec. 27, 1921.)

Primary Detonating Compound.—This invention refers to the use of diazodinitrophenol (4.6-dinitro-2-diazophenol) as a substitute for the fulminates, azides, etc., used in primary detonating charges. Non-metallic primers have met with little use for reasons of high cost, low brisance, unfavorable temperatures of melting and ignition and undependable sensitiveness to shock. It is claimed that diazodinitrophenol is free from these objections and can be used for general primary detonating charges and for special charges designed to avoid fouling and amalgamating the metals of ordnance. It is not hygroscopic and is stable in the presence of acids, hence is not decomposed by decomposition products of explosives during storage. When mixed with potassuim chlorate it is claimed to reveal greater power than the most efficient mixtures of potassium chlorate and mercury fulminate. (1,404,687. W. H. Dehn, Seattle. Jan. 24, 1922.)

Book Reviews

A LIFE OF GEORGE WESTINGHOUSE. By *Henry G. Prout, C.E., A.M., LL.D.* New York: Charles Scribner's Sons. 1922. Price, $2.50.

This is an interesting book about a remarkable man who was one of the great American inventors. The name Westinghouse, now known all over the world, appears to have been originally Wistinghausen until on the immigration of the pioneer to New Hampshire in 1755, when it was changed to the present style. Genealogy is seldom illuminating, because many of the factors are illusive, but the Westinghouse strain seems to have held true to form. There was the original John of 1755 who came over with his widowed mother when he was fifteen years old. On the ship he made for his mother an inlaid wooden work-box which is still in existence. John cleared the land, built a log cabin and raised a large family. That inlaid work-box indicates a mechanical knack. John was 6 ft. 4 in. tall. One of his sons was John Ferdinand, who had twelve children, the fifth of whom was George, Sr. He settled in Central Bridge, N. Y., married Emmeline Vedder, a cousin of the famous artist, Elihu Vedder, whose illustrations of the Rubaiyat of Omar Khayyam will be familiar to most of our readers. They had ten children, of whom George, Jr., was the eighth. George, Jr., was born in 1846. Ten years later George, Sr., established himself at Schenectady as G. Westinghouse & Co., makers of agricultural and mill machinery and small steam engines, on the site of the entrance to the General Electric Co.'s present great works.

There were three sons of the Schenectady master mechanic who served in the civil war: John, Albert and George, Jr. The tradition is that Albert, who was singularly gifted in mind and character, was the most promising of all the sons. He was killed while leading a cavalry charge in 1864. John served as an engineer officer in the navy and then returned to his father's business in Schenectady. There he established a night school and a mission, and he gave all his available time to helping the unfortunate. He died when George was forty-four years old.

If we were considering a baseball hero or a race horse we should be very diligent in noting qualities of inheritance, but we are less addicted to this in considering men who achieve greatness. We present the data, together with a reminder of his younger brother, Henry Herman Westinghouse, of Pittsburgh, and the fact that a considerable number of the Wistinghausen family in Westphalia have received patents of nobility, to indicate the strong rather than a weak biological strain that was the inheritance of George Westinghouse, Jr.

When George returned from the war, having enlisted at sixteen and been mustered out under nineteen, he entered Union College as a sophomore, but 3 months later he returned to the shop. The old "Hands Book" of the shop also shows that back in 1860 when he was thirteen and one-half years old he worked there for 50 cents a day, and that in 1863 he was getting $1.12½ a day. It appears therefore that after George was thirteen years old he had but 1½ years of school and college. Nevertheless he wrote and spoke English uncommonly well.

His first patent invention was a rotary steam engine, recorded in 1865. The foundation of his fame and fortune was the air brake, on which his first patent was granted in 1869. By 1873, when he had moved to Pittsburgh, he had taken out twenty or more patents on details of brake apparatus. Then followed at various times friction draft gear and the immense electric activities in which Westinghouse had the vision and the energy to press the development and application of alternating currents. This was a herculean task that we can only mention. In like manner we can only mention the development of the induction motor and meter, the rotary converter, turbo-generators, signaling and interlocking, and a vast number of other activitities.

His most outstanding quality today is the fact that while he was not scientifically trained (and all his life he felt his defect in higher mathematics and physics) he had the scientific spirit. He gathered men of sound scientific training about him and worked with them. He was on terms of intimate friendship with the leading scientific minds of the world. Unlike some chemical manufacturers of today, he respected science, revered it, had it in his blood, recognized its intricacies and did not suffer from the illusion that he could carry it on his pocket-book.

He blazed the trail for the introduction of science into industry. It would be gratuitous to say that he was alone in this, but the number of these pioneers is small. Look at the number of great engineers of today who have been through the course as graduates with the Westinghouse Co. and the General Electric Co.! Can the chemical industry of this country point to such a number of able, courageous and commanding men as the electrical industry has turned out? Everybody knows it cannot. And everybody ought to know why.

He was an idealist all the time and an optimist when others were lost in darkness. The panic of 1907 swamped him, and receivers were appointed for the Electric company. It would be difficult to make a correct analysis of the causes of this. Whether the single-phase electrification of the New Haven Railroad had much to do with it or not would probably be debated. Many lenders ask high discounts when money is scarce, and he may have held off too long. He made many mistakes among his efforts, and without doubt he made them in his financial planning. But when the crash came, he put what he had back in the works and so did his employees. And while he died in moderate circumstances, the works continue to do what he planned for them to do, and the name leads on, unsullied by failure.

ELLWOOD HENDRICK.

* * *

CHEMICAL REACTIONS AND THEIR EQUATIONS. A Guide and Reference Book for Students of Chemistry. By *I. W. D. Hackh*, professor of biochemistry, College of Physicians and Surgeons of San Francisco. Philadelphia: P. Blakison's Son & Co. Price, $1.75.

This convenient and helpful book was reviewed in our issue of Dec. 7, 1921. In that review the price was stated to be $1.25 and some readers have sent in orders with only that amount inclosed. The correct price, as stated above, is $1.75.

Outlining the Legitimate Activities of Trade Associations

ONE of the disturbing factors in the present business situation has been the uncertainty regarding the definition and scope of the activities of legitimate trade associations. Ever since the Supreme Court's decision in the case of the Hardwood Manufacturers' Association, business has anxiously awaited the anouncement of the government's attitude toward trade associations. It had been hoped that through the services of Secretary of Commerce Hoover, the Attorney-General might be induced to prepare a formal statement in the nature of an interpretation of the Supreme Court's decision. Following a number of conferences between officials of the Justice and Commerce Departments it was finally decided, however, that the government's statement should take the shape of "an informal interdepartmental inquiry regarding the present status of the law relating to legitimate trade associations and the extent that they may engage in legitimate co-operative activities."

The Hoover Inquiries

In the interdepartmental correspondence, which has recently been made public, Secretary Hoover has outlined a vigorous defense of the legitimate trade association as an essential service to industry. He made the following statement in the first of his letters to the Attorney-General:

> It is with much earnestness that I claim there is propriety, generally speaking, in trade associations. Their lawful field of endeavor is large, and their activities work for promotion and advancement of the public welfare and for progressive economic organization. In making this statement, I am not unmindful of the fact that the impression exists with a small minority that individual prohibited acts may be accomplished by organization under the disguise of a trade association. However, to make my position clear regarding the trade associations the existence of which I advocate, I desire to say that I have always taken the view that no body of men could combine in the form of a trade organization and do any act or thing forbidden by law if they were undertaken by them outside of a trade organization. The character of trade organization the existence of which should be preserved is one that carries only lawful purposes in its articles of association; its activities must be in harmony with its declared purposes. The articles of association, with their lawful, declared purposes, must not be used as a mask to hide unlawful purposes. In other words, the organization cannot be used to conceal or disguise any contract, combination, conspiracy, agreement or understanding, secret or otherwise, on the part of the officers of the organization or on the part of the membership or any part thereof to engage in activities in restraint of trade or otherwise in violation of the anti-trust laws.

The Attorney-General was asked by Secretary Hoover for an informal expression of his views as to the following activities of trade associations and their members, it being assumed, of course, that neither the form of the association nor the activity which appears perfectly fair and lawful on the surface is used to hide or conceal some contract, combination, conspiracy, agreement or understanding, secret or otherwise, on the part of the association, the membership or any part thereof actually to restrain trade or otherwise violate the Sherman act:

Uniform Costs and Industrial Standardization

(1) May a trade association provide for its members a standard or uniform system of cost accounting and recommend its use, provided that the costs so arrived at by the uniform method are not furnished by the members to each other or by the members to the association and by the latter to the individual members?

(2) May a trade association advocate and provide for uniformity in the use of trade phrases and trade names by its respective members for the purpose of ending confusion in trade expressions and for harmony of construction as to the meaning of trade phrases, names and terms?

(3) May a trade association, in co-operation with its members, advocate and provide for the standardization of quality and grades of product of such members, to the end that the buying public may know what it is to receive when a particular grade or quality is specified; and may such association, after standardizing quality and grade, provide standard form of contract for the purpose of correctly designating the standards of quality and grades of product; and may it standardize technical and scientific terms, its processes in production and its machinery; and may the association co-operate with its members in determining means for the elimination of waste processes in production and distribution and for the raising of ethical standards in trade for the prevention of dishonest practices?

Credit, Insurance and Co-operative Advertising

(4) May a trade association collect credit information as to the financial responsibility, business reputation and standing of those using the products of the industry; and may the association furnish such information to individual members upon request therefor, provided such information is not used by the association or the members for the purpose of unlawfully establishing so-called "blacklists"?

(5) May a trade association arrange for the handling of the insurance of its members, including fire, industrial, indemnity or group insurance? In other words, can the members of an industry, through the agency of a trade association, arrange for or place all of the insurance of the members?

(6) May a trade association, in co-operation with its members, engage in co-operative advertising for the promotion of trade of the members of that association engaged in the particular industry; and may the association engage in such form of promotion by furnishing trade labels, designs and trade marks for the use of its individual members?

Industrial Relations, Legislation and Governmental Co-operation

(7) May a trade association, for and in behalf of its members, engage in the promotion of welfare work in the plants or organizations of its members, which welfare work includes sick benefits and unemployment insurance for employees, uniform arrangements for apprenticeship in trade education, the prevention of accident and the establishment of an employment department or bureau for co-operation with employees?

(8) May a trade association, in co-operation with its members and acting for and in behalf of its members, handle all legislative questions that may affect the particular industry, regarding factories, trades, tariff, taxes, transportation, employers' liability and workmen's compensation, as well as the handling of rate litigation and railroad transportation questions?

(9) May a trade association, in co-operation with its members and acting for and in their behalf, undertake the promotion of closer relations between the particular industry and the federal and the state departments of government which may have administration of laws affecting the particular industry in any form?

Statistics of Production, Distribution and Prices

(10) *A.* May a trade association collect statistics from each member showing his volume of production, his capacity to produce, the wages paid, the consumption of his product in domestic or foreign trade, and his distribution thereof, specifying the volume of distribution by districts, together with his stock, wholesale or retail?

B. And may such trade association, on receipt of the individual reports of each member, compile the information in each report into a consolidated statement which shows the total volume of production of the membership, its capacity to produce by districts of production, which, in some instances, include a state or less area, the wages by districts of production, the consumption in foreign or domestic trade by districts, the volume of distribution by districts and the stocks on hand, wholesale and retail, by districts?

C. And if, after compiling the information as aforesaid, the information received from the members as well as the combined information is not given by the association to any other person, may it then file the combined statement with the Secretary of Commerce for distribution by him to the

members of the association through the public press or otherwise and to the public generally and to all persons who may be in any way interested in the product of the industry, it being understood that the individual reports for the members should cover either weekly, monthly, quarterly or longer periods as may be deemed desirable by the members, and, when a period is adopted, the report for each member shall cover that period, and the combined report shall be for that period?

(11) *A.* May a trade association, at the time it collects the production and distribution statistics above outlined, at the same time have its members report the prices they have received for the products they have sold during the period taken, specifying the volume of each grade, brand, size, style or quality, as the case may be, and the price received for the volume so sold in each of the respective districts where the product is sold?

B. And may the association, without making known to any person the individual price reports of any member, consolidate all of the reports into one, and show the average price received for the total volume of each grade, brand, size, style or quality, as the case may be, distributed in each district covered by the distribution statistics for the period covered by each individual report?

C. And may the association, after making such compilation, send the compiled report as to average price, as aforesaid, to the Secretary of Commerce, to be by him distributed to the public and to any or all persons who may be interested in the particular industry making the reports?

The Attorney-General's Reply

Mr. Daugherty's answers to these questions are contained in his letter to the Secretary of Commerce dated Feb. 8, 1922. The Attorney-General laid particular stress on the subjects of uniform cost accounting and standard trade marking and labeling especially when used as a means of restraining trade and competition. His statement is, in part, as follows:

Suspicious of Uniform Costs

With reference to the first paragraph, there is no apparent objection to a standard system of cost accounting, but I think associations should be warned to guard against uniform cost as to any item of expense. For illustration, a strong effort has been made by some lumber associations to take as a basis for estimating costs of production a uniform charge for stumpage. Of course the cost of the timber in the tree to the different manufacturers who own their timber in the woods varies greatly; and as to each it should be charged at its actual cost. It is as clearly a violation of the law to agree upon the cost of an item that constitutes a substantial part of the total cost price, when its cost actually varies, as to agree upon the sales price, because the sales price is substantially affected by such agreement. It has been ascertained that the members of one association go so far as to fix a uniform cost price, leaving to each member to determine what per cent profit he will add, thus eliminating competition entirely in so far as affected by the cost of production.

Uniform Labels Destroy Competition

Furthermore, I have serious doubts about the advisability of the latter part of the sixth paragraph. I can see no objection to co-operative advertising designed to extend the markets of the particular article produced or handled by the members of an association, but when the several producers or dealers use uniform trade labels, designs and trade marks it seems to me the inevitable result would be a uniformity of price. Where two competing articles are advertised in precisely the same way and bear exactly the same label or trade mark, it certainly would be difficult for one to be sold at a higher price than the other, although its quality may be superior. In a way this is illustrated in the cement industry. There a standard of quality has been adopted—that is, it is necessary for all cement to comply with a certain standard—but in practice no manufacturer undertakes to make, or at least no one advertises that he does make, a grade of cement superior to that standard. The result is that there is no competition in the sale of cement so far as quality is concerned. It seems to me therefore that it would be well to eliminate the latter clause in paragraph 6—to wit, "and may the association engage in such form of promotion by furnishing trade labels, designs and trade marks for the use of its individual members?"

I can now see nothing illegal in the exercise of the other activities mentioned, *provided always* that whatever is done is not used as a scheme or device to curtail production or enhance prices, and does not have the effect of suppressing competition. It is impossible to determine in advance just just what the effect of a plan put into actual operation may be This is especially true with reference to trade associations whose members are vitally interested in advancing or, as they term it, stabilizing prices, and who through the medium of the associations are brought into personal contact with each other. Therefore the expression of the view that the things enumerated by you, with the exceptions stated, may be done lawfully is only tentative; and if in the actual practice of any of them it shall develop that competition is suppressed or prices are materially enhanced, this department must treat such a practice as it treats any other one which is violative of the anti-trust act.

Community Trade Slogans and Not Trade Marks

Mr. Hoover in a second communication offers a further explanation of paragraph 6, which had been questioned by the Attorney-General. It was intended that the question should really relate to trade promotion through the use of trade slogans, such as "Made in Grand Rapids," and not to the use of the same trademark by every member of an association. Since this is primarily the sort of co-operative advertising to which Mr. Daugherty referred—i. e., "designed to extend the markets of the particular article produced or handled by the members of an association," it is apparent that the views of the two departments are in complete accord.

A List of Trade Association Activities

The fabricated production department of the U. S. Chamber of Commerce has prepared a tentative list of trade association activities which is based upon returns received from many association secretaries. It will be noted that in addition to those discussed in the Hoover-Daugherty correspondence there are numerous activities which have had the attention of the various trade associations. The listing by the Chamber of Commerce is not, however, an indication of the legal character of the different activities and no effort has been made to comment on their relative importance to business. The list of seventy-eight trade association activities is as follows:

Adjustments.
Advertising.
Arbitration.
"Association Spirit" and "Acquaintanceship."
Bulletins.
Classifications.
Collections.
Compensation.
Compilation of Trade Information.
Conservation.
Co-operation.
Co-operative Advertising.
Co-operative Buying.
Co-operative Selling.
Co-operation With Other Trade Organizations.
Cost Accounting and Cost Finding.
Credit Bureau.
Demonstrations.
"Distribution and New Markets."
Educational.
Eliminations of Excess Variety.
Elimination of Abuses (Trade Practices).
Employment Bureau.
Ethics of Business.
Exchange of Surplus Materials.
Exhibits.
Financial Statement Consolidated, Yearly.
Foreign Trade Service.
Freight Classification.
Group Meetings.
Hand Books.
House Organs.
Industrial Bureau.
Inspection Service.
Insurance.
Investigations. Technical (Testing, etc.).
Labor Problem.
Legal Advice.
Legal Aid.
Legislative Work.
Litigation.
Market Reports.
Materials, Raw.
Methods.
Open Price Bureau.
Open Shop.
Organization.
Patents and Trade Marks.
Price Data Exchange.
Production.
Publicity, General.
Purchasing.
Price Lists and Classified Buyers' Guides.
Relation Between Own Industry and Allied Industries.
Research.
Restriction of Production.
Sales Promotion.
Social Contact of Competitors.
Standardization.
Statistics (1. Production, 2. Shipments, 3. Orders).
Statistics, Production.
Statistics, Wage Rates, Volume of Orders on Hand, Cost of Manufacture, Overhead Expense.
Style Bureau.
Tariff Work.
Taxation.
Technical Education.
Technical Information.
Trade Extension Work.
Trade Information.
Trade Marks and Copyrights.
Trade Practices (Co-ordination).
Trade Promotion (or Stimulation).
Traffic Department.
"Unfair Competition Bureau."
Wage Rates Compilation.
Wage Schedules, Detailed.
Washington Representation.
Welfare.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Chemical Research for Army and Navy Threatened by Abolition of Gas

If the treaty among the United States, Great Britain, France, Italy and Japan dealing with the use of submarines and gases in warfare is ratified, there is reason to believe that an attempt will be made not only to abolish the Chemical Warfare Service as such but to stop practically all of the research work being done on war gases. A good deal of money is being expended at Edgewood Arsenal and in view of the way expenses are being lopped off, it is regarded in Washington as highly probable that executives will not overlook this chance to reduce expenditures.

The Chemical Warfare Service brought to the military and naval establishments the first chemical research of any proportion ever undertaken in these large and important government departments. Every effort has been made at Edgewood Arsenal to be helpful to all branches of the Army and the Navy when a matter of chemistry was involved. Unless a very determined protest is made, the chances favor the wiping out of this service.

It will be recalled that Congress has been more alive to the chemical warfare situation than have the General Staff or secretaries of war. Due to the fact that Congress now has under consideration the War Department appropriation bill, it will have an opportunity to present its own interpretation of the gas treaty. Hearings on this bill are now in progress before the Appropriations Committee of the House. Every effort will be made to convince the committee that gas research should continue as a necessary measure toward national defense with which can be combined such other chemical research as is required by the Army and Navy.

E. F. Smith to Deliver Chandler Foundation Lecture at Columbia University

Friends of Professor Chandler presented in 1910 to the trustees of Columbia University a sum of money which constitutes the Charles Frederick Chandler Foundation. The income from this fund is used to provide a lecture by an eminent chemist and to purchase a medal to be presented to the lecturer in further recognition of his achievements in science. Previous lecturers on this foundation were L. H. Baekeland, Sc.D., W. F. Hillebrand, Ph.D., W. R. Whitney, Ph.D., and F. Gowland Hopkins, Ph.D.

The lecturer this year will be Edgar Fahs Smith, formerly professor of chemistry at the University of Pennsylvania, now president of the American Chemical Society. Dr. Smith's subject will be "Samuel Latham Mitchill—A Father in American Chemistry." Samuel Latham Mitchill was the first professor of chemistry at Columbia College and the first Senator from the State of New York. The lecture will be in Havemeyer Hall, Columbia University, on March 2, 1922, at 8:15 p.m.

Revised Patent Office Relief Bill Passes Senate Without Opposition

Not even the most optimistic friend of the Patent Office relief bill expected that measure to go through the Senate without considerable debate. The greatest surprise of all was that no roll call was demanded. Senator Johnson simply pointed out that the Senate is entirely familiar with this measure, which had been passed at the last session but which failed due to differences in conference over a proposal to handle government employee patents on a preferred basis, which is not a part of the present measure.

The bill provides for an increased salary schedule for technical employees in the Patent Office and authorizes the reorganization of that important bureau.

Discussion Aroused by Superpower Report Paves Way for Further Action

Now that ample time has been given to obtain the reactions of the electrical industry to the superpower report, the members of the advisory board are to be called together in the near future for further discussion of the project.

Dr. George Otis Smith, director of the U. S. Geological Survey, under whose direction the superpower report was prepared, believes that the showing of economies presented in the report has stimulated interconnection between existing systems throughout the country. The nationwide interest that has been taken in the report is indicated by the fact that the entire edition of 10,000 copies of the report has been exhausted. Thousands of inquiries have been received in regard to various phases of the problems involved and a large amount of discussion has been incited in technical societies and the technical press.

Secretary of Commerce Hoover states that the superpower report has stimulated the desire for similar studies in the Pittsburgh-Chicago area and in other sections.

Appointment of A. B. Houghton as Ambassador to Germany Confirmed

The choice of a manufacturer as Ambassador to Germany is of general interest to American industry and in this case, of particular interest to the chemical industry. In selecting Alanson B. Houghton for that post, the President has picked a practical man who is thoroughly familiar with the chemical industries and who has made research one of the important features of his great glass-making enterprise at Corning, N. Y. The laboratory that he maintains in connection with his glass works is said to be the most complete of its kind in the world.

Mr. Houghton was born in Cambridge, Mass., in 1863. His preliminary education was obtained at St. Paul's School at Concord. He specialized in economics at Harvard and was graduated from that institution in 1886. Shortly after his graduation he continued his study of economics in Europe. Three years of that time were spent in Germany. On his return to the United States he entered the glass works in one of the most humble capacities and learned the business in the plant of which he finally became the head. In 1918 he was elected to Congress. For 2 years he served on the Foreign Affairs Committee, after which he was chosen for membership on the Ways and Means Committee. He took an active part in the framing of the Fordney tariff bill. His intimate knowledge of the industrial situation in Germany made it possible for him to interpret to the committee many phases of the German situation which had a bearing on tariff making.

New Jersey Chemical Society Hears Prof. Hill and R. H. McCready

An interesting discussion of some of the peculiar properties of silver perchlorate was presented before the New Jersey Chemical Society in Newark, N. J., Feb. 13, by Arthur E. Hill, professor of physical chemistry at New York University. Besides a description of this and other little-known salts related to it, the speaker pointed out some of the possible practical applications of these properties. He suggested the possibility of using the salt in the determination of water in gasoline and for the quantitative estimation of aniline.

Robert H. McCready, publisher of *Chemical Age*, New York, described some of the features of his recent trip to Germany, emphasizing the apparently prosperous condition of the population.

Interest in Power Company's Offer Overshadows Ford Proposal

With the submission of a bid for Muscle Shoals by the Alabama Power Co., the discussion of the project has taken on a new interest. The hearings in progress before the House Committee on Military Affairs had excited very great interest since their inception on Feb. 9. Apparently, nine members of the committee have not been convinced that the Ford proposition should be accepted. Seven members are avowedly for the acceptance of the offer, while the five remaining members can be classed as doubtful.

From a chemical standpoint, most interest centers around the testimony of Richard C. Tolman, director of the Fixed Nitrogen Research Laboratory of the Department of Agriculture. Dr. Tolman made a clear and complete statement concerning the kinds of material that can now be manufactured at the nitrate plant and the possible future development of other materials such as fertilizer, urea and nitroguanidine. He described the changes that would be necessary in the plant to produce these different products and expressed the opinion of the laboratory that the plant could not be made to pay expenses if run to produce ammonium sulphate at its present market price.

Offer by Alabama Power Co.

The Alabama Power Co., Birmingham, Ala., has submitted an offer to the secretary of war which seems to offer advantages not presented in previous offers. The company proposes to take out a license under the federal water-power act under which it will complete the construction of Wilson dam and power house at its own expense. The company offers to furnish free to the government or anyone it may designate, from the hydro power plant, 100,000 hp. as required for the production of fertilizers and munitions of war.

It is proposed that the company purchase the government's interest in the Warrior extension of the steam plant, substations, transmission line and the steam plant at Nitrate Plant No. 2, with the necessary rights of way, and to pay therefor the sum of $5,000,000, less an amount to be agreed upon to cover the cost of the locks and navigation structures at Wilson dam. Under the terms of the proposal, the government is to transfer to the licensee the Wilson dam property represented by its investment and commitments to date, free of liabilities and unencumbered. The locks and navigation structures would be conveyed to the government in fee on completion of construction. In accordance with the water-power law, the project covered by the license would be subject to recapture by the government at the end of 50 years and would be turned over to the government for the production of munitions at any time as may be judged necessary by the President.

House Considering Several Proposals Regarding Project

Senator Norris of Nebraska, chairman of the Senate Agriculture Committee, which will consider the Muscle Shoals lease project, proposes that the committee shall visit Muscle Shoals to take evidence and make a personal investigation as to the advisability of completion of the government improvement either by the government or by lease. He has introduced a resolution authorizing this investigation, which has been referred to the committee controlling Senate expenses.

Representative Jones of Texas has introduced in the House a bill to accept the Ford proposal to lease the plant.

The Association of Practical Inventors of New York has petitioned Congress asking that the War Department retain the nitrate plant for the establishment of national instruction, training, experimenting and testing bureau for explosive chemicals, instructors, testers, etc., in preparing chemicals used for explosive chemical purposes.

General Williams Before Military Affairs Committee

While no new points of great significance have been brought out during the Muscle Shoals hearing before the Military Affairs Committee of the House, the testimony has had the effect of concentrating attention on the more important phases of an intricate negotiation.

General C. C. Williams, Chief of Ordnance, emphasized that the Ordnance Department feels a very vital interest in fixation of nitrogen, and that it must use every endeavor to see it brought about. The guarantee embodied in the Ford offer to keep the plant in operation during the term of the lease was held by General Williams to be of greatest importance. To pay $11,000,000 for nitrogen preparedness is a very moderate sum, he said.

Will Not Reduce Fertilizer Cost

When Representative Parker of New Jersey stated that he was not impressed with the arguments to the effect that fertilizer could be made cheaper by the operation of these plants, General Williams stated that his estimates on the cost of ammonium sulphate produced at Muscle Shoals does not lead him to believe that the cost of fertilizer can be cheapened materially. He pointed out, however, that the fixation of nitrogen is in its infancy. In that connection he said: "Fixation of nitrogen is being studied constantly in all of the scientific countries. It is something all recognize as essential. The supplies in Chile are being exhausted and it probably will not be a great many years before that country no longer will be able to supply the needs of the world. Just which will be the successful synthetic method no one can say. Those who have studied the question differ as to the best process. They all agree that in the not far distant future the fixation of nitrogen will be on a commercial basis, just as the production of pig iron."

General Beach Favors Ford Offer

General Lansing H. Beach, Chief of Engineers of the Army, told the committee that one of the great difficulties in handling the Muscle Shoals proposition was the fact that no definite assurance could be given prospective bidders. He said Mr. Ford is the only one who would make a definite response under those conditions.

With regard to the 50-year limit on water-power leases, General Beach said it is not always advisable to apply a general rule. In the case of Muscle Shoals there are arguments for an exception. The territory tributary to Muscle Shoals, he pointed out, is not yet a thickly settled portion of the country. Manufacturing is not highly developed and the length of time that would be required to develop a market for the power must receive careful consideration. He said that it had taken 20 years to utilize all of the power at Niagara Falls in spite of the fact that it is in the heart of a great industrial section. Continuing, General Beach said: "I understand that Mr. Ford intends to utilize this secondary power in a way that we would have considerable difficulty in developing a customer. I believe he proposes to install electric furnaces. They would be used whenever the power is available and he could utilize the secondary power in that way to great advantage and do it immediately."

Secretary Weeks Repeats Former Views

The testimony of Secretary of War Weeks before the committee was practically a reiteration of points made in his statement in transmitting the offer to Congress, published in Chemical & Metallurgical Engineering for Feb. 8, 1922.

"I believe there will be in 20 years a large number of plants in the United States producing nitrates," he said. "It is going to be a very common process. Within a limited number of years there will be a great amount of nitrogen recovered from the atmosphere, so that the question of the government maintaining a plant for this purpose may not be vital.

"The whole essence of Mr. Ford's offer, in my judgment, is whether people are going to get fertilizer at lower cost than heretofore. If that phase of the offer were eliminated, I think quite as advantageous disposition could be made of this property."

Interior Department Research Appropriation

The Interior Department appropriation bill as reported to the House provides $40,000 for chemical and physical researches by the Geological Survey, which is the same appropriation as for the current year.

International Conference on Water Pollution by Vessels at Sea Proposed

Hearings were held Feb. 15 by the House Foreign Affairs Committee on a resolution of Representative Appleby to call an international conference to amend the maritime laws to prevent discharge of oil by vessels at sea, which is said to contaminate shore waters. This is a companion measure of the Appleby bill to regulate discharge of oil, chemicals, etc., in American waters. Government officials were heard by the committee, including legal authorities of the Departments of State and Commerce.

A.C.S. Plans Trip to Southern Plants as Preliminary to Convention

The Washington Section of the American Chemical Society is arranging for a special train to leave Washington Friday evening, March 31, to enable members to visit Kingsport, Tenn., and the Clinchfield region, Chattanooga, Tenn., and Muscle Shoals, Ala., and arrive in Birmingham, Ala., on April 3 for the annual convention of the society. Detailed plans have not yet been made for the entertainment at Kingsport, Tenn., and at Muscle Shoals.

Saturday will be spent either at Knoxville or at Chattanooga, probably at the latter city. The region around Kingsport, Tenn., has become an interesting industrial center and large plants, such as the Clinchfield Portland Cement plant, the extract plant and tannery of the Grant Leather Corporation, a large facebrick plant and the wood-distillation plant of the Tennessee Eastman Corporation, are in operation. An immense leather-working plant of the Simmons Hardware Co. and the new plant of the Corning Glass Co. are ready for operation, but are at present closed down. The Union Dye & Chemical plant has ceased operations. The plants which are in operation, however, are sufficient to give a very interesting day for members and it may be possible to extend the trip to South Clinchfield to view the Carbocoal process of the International Coal Products Co., which is the only going concern making use of processes of low-temperature distillation of coal combined with the production of briquetted solid fuel. The possibility of visiting this plant appears to be entirely a question of time. If visited, there will be a slight addition to the railroad fare. At Chattanooga there are important industrial plants, such as byproduct coke plants, electric furnace manufacture of ferro-alloys, cottonseed and peanut oil refining, hydrogenation of oils, alum plant, etc.

Permission has been obtained to visit the nitrate plant and water-power development at Muscle Shoals. This permission is limited to American citizens and to those who have no personal connection with or financial interest in the manufacture of cyanamide. Ladies and personal guests may accompany members.

The train is contingent upon 125 guaranteed fares. Early application should be made to secure accommodations desired. Tickets should be bought from point of departure, via Washington over the Southern and Norfolk & Western railroads, direct to Birmingham. If 350 people purchasing tickets by certificate plan are present in Birmingham at the meeting, a return ticket via same route may be purchased at one-half the regular fare. Extra tickets for side trips and for Pullman accommodations must be purchased in advance and check for same, made out to Charles L. Parsons, chairman of the committee, must accompany application. No application for space will be considered unless accompanied by remittance.

Extra railroad charges for side trips Johnson City to Kingsport and return and Chattanooga to Muscle Shoals will be $10.87. The Pullman fares for all four days will be $13.20 for upper berth, $16.50 for lower and $58 for drawing rooms. These charges for Pullman are made to cover necessary guarantees. If Pullman cars are filled, there will be rebate of any excess fare paid. Application for space must be made on or before March 20. If 125 applications accompanied by full remittance for extra fare and Pullman are not received by that date, the train will be abandoned and all remittances returned. If the train runs, no remittances will be returned for any cause, as they are part of the guarantee.

Industrial Developments of the Week Marked by Production Increases

Paper.—The Riverside Paper Co., Glastonbury, Conn., has increased production to a full-time operating schedule at its local mill. Orders on hand are said to insure capacity operation for at least 2 months.

The United Paper Board Co., Whippany, N. J., is arranging for the immediate resumption of operations at its Hanover mill, which has been shut down for about a year past. A large working force is being recruited.

The Eastern Manufacturing Co., Bangor, Me., is operating its paper mills at capacity, and reports that incoming orders are running at about 110 per cent of rated production. The pulp department of the company is operating at about 65 per cent of normal.

Leather.—The Dietz Leather Co., Lynn, Mass., is completing a new beam house at its tannery and plans to place the structure in service at once. The capacity will be increased by about 300 dozen skins a day.

Every leather plant at Wilmington, Del., is now in operation and a new tannery at South Wilmington will commence operations at an early date. One of the largest local plants is now soaking 1,400 to 1,600 skins per day, or more than double the average daily amount during the year past.

The Greiss-Pfleger Tanning Co., is operating its two plants at Chicago, Ill., and Waukegan, Ill., at full capacity.

The Widen-Lord Tanning Co., Danversport, Mass., is operating its plant at capacity, with daily production totaling about 3,500 hides.

The Northwestern Leather Co., Boston, Mass., is operating at all of its tanneries at full capacity, including the plants at Portville, N. Y., Sault Ste. Marie and Manistique, Mich.

Ceramic.—The Maddock Pottery Co., Trenton, N. J., manufacturer of chinaware, is operating at full capacity, and has orders ahead to maintain operations indefinitely.

The Glen-Gery Shale Brick Co., Reading, Pa., has made a number of extensions and improvements in its plant to increase the production to more than 210,000 bricks per day. Capacity operations will be maintained.

Glass.—The Greensburg Glass Co., Greensburg, Pa., has resumed production at its plant after a shut-down of several months. Capacity operations are planned throughout the summer.

Six general glass plants in the Charleston, W. Va., district have resumed operations, giving employment to about 1,500 men. Three window glass plants have also started up, employing approximately 850 men.

Tin.—The McKeesport Tin Plate Co., McKeesport, Pa., began operations under a full-time schedule on Feb. 12, for the first time in several weeks. The plant is giving employment to about 3,500 men.

The American Sheet & Tin Plate Co. is operating at thirty of the forty hot mills at its Shenango, Pa., works. At the Newcastle, Pa., plant, twelve of the twenty hot mills are in active service.

Iron and Steel.—The Gulf States Steel Co. has resumed operations at its blast furnace at Birmingham, Ala. The unit was blown in Feb. 7.

The British Empire Steel Corp., Glace Bay, Nova Scotia, has resumed operations at its local plant on a full-time schedule.

The Wheeling Steel Corporation, Wheeling, W. Va., has resumed operations at three mills at Yorkville, Ohio, effective Feb. 7. The plant has been closed since last June.

The Trumbull Steel Co., Youngstown, Ohio, is working at 90 per cent capacity at its different plants. The entire battery of ten tinplate mills at the Liberty plant is in operation.

The Inland Steel Co., Chicago, Ill., is planning to start its new rail mill at the East Chicago, Ind., works, on March 1, with initial production on a 70 per cent basis. The mill will have a capacity of about 15,000 tons of finished rails per day.

Copper.—The Phelps-Dodge Corporation has placed three copper furnaces in operation at its Copper Queen smelter, Douglas, Ariz.

The Calumet & Arizona Mining Co. has resumed operations at two reverberatory furnaces at its smelter at Douglas, Ariz.

Engineering Foundation Board Considers Steps to Encourage Research

At the meeting of the Engineering Foundation Board on Feb. 9, a communication from Byron E. Eldred, well-known mechanical engineer and inventor, was presented proposing the establishment of an organization for the encouragement and development of meritorious research and invention. It is proposed to establish a department under the direction of an experienced engineer to furnish to inventors information, advice and financial assistance, to examine suggestions and inventions offered, to develop ideas believed to be of value and to obtain patents for and commercialize inventions which have passed thorough examination. The proposal includes the formation of a board of review composed of eminent engineers, scientists and patent attorneys and a board on commercialization of inventions to be composed of business men, industrialists and bankers. It also suggests the formation of a large endowment fund, the income of which would support the work and which would be increased by participation in the emoluments of successful inventions.

The board referred Dr. Eldred's suggestion to a committee of four consisting of Bancroft Gherardi, H. Hobart Porter, E. D. Adams and John H. Barr.

Sectional Meeting American Society for Steel Treating

Members of the New England and Seaboard Chapters of the American Society for Steel Treating will hold a sectional meeting at the Hotel McAlpin, New York City, on Friday, March 3. Technical sessions will be held at 2 and 8 p. m., and an informal dinner will be served at 6 o'clock. Papers on "Cold-Headed Bolts," "Influence of Mass in Heat-Treatment," "Magnetic Testing of Chain," "Stainless Steel," "A New Heat-Treating Alloy," "Perfecting a Drop Forging" and "The Manufacture of Steel" will be read and discussed.

All those interested in metallurgy and heat-treatment of steel are cordially invited to attend, whether members of the society or not.

Personal

E. T. Allen of the Geophysical Laboratory, Washington, D. C., addressed the Chemical Society of Washington on "Chemical Aspects of Volcanism" at the regular meeting of the section on Feb. 9.

S. E. Beach has been re-elected president of the Sun Oil Co. of California, Los Angeles, Cal.

F. E. Carroll, former representative of the Goodyear Tire & Rubber Co. in San Francisco, has been appointed Pacific Coast manager for the New York Lubricating Oil Co., with headquarters in San Francisco.

Dr. H. S. Davis has resigned his industrial fellowship at the Mellon Institute of Industrial Research, Pittsburgh, Pa., to accept a position on the research staff of Arthur D. Little, Inc., of Cambridge, Mass.

Arnold M. Eastman is now in charge of all chemical work at the plant of the Upson Co., Lockport, N. Y.

Charles H. Eldridge is now with the non-ferrous metallurgy section of the Bureau of Mines, Pittsburgh, Pa. For the past 4 years he was associated with Dr. C. G. Fink in the development of an insoluble anode now used by the Chile Exploration Co.

G. V. Geisler, export manager for the American Vulcanized Fiber Co., Wilmington, Del., has been appointed chairman of the Southern States committee of the Export Managers Club of New York.

Grosvenor M. Jones, who before 1913 was engaged in a special investigation in Washington in behalf of the American Paper and Pulp Association and since then has been with the Bureau of Foreign and Domestic Commerce, has taken charge of the latter's new paper division. He was assistant director of the Bureau of Foreign and Domestic Commerce from February, 1918, to August, 1919.

Warren A. King, president of the King Chemical Co., Bound Brook, N. J., has been re-elected president of the Manufacturers' Council of the State of New Jersey.

Eric A. Lof, industrial engineer and specialist of the power and mining engineering department of the General Electric Co., had the Royal Order of Vasa conferred on him by the King of Sweden, in recognition of meritorious service to his government.

Prof. J. H. Mathews, chairman of the department of chemistry, University of Wisconsin, addressed the Purdue Section of the American Chemical Society, Feb. 9, on the subject "Some of the Research Methods and Research Problems of Photochemistry."

Herman C. Mueller, head of the Mueller Mosaic Co., Trenton, N. J., gave an interesting address before students of the local Industrial Art School and other guests in the auditorium at the institution, Feb. 8, on the subject of "Industrial Training From the Standpoint of the Manufacturer and the Workman."

C. W. Sutton has been re-elected president of the American Vulcanized Fiber Co., Wilmington, Del.

Herbert Talley, chief engineer of the Hercules Powder Co., has resigned his position to become the operating head of the United States Powder Co. of Terre Haute, Ind.

H. G. Thiele, formerly with the Oliver Continuous Filter Co., is now connected with the Engineering Structures Co., Call Building, San Francisco, specializing on structural erection.

Dr. J. C. Witt, of Chicago, has been called into consultation by the Bureau of Mines to co-operate in research on portland cement-manufacturing processes.

Obituary

William A. Barstow, president of the Union Tank Car Co., New York, died recently at his home in West Orange, N. J., of pneumonia.

William James Comstock, for many years instructor in organic chemistry at the Sheffield Scientific School of Yale University, died Jan. 24, at St. Raphael's Hospital, New Haven, Conn., after an illness of 5 weeks. He was born at Toledo, Ohio, June 15, 1860; was graduated from Sheffield Scientific School in the Class of '79, was a Fellow in Chemistry at Johns Hopkins in 1881, and from 1882 to 1887 studied in Germany at the University of Munich. On his return to the United States he became an instructor at Yale, where he spent most of the active portion of his life.

William H. Gould, president of the Hoboken Paper Mill Co., Hoboken, N. J., died Feb. 4, following an illness of many months. He was sixty-eight years of age.

William C. Sargent, for 22 years secretary and also a director of Chain Belt Co., Milwaukee, Wis., died suddenly on Feb. 5 as the result of heart failure. He was seventy-three years of age and had been in ill health for several years. Mr. Sargent, prominent in industrial circles of Milwaukee and St. Paul, had a wide national acquaintanceship. He was born at Troy, N. Y., Feb. 2, 1849. In 1871 he moved west, locating at St. Paul, where he organized the De Cou, Corliss & Sargent Co., manufacturer of sash and doors. He later became affiliated with the St. Paul Harvester Co., and met C. W. Le Valley, who later founded the Chain Belt Co. of Milwaukee. This meeting was the beginning of a long business association, for in 1900 Mr. Sargent went to Milwaukee to become secretary and later a director of the Chain Belt Co. He was also a director of the Federal Malleable Co., West Allis, Wis. His father was one of the founders of the Terre Haute, Alton & St. Louis R.R. Mr. Sargent established many of the early business connections of the Chain Belt Co., a large number of which are still among the company's jobbers.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Annual Reports and Financial Statements

We are now in the midst of the season of annual reports. The columns of the business papers are crowded with figures from financial statements and consolidated balance sheets. Such compilations of profit and loss and assets and liabilities in themselves mean but little to the uninitiated, but to the stockholder, banker or investor for whom they are intended they offer a ready means for appraising the stability of a company's finances. To the average engineer they may be almost void of meaning, but the financier familiar with the companies' policies uses them as an accurate check upon efficiency in operation and management.

At this time, perhaps more than any other, is the layman finding it difficult intelligently to interpret business statistics. The terrific decline in commodity prices has often necessitated radical revision of company policies. Inventories have had to be written down to replacement values. Stocks of finished goods have had to be carried at current manufacturing costs. Properties have had to be evaluated at a time when actual market values are probably nonexistent.

The condensed income statement derives its principal value as an index of general tendencies. However, in these days of business depression, comparison with previous years has lost much of its significance. Some sort of mental correction has to be made for relative values. The same thing that applies to inventories is equally applicable to reserves and to accounts payable and receivable. Furthermore, shutdown expenses, excessive depreciation and many other unusual items figure prominently in this year's balance sheets.

According to the policy pursued by some companies, it is customary to furnish stockholders and the general public with summarized reports of the year's activities in production and distribution. These are usually of real value to those interested in the general study of business conditions in the different industries.

During the past week a number of prominent chemical and metallurgical firms have made public the reports of their operations during 1921. Statements taken from some of these of more general interest are summarized in the following paragraphs.

The Hercules Powder Co.

The Hercules Powder Co. is one of the companies whose annual financial statement is accompanied by an illuminating explanatory report. Thus at the close of its ninth year, President R. H. Dunham of the Hercules company has presented a consolidated report showing the 1921 operations of that company, together with its subsidiaries, the Yaryan Rosin & Turpentine Co. and the Hercules Explosives Corporation of New York. The last-named corporation represents the entire assets and business of the former Aetna Explosives Co., Inc.

New Facilities Established

"This purchase," says President Dunham, "brought to the Hercules company manufacturing facilities and established business equal to approximately one-half its own in dynamite and one-quarter in black blasting powder. Also new facilities were obtained for the manufacture of blasting caps sufficient to supply not only the business acquired from the Aetna company but also all such requirements formerly purchased from other manufacturers." Furthermore, these manufacturing facilities are now so favorably located that it is possible to compete in the markets of practically every state in which there is a substantial consumption of explosive materials.

Naval Stores Division

In referring to the manufacture of naval stores—rosin, turpentine and pine oil—President Dunham reported that the company's plants were shut down early in 1921 with stocks sufficient to supply customers' reduced requirements for several months. During September the plant at Brunswick, Ga., was put into operation and this branch of the company's business is now operating without loss notwithstanding the very low prevailing prices, which are generally conceded to be below the cost of production by the ordinary method of obtaining rosin and turpentine from the living trees.

The Year's Profits

"Largely as a result of such economies," says the report, "as well as reductions in salaries and wages, the quarterly statements have shown steady improvement from a net deficit before the preferred dividend in the first quarter to the earning in the last quarter of a slight excess over the quarterly common dividend paid in December."

The Hercules company still retains at the close of 1921 a profit and loss surplus double its outstanding common capital stock, notwithstanding that the common dividends for the first three quarters were paid out of previously accumulated surplus. Because of the conservative dividend policy in the period of large earnings during the early war years and the accumulation of this large surplus equity belonging to the common stock the directors have felt that the common dividend should be continued while the company's financial position permitted, even though, for a reasonable time, the current net earnings should fail to equal such dividends.

Annual Earnings and Dividends

The amounts available for dividends and those paid on common stock, together with the net earnings on the investments, are shown in the following table adapted from the company's financial statement:

Year	Available for Dividend Equivalent to Annual Rate on Common Stock, Per Cent	Dividends Paid During Period on Common Stock, Per Cent	Net Earnings From All Sources Equivalent to Annual Rate on Total Investment, Per Cent
1913	15.65	3.00	9.52
1914	14.32	8.00	8.55
1915	63.18	16.00	13.97
1916	227.75	95.00	46.54
1917	76.19	70.00	17.88
1918	27.15	17.00	5.43
1919	16.86	16.00	5.09
1920	1.02	16.00	1.57
1921	3.48	12.00	2.19

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base=100 for the year July 1, 1913, to June 30, 1914

This week	149.05
Last week	147.46
February, 1921	166
February, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The phenomenal increase in the price of linseed oil from 78c. to 86c. per gal. and a lesser rise in cottonseed oil are directly responsible for this week's higher index number. Slightly lower prices were reported for methanol, formaldehyde, caustic soda and crude potassium carbonate.

International Nickel Co.

The International Nickel Co. reported a deficit, after charges and federal taxes, of $641,678.11 for the 9 months ended with the calendar year. This is to be compared with net profits of $2,620,873 earned on the $41,834,600 of common stock in the corresponding period in 1920. Earnings were $143,714, as against $4,415,774 in the preceding year. Accounts payable, including tax reserves, amounted to $1,122,977, compared with $1,786,674.

The consolidated general profit and loss statement for the 9 months ended Dec. 31, 1921, follows:

Earnings		$143,713.96
Other income		220,560.73
Total income		$364,274.69
Administration and general expense	$311,874.17	
Reserved for United States and foreign taxes	70,128.01	382,002.18
Net income (deficit)		$17,727.49
Maintenance and shutdown expense of plants not operating	$228,266.09	
Depreciation and mineral exhaustion	395,684.53	623,950.62
Deficit		$641,678.11
Dividends		$401,067.00
Balance (deficit)		$1,042,745.11

Armour Leather Co.

The annual report of the Armour Leather Co. shows a deficit of $7,564,196 for the year 1921. This compares with a deficit of $4,313,653 in the previous year.

In his report to the stockholders, President Henry W. Boyd calls attention to the company's conservative policy in the purchasing of hides during the period of highly inflated prices. In this connection he continues: "We made the largest purchases of hides in our history in April, 1921, at the lowest prices prevailing in 15 years, and have been in the market often since.

"Our Sheboygan plant, which was destroyed in January, 1920, was rebuilt last year and resumed operations during 1921, its output meeting excellent demand.

"With our hides inventoried at cost and leather at the market, we made an operating profit during the last quarter of $869,000. The first quarter of this year will also show an operating profit. We are of the opinion that the hide and leather markets are sound and the remaining three-quarters of 1922 will show profits."

United States Rubber Co.

In a letter to the stockholders of the United States Rubber Co., C. B. Seger, chairman of the board of directors, declared that the annual report of the company will show a net profit of $470,817. This is in spite of a decrease of approximately $18,000,000 in the income from sales, caused by the drastic reduction in prices made after Jan. 1, 1921.

Mr. Seger stated that the volume of the company's business during 1921, expressed in tonnage rather than in dollars, was entirely satisfactory in view of the general business depression.

"The company closed the year in a strong financial condition," he continued. "Substantial liquidation having been effected, overhead expenses having been reduced to the minimum consistent with efficient operations, the company is in a strong position to meet the future."

Foreign Trade of the United Kingdom in 1921

The value of imports and exports of chemicals and allied products for Great Britain during 1920 and 1921 are shown in the following table taken from the *Official Board of Trade Journal* of Jan. 19, 1922.

Classification	Imports c.i.f. Value £1,000 Sterling 1920	1921	Exports of British Manufacture f.o.b. Value £1,000 Sterling 1920	1921
Chemicals, drugs, dyes and colors	34,329.5	12,682.2	40,535.7	19,057.3
Oils, fats and resins	76,853.3	56,589.2	13,626.4	5,230.4
Leather, and manufactures of	20,445.1	8,666.5	11,664.9	4,760.5
Paper and cardboard	30,243.7	11,601.3	12,810.4	7,736.4
Rubber goods	7,102.5	4,919.7	11,520.2	4,662.4
Earthenware, glass and abrasives	11,113.2	7,014.3	18,290.7	12,080
Iron and steel and manufactures of	29,016.7	22,887.4	128,907.4	63,772.4
Non-ferrous metals and manufactures of	39,132.6	18,467.6	25,781.8	11,733.7

The New York Market

NEW YORK, Feb. 20, 1922.

Interest in the chemical market during the past week has been limited to special items. Foreign buying has featured these commodity markets and there has been an appreciable increase in the aggregate volume of export sales. Dealers in caustic soda have been successful in obtaining a considerable portion of this business and sales were reported to Japan, Italy and South American countries. The advancing exchange has apparently broadened the field for export business. Copper sulphate is another item that has been sold in quantities sufficient to tax the capacities of leading producers. Italy and Greece are large buyers at present. Some small transactions were recorded to South America and are very significant because these countries have practically ignored American blue vitriol during the past year.

GENERAL CHEMICALS

Arsenic—Dealers report odd-lot sales in this item at 7@7¼c. per lb. on spot. Producers are not very anxious to shade 7½c. and report moderate orders at this figure. The present market, as a whole, is in a very healthy position, owing to the scant supplies and higher prices abroad.

Bleaching Powder—Producers quote the market at 2@2¼c. per lb. for large drums f.o.b. works. The demand has shown some improvement and the general market is firmer.

Bichromate of Potash—Leading factors are lower in their views and quote the market at 10½@10¾c. per lb.

Bichromate of Soda—Dealers were not anxious to quote below 7¾c. per lb. for spot material at the close of trading, with the general range around 7¾@8c. per lb. A fairly active call was noted to the consuming trades.

Carbonate of Potash—While some importers are quoting the 80-85 per cent material at 4@4½c. per lb., others are shading this figure and are offering spot goods as low as 3½c. Activity in this item has been very dull since the beginning of the year and keener competition has arisen.

Caustic Soda—Export inquiries continue to reach the market and sales are going through, but the majority of these are for small quantities. Leading dealers quote $3.25 per 100 lb. f.a.s. New York and in some quarters it was intimated that a shade under this figure might be done on business of a sizable proportion. Prices remain unchanged at the works.

Copper Sulphate—The demand for this chemical has improved during the past week. Export inquiries have reached the market and some of the larger producers have booked considerable business with Greece and Italy. American producers have been able to procure this business only through very close bidding. The domestic inquiry has not been very active, although the farmers are expected to come into the market in the near future. The general tone is firm with prices unchanged.

Nitrite of Soda — This chemical has been one of the leading features of the week's activities. Absorption of spot supplies has strengthened the market and some of the largest sellers have withdrawn from the market. While odd lots could possibly be purchased in a limited way at 7¼c. per lb., producers are firm at 7½c. The demand has shown considerable activity.

Prussiate of Soda—The limited spot supplies and improved demand have created a stronger market for this product and it is very doubtful if better than 18½c. per lb. could be done at present. February shipment was quoted at 17¼c. and March shipment at 17c. per lb. c.i.f. New York.

Soda Ash—Dealers report few inquiries on spot. Light ash in bags is offered in carload lots at $1.65 per 100 lb. and in barrels at $7.90. Smaller quantities demand a higher price. Producers quote light ash at $1.27½ per 100 lb. in single bags, basis 48 per cent, f.o.b. works.

Linseed Oil—Owing to the strengthened position of flaxseed, linseed oil took a sensational rise during the past few days and advanced during the week from 78c. to 86c. per gal. Imported material has been difficult to locate at any reasonable figure and as a result buyers were not inclined to purchase either domestic or foreign goods at the high prices.

The St. Louis Market

ST. LOUIS, Feb. 16, 1922.

There are no developments of great importance to mention at this time. Conditions in this market continue on the road to improvement. Confidence is gradually being restored, and buyers are more liberally inclined in covering their requirements. There have been very few price changes during the last period, and the general trend of the market is upward.

Alkalis—There is a slight decline on caustic soda. Carloads, 76 per cent, solid, are quoted at $3.40 per 100 lb., f.o.b. point of production, but 1- to 10-drum lots can be had for $4@$4.10 f.o.b. consumer's door. Flake, 76 per cent, in carloads is $3.75, f.o.b. point of production, with the 1- to 10-drum lots at $4.40@$4.50 per 100 lb., f.o.b. consumer's door. Light soda ash, 58 per cent, is still to be had at the previous price $2.40@$2.75 in less than carlots, carloads at about $1.85 f.o.b. point of production. Sal soda shows no change either in demand or price, and is quoted at $2@$2.25 per 100 lb. Bicarbonate of soda is moving slowly at the same price of $2.75 per 100 lb. in barrels.

General and Special Chemicals—While the demand for citric acid since the decline has not shown any great improvement, the season for this material is opening and larger stock should be carried. Acid gallic and pyrogallic continue to be quite active. Acid tartaric is again coming to life with prices firm. White arsenic is being quoted in carlots at 7c. St. Louis with one producer sold up. The increase in the demand for bromides is noticeable and orders of larger volume are passing. Ammonia water, 26 deg. U.S.P. is moving through regular channels. Carbon bisulphide prices are very firm with a brisk demand. The decline in prices on carbon tetrachloride about 2 weeks ago has not stimulated buying to a great extent, the demand being routine. The market on copperas remains the same, and the demand is still beyond manufacturers' output. Glycerine continues firm and in good demand at 16½c. in drums for spot goods; practically nothing is being done in the way of contracts. Owing to the continued increase in the sterling exchange, manufacturers advanced their prices yesterday on all iodide salts, with demand very good. Zinc sulphate is still being quoted at 3@3½c. per lb., f.o.b. point of production, with a fair demand.

Vegetable Oils and Naval Stores—The vegetable oil market shows a very firm condition with no declines, and stiff advances in linseed oil, which is now being held at 89c. basis raw oil, no futures accepted. Castor oil continues firm and in good demand at 13c. per lb. in drums. Turpentine is quoted at 96½c. in single barrels for pure gum spirits, the lowest price since our last report having been 93½c.

Paint Materials—Conditions in the barytes market remain practically as they were, so far as price is concerned, but there is improvement in the demand. Prices are quoted at $23@$25, cooperage included, f.o.b. St. Louis, for highest grade water-floated material. Domestic lithopone is apparently coming into its own again. Local producers report that they are practically out of stock, while a year ago stocks on hand were considerable. Zinc oxide is improving slightly, with demand fair and no price changes reported.

The Iron and Steel Market

PITTSBURGH, Feb. 17, 1922.

A particularly sharp increase in steel production occurred this week, the present rate being certainly well above 26,000,000 tons a year, and possibly as much as 28,000,000 tons. Our last report indicated that the average rate during January was about 22,750,000 tons.

There has been a very moderate increase in demand for practically all steel products since the first of the year. The particular jump in production this week seems to be due in part to the scheduling of rail mills in the Pittsburgh and Chicago districts to a good rate, caused not by strictly new buying but rather by specifying against contracts placed several months ago. There is also increased production of steel against orders for cars placed in 1921.

A point in analysis of the steel situation, as pointed out last week, is that in general the buying of steel is for very prompt shipment, and hence the best measure of market activity is the rate of steel mill operation. This can be estimated as a total, while the synthesis of market activity in different steel products, among different classes of consumers and in different parts of the country, is naturally not very precise. Technically, a disturbing element is this production of railroad material, since it does not represent hand-to-mouth buying as is the case with other steel products, hence cannot be counted upon with the same certainty.

Were it not for this element, the fact that steel ingot production has probably reached a rate of close to 28,000,000 tons a year would be of transcending importance. Production was at 11,000,000 tons a year last July, and rose, with the autumn demand, to 23,000,000 tons in October and November. A jump to a point so much higher, when spring is still several weeks distant, would indicate an extremely promising pace of improvement. No such continued rapid increase can be expected. With last autumn's demand measured by a 23,000,000-ton rate of ingot production, the industry may well be satisfied if it maintains an average rate, February to June inclusive, between 25,000,000 and 30,000,000 tons. The summer, no doubt, will be dull. Next autumn should bring a still higher tide.

STEEL PRICES

As indicated in previous reports, competition between mills became much keener just after the first of the year. The price competition did not consist, to any great extent, in naming new extremes for large orders, but was rather along the line of making concessions from regular prices for smaller orders. In bars, shapes and plates the regular or open market has been 1.50c. for more than 2 months, while the average price of all sales has been falling. Concessions have now extended to such small orders that the general market is more properly quotable at 1.40c. than at 1.50c., a price now reserved for small orders. Concessions below 1.40c. are altogether exceptional, but using the price as a general Pittsburgh basis there are departures in various sections, representing really a departure from Pittsburgh basing. The seller realizes, f.o.b. his mill, more than the Pittsburgh price, but does not get the full advantage of his location as he did when selling on the "Pittsburgh plus" system. Thus some Eastern mills have sold at above 1.50c. f.o.b. mill, when the same delivered price would have netted the Pittsburgh mill less than 1.40c.

Sheet prices are very well maintained at 2.25c. for blue annealed except in case of the heaviest gages, 3c. for black and 4c. for galvanized. This price steadiness has been one of the market phenomena for more than two months. Nails continue to be shaded to $2.40 in the case of large buyers, but mills insist that $2.50 is being obtained from the smaller buyers. Standard steel pipe is being shaded by 2½ to 5 per cent by most independents, this being to an extent a sort of trade custom.

PIG IRON

Despite a resale of basic pig iron on the basis of $17.75 valley recently, the producers seem strongly committed to maintaining the old price of $18. Bessemer remains at $19.50 valley, and is quite inactive. Foundry iron is not over-steady at its price of $19 valley. Jackson county furnaces have reduced bessemer ferrosilicon and silvery irons $2 a ton. These irons do not come to the Pittsburgh district to any extent, the preference being for the 50 per cent electrolytic, one advantage of which is that the buyer does not need to pay freight on a large percentage of iron.

Connellsville coke, reported a week ago as stiffening, has undergone a sharp advance, due to an actual demand developing in a situation which had secured a firm foundation. It is reported that a purchase of 75 carloads of prompt furnace coke has been made at $3.25 and another of 50 carloads at $3.50, the buyers, of course, being furnaces, while the market previously had been depending on the small-lot buying of miscellaneous consumers. Foundry coke is quotable at $4@$4.25, against $3.75@$4.25 formerly quoted. Dover furnace, Dover, Ohio, which blew in yesterday, contracted for its coke to July 1 at $3.25.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 40 – $0 42
Acetone	lb.	$0.12½ – $0 12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	.12½ – .12¾	13 – .13½
Boric, powder	lb.	.12¼ – .13	13½ – .14
Citric	lb.	..... –	.44 – .45
Hydrochloric	100 lb.	1.15 – 1 25	1.30 – 1 75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11¾ – 12
Lactic, 44 per cent tech	lb.	.09½ – .10	10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04¼	04½ – 05
Molybdic, c.p.	lb.	3.00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06¼ – .06½	.06¾ – .07
Nitric, 42 deg	lb.	.06¾ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.14 – .14½	14¾ – 15½
Phosphoric, 50 per cent solution	lb.	.08 – .08½	08¾ – 09½
Picric	lb.	.20 – .25	.27 – 35
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16 00 – 16 50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	..... –	.65 – 75
Tannic (tech.)	lb.	.45 – .50	.51 – .55
Tartaric, imported crystals	lb.	..... –	.25½ – .27
Tartaric acid, imported, powdered	lb.	..... –	.26 – .29
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1 00 – 1 10
Alcohol, ethyl	gal.	..... –	4 75 – 5 50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.36 – .37
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.36 – .37
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¾ – .04	.04¼ – .04¾
Alum, chrome lump	lb.	.07½ – 08	08¼ – 08¾
Aluminum sulphate, commercial	100 lb.	1 65 – 1 85	1 90 – 2 40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07¼ – .07¾
Amylacetate tech	gal.	..... –	2.00 – 2 40
Arsenic, white, powdered	lb.	.07¼ – 07½	.07¾ – 08¼
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	57 00 – 58 00	59.00 – 70.00
Barium dioxide (peroxide)	lb.	.21 – .21½	.22 – .23
Barium nitrate	lb.	.06½ – .07	.07¼ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	2.00 – 2 25	2 30 – 3.25
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05¼ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.20 – 21	.21½ – .26
Calcium acetate	100 lbs.	1.75 – 2 00	..... – .....
Calcium carbide	lb.	04½ – 04¾	.05 – 05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01¾ – .02	02¼ – 02½
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.94 – .96
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.10½ – 10¼	11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – ....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.39 – .43
Cobalt oxide	lb.	..... –	2 00 – 2 10
Copperas	ton	15 00 – 16 00	16 50 – 20.00
Copper carbonate, green precipitate	lb.	.19 – 20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.55 – 5 65	5 70 – 6 25
Cream of tartar	lb.	..... –	23 – .24½
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	93 – .....
Formaldehyde, 40 per cent	lb.	.09¾ – .10	10¼ – .11
Fullers earth, f.o.b. mines	net ton	16.00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32 00	..... – .....
Fusel oil, ref	gal.	..... –	2 50 – 3 00
Fusel oil, crude	gal.	..... –	1 40 – 1 75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16½ – .17
Iodine, resublimed	lb.	..... –	3 80 – 3 90
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	10¾ – .12½
Lead arsenate, powd	lb.	.15 – .15½	15¾ – 16½
Lead nitrate	lb.	..... –	15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2 65 – 2 70	2 75 – 3 00
Magnesium sulphate, technical	100 lb.	..... –	1 65 – 1 80
Methanol, 95%	gal.	..... –	56 – .57
Methanol, 97%	gal.	..... –	.58 – .59
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	10¼ – 10½	.10¾ – .10¾
Potassium bromide, granular	lb.	..... –	.13 – .17
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80-85%	lb.	.04 – .04½	.04½ – .05½
Potassium chlorate, crystals	lb.	.05½ – .06	.06½ – .08
Potassium cyanide	lb	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.65 – 5.75	5.80 – 6.50
Potassium iodide	lb.	..... –	2.90 – 3.00
Potassium nitrate	lb.	.07⅞ – .07½	.08 – .09
Potassium permanganate	lb.	.13 – .14	.14½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	25 – .25½	.25½ – .26½
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.06¾ – .07	.07¼ – .07½
Salammoniac, gray, granular	lb.	.06½ – .06¾	.07 – .07¼
Salsoda	100 lb.	1.60 – 1 70	1 75 – 2.00
Salt cake (bulk)	ton	17.00 – 20.00	..... – .....
Soda ash, light	100 lb.	1.65 – 1.80	1.85 – 2.40
Soda ash, dense	100 lb.	1.75 – 1.85	1.90 – 2.40
Sodium acetate	lb.	.04 – .04½	.04½ – .05
Sodium bicarbonate	100 lb.	2.20 – 2.25	2.30 – 2.75
Sodium bichromate	lb.	.07¾ – .08	.08½ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05½
Sodium chlorate	lb.	.06¼ – .06¾	.07 – .07½
Sodium chloride	long ton	12 00 – 13 00	..... – .....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10¼ – .11
Sodium hydroxide (caustic soda)	100 lb.	3.25 – 3.35	3.40 – 4.00
Sodium hyposulphite	lb.	.03¼ – .03½	.03¾ – .04
Sodium nitrite	lb.	.07½ – .07¾	.08 – .08½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03 – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.18¼ – .18½	.18¾ – .19
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.15 – 1.25	1.30 – 1.90
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ – .04½	.04¾ – .05
Sodium sulphite, crystals	lb.	.03½ – .03¾	.03¾ – .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, red	lb.	.05 – .05½	.05¾ – .06
Sulphur, crude	ton	18.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 – 40 00	..... – .....
Talc—domestic powdered	ton	18 00 – 25 00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran	lb.	.08 – .08½	.08¾ – .09
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.17 — .18
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.30 — 1.35
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)	lb.	.20 — .22
Cresylic acid, 97-99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.00 — 1.10
Dimethylaniline	lb.	.41 — .45
Dinitrobenzene	lb.	.21 — 25
Dinitroclorbenzene	lb.	.25 — .27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.23 — 25
Dip oil, 25%, car lots, in drums	gal.	.25 — .28
Diphenylamine	lb.	.60 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	1.00 — 1.05
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.15 — 1.20
Naphthalene crushed, in obls.	lb.	.06½ — .07
Naphthalene, flake	lb.	.06¾ — .07½
Naphthalene, balls	lb.	.07½ — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb	1.35 — 1.40
Para-dichlorbenzene	lb.	.17 — 18
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.55 — 1.60
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.37 — 40
Phenol, U. S. P., drums	lb.	.12 — .16

Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.25 —	1.30
Resorcinol, pure	lb.	1.85 —	2.00
Salicylic acid, tech., in bbls.	lb.	.18 —	.20
Salicylic acid, U. S. P.	lb.	.22 —	.23
Salol	lb.	.80 —	.82
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.26 —	.28
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.24 —	.25
Beeswax, refined, light	lb.	.28 —	.30
Beeswax, white pure	lb.	.34 —	.38
Candellila wax	lb.	.24 —	.25
Carnauba, No. 1	lb.	.45 —	.46
Carnauba, No. 2, North Country	lb.	.22 —	.22½
Carnauba, No. 3, North Country	lb.	.14½ —	.15
Japan	lb.	.19 —	.20
Montan, crude	lb.	.04½ —	.05
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03¼
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04¼ —	.05
Paraffine waxes, refined, 135-137 m.p.	lb	.05¼ —	.05½
Stearic acid, single pressed	lb.	.08½ —	.09
Stearic acid, double pressed	lb.	.09½ —	.09½
Stearic acid, triple pressed	lb	.10¼ —	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.30 —	5.35
Rosin E-I	280 lb.	5.40 —	5.45
Rosin K-N	280 lb.	6.05 —	6.80
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.90 —	....
Wood turpentine, steam dist.	gal.	.87½ —	....
Wood turpentine, dest. dist.	gal.	.86½ —	....
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, bulk	100 lb.	$2.50 —	2.60
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.37 —	2.40
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	37.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Quotations Unchanged as of Feb. 8.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.14½ —	.14¾
Coconut oil, Ceylon grade, in bbls.	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09¾ —	.10
Corn oil, crude, in bbls.	lb.	.08¾ —	.09
Cottonseed oil, crude (f. o. b. mill)	lb.	.08¼ —	.08¾
Cottonseed oil, summer yellow	lb.	.09¾ —	.10
Cottonseed oil, winter yellow	lb.	.10½ —	.10¾
Linseed oil, raw, car lots (domestic)	gal.	.86 —	.87
Linseed oil, raw, tank cars (domestic)	gal.	.82 —	.83
Linseed oil, in 5-bbl lots (domestic)	gal.	.90 —	.91
Olive oil, denatured	gal.	1.10 —	1.12
Palm, Lagos	lb.	.08 —	.08¼
Palm, Niger	lb.	.06¾ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08¼ —	.08½
Peanut oil, refined, in bbls.	lb.	.11 —	.11¼
Rapeseed oil, refined in bbls.	gal.	.84 —	.85
Rapeseed oil, blown, in bbls.	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 —	....

FISH

Light pressed menhaden	gal.	$0.48 —	....
Yellow bleached menhaden	gal.	.51 —	....
White bleached menhaden	gal.	.50 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

Prices Remain the Same as Feb. 8 Report

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in.	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	53–55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½ —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 78-82% Mn, English and German c. i. f. Atlantic seaport	gross ton	58.00 —	62.50
Spiegeleisen, 18-22% Mn	gross ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.40
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.00 —	4.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00 —	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	20.00 —	21.00
Coke, foundry, f.o.b. ovens	net ton	3.75 —	4.25
Coke, furnace, f.o.b. ovens	net ton	2.85 —	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24 —	....
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.48 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport.	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13¼

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.125–13.25
Aluminum, 98 to 99 per cent.	19.00
Antimony, wholesale lots, Chinese and Japanese	4.45
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	30.375
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.375–4.40
Zinc, spot, New York	4.925–4.95
Zinc, spot, E. St. Louis	4.475–4.50

OTHER METALS

Silver (commercial)	oz.	$0.66⅜
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	85.00@ 90.00
Iridium	oz.	170.00@ 190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	48.00

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—V. L. Smith, 208 North 54th St., and associates are organizing a new company to construct and operate an oil-refining plant in this vicinity, with reclaiming department for byproducts manufacture. Plans will be prepared at an early date.

BESSEMER—The W. L. Lemly Foundry Co. is planning for enlargements and improvements in its plant. The company recently acquired the Columbus Foundry Co., Columbus, Ga., and its plant will be removed to the Bessemer site.

California

LONG BEACH—Hancock Bros., 620 East Anaheim Ave., operating a local metal works, are planning for the erection of a 2-story addition, 50 x 60 ft., to be equipped as an enameling and electroplating plant. The new building will adjoin the present plant structures.

FILLMORE—The California Asbestos & Kieselguhr Co., Los Angeles, recently incorporated with a capital of $1,000,000, is planning for the erection of a new plant in the vicinity of Fillmore for the manufacture of mineral insulation products. The company is headed by O. P. Posey, Pasadena, Cal.

LOS ANGELES—The Los Angeles Fertilizer Co. has awarded a contract to the Ralph E. Homann Co., 3720 South Park Ave., for the erection of a new 1-story building at 2643 Edwin St., 45 x 100 ft.

Connecticut

WALLINGFORD—The Wallingford Steel Co., recently organized with a capital of $200,000, is perfecting plans for the erection of its proposed new steel works on property acquired at the terminus of Valley St., to comprise three 1-story buildings, 100 x 130 ft., 50 x 110 ft. and 25 x 100 ft., respectively. F. A. Wallace and C. W. Leavenworth, both of Wallingford, head the company.

Delaware

LEWES—The Lewes Fertilizer Co. has awarded a contract to the Austin Co., Bulletin Bldg., Philadelphia, Pa., for the erection of a new 1-story plant, estimated to cost about $65,000. Work will be commenced at once.

Florida

CLERMONT—The Board of Trade is perfecting plans for the organization of a new local company to operate a glass-manufacturing plant, and has selected a site for the erection of a 1-story plant, 150 x 200 ft., to be equipped for the production of bottles, preserving jars, etc. The machinery is estimated to cost about $20,000.

Illinois

CHICAGO—The National Card, Mat & Board Co., 218 West Superior St., manufacturer of cardboard, paper products, etc., has awarded a contract to the Holton Seelye & Co., 140 South Dearborn St., for the erection of a 1-story plant at 4318-36 Carroll Ave., 100 x 140 ft., estimated to cost about $35,000. C. H. Crysler is president.

Indiana

MARION—The Indiana Fiber Co. has work under way on a number of extensions and improvements in its plant to double, approximately, the present capacity.

EDINBURG—The Union Starch & Refining Co. is considering tentative plans for the establishment of a soy bean oil-extraction plant in connection with its present works. A byproducts extension will also be erected.

Kansas

HUTCHINSON—The Carey Fiber Products Co., is planning for the rebuilding of the portion of its plant, destroyed by fire, Feb. 1, with loss estimated to be in the neighborhood of $35,000.

Kentucky

PAINTSVILLE—The Big Sandy Refining Co., recently organized, is planning for the erection of a new oil refinery on local site, with initial capacity of about 100 bbl. per day. The plant will utilize crude oil from the Berea field, Johnson County. Ralph Stafford is president; and Earl Stafford, secretary and treasurer.

Maryland

BALTIMORE—The Commercial Chemical Co. has leased space in the building at 23 Light St., and will establish a plant for the manufacture of denatured alcohol products and derivitives. Edward S. Tyler is president.

BALTIMORE—The American Concrete Tile & Products Co., 305 Gaither Bldg., will take bids early in March for the erection of its proposed new local plant, to be 1-story, 60 x 200 ft., and estimated to cost about $70,000, including equipment. John E. Springer is president, and John W. Ritter, secretary and treasurer.

BALTIMORE—The White Co., 206 Water St., manufacturer of paints and varnishes, is planning for the erection of a new 3-story plant, to be equipped primarily for the manufacture of paint products. It is proposed to commence construction at an early date. C. M. Stengle is president.

HAVRE DE GRACE—Norman Marritt and associates have acquired the property of the Maryland Flint & Feldspar Co., at Kalmia, near Havre de Grace, and plan for extensive operations.

BALTIMORE—Hynson, Westcott & Dunning, Charles and Franklin Sts., manufacturers of drugs, chemicals, compounds, etc., have awarded a contract to Hicks, Tase & Norris, 106 West Madison St., for the erection of a new 3-story plant, 50 x 150 ft., estimated to cost about $175,000, including equipment. Howard Sill, 11 East Pleasant St., is architect.

Massachusetts

CANTON—The George Grow Tire Co., 323 Columbus Ave., Boston, Mass., has awarded a contract to Coleman Bros., 49 Medford St., Charlestown, Mass., for the erection of a new addition to its rubber factory on Jackson St., Canton, 40 x 100 ft., estimated to cost close to $60,000. Work will be commenced at once.

Michigan

ESCANABA—B. C. Chatfield, Escanaba, is organizing a company to construct and operate a new local foundry for the manufacture of iron, brass and other metal castings. It will be located in the Iron Mountain district. Plans will be prepared at an early date.

Missouri

LEEDS—The Wilson Slaughtering Device Co., 511 American Bank Bldg., Kansas City, Mo., has commenced excavations for a new plant near Leeds, to be equipped for the manufacture of serums. It will consist of four units, each about 30 x 40 ft., and is estimated to cost about $50,000.

New York

BROOKLYN—The Perfect Brick & Hollow Tile Co., care of Silverman & Infanger, architects, 188 Montague St., is taking bids for the erection of its proposed new 1-story plant, 100 x 100 ft., on Grand St., estimated to cost about $50,000.

NEW YORK—The Fleischmann Co., 701 Washington St., manufacturer of yeast, has taken title to property on Mott Ave. near 157th St., 210 x 257 ft., for a consideration said to be $125,000, and will use the site for its proposed new 3-story laboratory building, 52 x 165 ft., estimated to cost about $250,000, instead of $150,000, as previously announced. Contract for erection has been let to the George A. Fuller Co., Flatiron Bldg., New York.

NEW YORK—Fire, Feb. 10, destroyed a portion of the plant of the Goldberger Plate Glass Co., 457-61 First Ave., with loss estimated at about $75,000.

POUGHKEEPSIE—The Corrugated Rubber Co., care of W. J. Beardsley, architect, 49 Market St., Poughkeepsie, is completing plans and will soon take bids for the erection of a new plant in the Fairview section, to be 1-story, 60 x 200 ft., and estimated to cost about $90,000.

NORTH TONAWANDA—The Board of City Commissioners will have plans prepared at once for a new filtration plant at the city waterworks, to cost about $250,000, including equipment. J. N. Chester, Pittsburgh, Pa., is engineer. The Board of Public Works is in charge.

Oklahoma

MUSKOGEE—The Muskogee Oil Refining Co., South Cherokee St., is planning for extensions and improvements in its oil-refining plant to cost about $200,000, including equipment.

Pennsylvania

PHILADELPHIA—The Bath Portland Cement Co., Finance Bldg., has completed plans and will call for bids immediately for the erection of a new cement-manufacturing plant at Sandts Eddy, Pa., utilizing a site acquired by the company a number of months ago. The plant will comprise a number of buildings and is estimated to cost about $1,750,000, including machinery. It will be electrically operated in all departments. The company has arranged a fund of $300,000 for extensions and improvements to its mill at Bath, Pa., including the complete electrification of this works. Louis Rafetto is president; and P. H. Hahneman, treasurer.

PHILADELPHIA — The Pennsylvania Synthetic Gas & Chemical Co., Witherspoon Bldg., has leased space in the building at Broad and Spring Garden Sts., for a local works.

LOCH HAVEN—The Queens Run Refractories Co., Inc., has been organized to take over and consolidate the Queens Run Fire Brick Co., North Bend Fire Brick Co. and the West Branch Fire Brick Co. The new organization will continue the operation of the different plants, and has plans under consideration for expansion. William Sleicher is president, and John F. Marshall, secretary.

Tennessee

JOHNSON CITY—The Crab Tree Corporation, Johnson City, is planning for extensive operations on feldspar, mica and kaolin properties in Mitchell and Yancey Counties, N. C. The company has a tract of about 2,500 acres of land and will erect a new grinding mill and other plant buildings. Equipment to cost in excess of $150,000, a portion of which has been ordered, will be installed. A housing development for operatives will also be established. Frank R. Scott is president.

Texas

MEXIA—The Humphreys-Pure Oil Co. is perfecting plans for the erection of its proposed new refinery at Port Neches, Tex., and plans to commence work early in the spring. It will have an initial capacity of about 40,000 bbl. of crude oil per day. A pipe line will be constructed from the Mexia fields to the plant. The refinery will cost close to $1,000,000. Col. E. A. Humphreys is president. The company is erecting a 3-story office building on Belknap St., Mexia.

SNYDER—Smith & Hamer, Snyder, have acquired a local site and plan for the immediate erection of a new leather tannery.

Utah

PARK CITY—The Silver King Coalition Co. has construction under way on a new concentrating plant and proposes to begin operations late in March. The machinery installation has been commenced.

Virginia

NORFOLK — The Robertson Chemical Corp. is planning for the rebuilding of its plant unit, recently destroyed by fire. Walter H. Roberston is president.

West Virginia

PARKERSBURG—Fire, Feb. 2, destroyed the local branch plant of the Biddle Concrete Co., Clarksburg, W. Va., manufacturer of sewer pipe, blocks, etc., with loss estimated at about $30,000, including equipment. John C. Biddle is general manager.

New Companies

THE DODGE CHEMICAL CO., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. Albert N. Lockhart is president; and C. F. Dodge, 20 Weban St., Boston, treasurer.

THE AMERICAN CELLO GLASS CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture paper products, artificial silk and kindred specialties. The incorporators are R. Harris, T. T. Curran and C. W. Mitchell, 2 Rector St., New York.

THE JOHNSTON PAINT & GLASS CO., 8727 Grand River Ave., Detroit, Mich., has been incorporated with a capital of $25,000, to manufacture paints, oils, varnishes, etc. The incorporators are R. Fee Johnston, William C. and John L. Shepard.

THE GRANT CHEMICAL CO., Newark, N. J., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are Nathan Gelb, William M. and Lovett A. Grant, 790 Broad St., Newark.

JAMES C. DEERY, INC., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture pulp products. The incorporators are J. C. and L. E. Deery, and J. A. F. Newton. The company is represented by A. Warshow, 464 Broome St., New York.

JEFFERY & SON LUBRICANTS CO., Greenleaf and Hartrey Aves., Evanston, Ill., has been incorporated with a capital of $500,000, to manufacture lubricating oils. The incorporators are E. R. and W. O. Jeffery, Sr. and Jr.

SAMUEL KIDDER & CO., INC., Boston, Mass., has been incorporated with a capital of $27,000, to manufacture chemicals and chemical compounds. George A. Spear is president; and George P. Nason, Medford, Mass., treasurer.

THE PENN-BEDFORD OIL CO., Johnstown, Pa., has been incorporated with a capital of $100,000, to manufacture petroleum products. Thomas H. Watt, Johnstown, is treasurer.

LEVIN & CO., INC., San Antonio, Tex., has been incorporated with a capital of $10,000, to manufacture greases, lubricants, etc. The incorporators are William Levin and W. P. Gee, both of San Antonio.

THE CHEMICAL INK CO., Brooklyn, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, inks and affiliated products. The incorporators are J. A. Seixas, K. Dyer and W. H. Stieglitz. The company is represented by M. J. Moore, 141 Broadway, New York.

THE CHOLORO CHEMICAL CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $200,000, to manufacture chemicals and chemical byproducts. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE BIRMINGHAM METAL CO., 231 South Exeter St., Baltimore, Md., has been incorporated with a capital of $200,000, to operate a metal-refining plant and ore-reduction works. The incorporators are Charles H. Birmingham, Joseph C. Rintelen and John P. Simon.

THE S. L. AGOOS TANNING CO., INC., Boston, Mass., has been incorporated with a capital of $75,000, to manufacture leather. Samuel L. Agoos, 60 Amory St. Brookline, Mass., is president and treasurer; Norman D. Nepon is vice-president.

THE ESTATE OF JAMES R. SAYRE, JR., INC., Newark, N. J., has been incorporated with a capital of $728,000, to manufacture bricks and other burned clay products. The incorporators are M. H. Barker, E. M. Burbank and H. T. Brooks. The company is represented by Edward M. and Runyon Colie, 763 Broad St., Newark.

THE WESCO PRODUCTS CO., 39 South La Salle St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture paints, cement preparations, etc. The incorporators are Thomas H. Maddock, Jacob H. Jaffe and Vincent J. Green.

THE LION OIL & REFINING CO., El Dorado, Ark., has been incorporated with a capital of $150,000, to manufacture refined petroleum products. The incorporators are F. H. Thwing, E. D. Ellison and George A. Todd, El Dorado. The last noted represents the company.

SNELL & PIERCE, INC., Syracuse, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are A. W. Snell, H. O. Pierce and D. E. Alvord. The company is represented by Alvord & Brewster, attorneys, Syracuse.

THE ARIZON TRIPLE MOUNTAIN COPPER CO., Franklin, Tenn., has been incorporated under Delaware laws with a capital of $5,000,000, to operate a metal-refining plant for copper production. The incorporators are P. V. Channel, Franklin, Tenn.; J. C. Askew and C. F. Matthews, Nashville, Tenn. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE PLYMOUTH PAPER PRODUCTS CO., Mount Vernon, N. Y., has been incorporated with a capital of $100,000, to manufacture paper goods. The incorporators are L. C. Smith, H. Moak and M. J. White. Holden & Cavanaugh, attorneys, Mount Vernon, represent the company.

THE DETROIT ELECTRO-METALS CO., Detroit, Mich., has been chartered under state laws to manufacture aluminum and other metal products, metal alloys and chemical specialties. The incorporators are Dennis Boyle, Clarence E. Lehr and Thomas F. Murphy, 217 Philip Ave., Detroit.

THE SHELL-UNION OIL CO., New York, has been incorporated under Delaware laws with a capital of $1,000,000, to form a merger between the Union Oil Co. of Delaware, 17 East 42d St., New York, and the Shell Transport & Trading Co., San Francisco, Cal., to operate oil refineries in California and other districts, and manufacture refined petroleum products of various kinds. Headquarters will be at the New York address noted.

THE NIAGARA INK CO., Albany, N. Y., has been incorporated with a capital of $500,000, to manufacture inks and affiliated products. The incorporators are E. W. Ladd, J. B. Condon and T. A. Brown. The company is represented by H. J. Crawford, attorney, Albany.

THE INDUSTRIAL DYESTUFF CO., East Providence, R. I., has been incorporated with a capital of $50,000, to manufacture dyes, chemicals, etc. The incorporators are Herbert L. Tobey, Simon Norman and John H. Caton, Jr., 96 Arnold Ave., Edgewood, R. I.

THE SOUTHWEST PULP & PAPER CO., Wilmington, Del., has been incorporated under state laws with capital of $2,500,000, to manufacture pulp and paper products. The company is represented by the Corporat'on Trust Co. of America, du Pont Bldg., Wilmington.

THE GLOBE PETROLEUM CO., Richmond, Va., has been incorporated with a capital of $5,000,000, to manufacture petroleum products. Sherwood E. Hall is president; and Frederic G. Bastian, secretary, both of Richmond.

THE STERLING-WELD CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture aluminum and other metal products. The incorporators are W. H. Sterling, V. A. Whitla and E. F. Degruchy. The company is represented by C. M. Russell, 50 Church St., New York.

THE GOULD FIRE PREVENTION PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of $500,000, to manufacture fireproof paints and other fire-resisting compounds. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

POMEROY & FISHER, INC., New York, N. Y., has been incorporated with a capital of $250,000, to manufacture chemicals, paints and kindred products. The incorporators are A. P. Demarmon, S. Steinkamp and C. B. Grimes. The company is represented by Salter & Steinkamp, 140 Nassau St., New York.

THE BARIUM PRODUCTS CORP., Carbondale, Ill., has been incorporated with a capital of $40,000, to manufacture chemicals and metallurgical specialties. The incorporators are Robert Forsyth, J. H. Mitchell and R. A. Taylor. The company is represented by Herbert A. Hays, Carbondale.

THE RUSSELL CLAY MFG. CO., Wilmington, Del., has been incorporated under state laws with a capital of $600,000, to manufacture ceramic and burned clay products. The company is represented by the Corporation Service Co., Wilmington.

THE RED CIRCLE RUBBER CO., Wilmington, Del., has been incorporated under state laws with capital of $1,000,000, to manufacture automobile tires and tubes, and other rubber products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE MORRIS TANNING CO., Peabody, Mass., has been incorporated with a capital of $100,000, to manufacture leather. Charles D. C. Moore is president; and Abraham Cohen, Beachmont, Mass., treasurer.

THE HAINES SHELLAC WORKS, INC., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture shellac and kindred products. The incorporators are S. J. and J. Haines, and H. Maas. The company is represented by David Sobel, 136 William St., New York.

Capital Increases

THE DETROIT SOLUBLE OIL CO., Detroit, Mich., has filed notice of increase in capital from $50,000 to $150,000.

THE OSWEGO FALLS CORP., Fulton, N. Y., recently incorporated with a capital of $2,500,000, to manufacture pulp and paper products, comprising a merger of a number of mills in this section, has arranged for a bond issue of $2,100,000, for general operations, financing and expansion. H. L. Paddock is president.

LOUIS SACKS, INC., Wilson Ave., Newark, N. J., manufacturer of iron and other metal castings, has filed notice of increase in capital from $500,000 to $600,000.

THE ASBESTOS & MINERAL CORP., 1819 Broadway, New York, N. Y., has filed notice of a reduction in capital from $500,000 to $135,000.

THE RABE PIPE & FOUNDRY CO., Chattanooga, Tenn., has filed notice of increase in capital from $200,000 to $350,000. R. R. Rabe is president.

THE BARCO PETROLEUM CORP., 149 Broadway, New York, N. Y., a Delaware corporation, has filed notice of increase in capital from $3,000,000 to $12,000,000.

THE AJAX ENAMELING & FOUNDRY CO., Battle Creek, Mich., has filed notice of dissolution under state laws.

John S. Dickerson, trustee in bankruptcy for the AMERICAN TIN SMELTERIES, INC., has arranged for the sale of the company's smelting plant at Matawan, N. J.

THE WANDER & SONS CHEMICAL CO., Albany, N. Y., has field a petition in bankruptcy, with liabilities stated at $594,078 and assets $183,588. Frank M. Wright has been appointed receiver.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 3, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting, Friday, March 3, at the Hotel McAlpin, New York City. A sectional meeting will also be held at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Patent Legislation Will Benefit Industry

INDUSTRY will receive many direct benefits as a result of the passing and signing of the bill to relieve conditions in the Patent Office. As soon as the necessary appropriations can be made it will be possible to increase the force by 10 per cent and salaries by 45 per cent. As much as $450,000 per annum will be added to the payroll. These figures are not mentioned in a spirit of elation, because Congress has long been niggardly with the Patent Office and has neglected a self-supporting institution to the detriment of the country's business. The new salaries authorized are still inadequate, but they will afford sufficient relief to prevent a complete disintegration of the Patent Office staff.

When the full force of the new bill is in effect it will be possible to get prompter action on applications for patents. And with promptness will come a higher degree of efficiency that should reduce the amount of litigation that arises from hurried consideration of patent claims. Inventors will not be discouraged by interminable delay that has characterized Patent Office procedure for the past few years. This was coming to be a very serious matter, even threatening the acknowledged supremacy of the United States in stimulating the inventive genius of its people.

An important feature of the bill is an amendment enabling a patentee to recover cash damages for infringement of his patent. Hitherto it has been exceedingly difficult to obtain such damages, but the present bill provides for a means of accounting that simplifies matters and makes reasonable compensation a certainty.

All in all we may feel encouraged over the consummation of this legislation, but we should be constantly on guard to see that the Patent Office does not again fall into such dire straits.

Mr. Ford As a Catalyst

IT WOULD BE ironical if the sequence of events in the final disposition of Muscle Shoals should prove that HENRY FORD and his offer for the power and nitrate plants served merely to stimulate others to bring more acceptable proposals before the government. Such is likely to be the case, however, if we may judge from the terms on which the Alabama Power Co. has already proposed to buy the power plants and complete the Wilson dam under the federal water-power act.

We hold no brief for the Alabama Power Co. or for any other individual or corporation that may bid on these government properties, but it is gratifying to see in the power company's proposal a vindication of our contention that Muscle Shoals should be looked upon as two separate and unrelated projects, one a water-power development and the other a chemical-manufacturing plant. The power company in its bid proposes to complete the Wilson dam and hydro-electric power plants at its own expense and offers a fixed quantity of power per annum for government use. No reference is made to the nitrate plants. They would still be left at the disposal of the government either to be kept in standby condition for the Ordnance Department of the Army or sold to some private concern. In other words, the offer of the Alabama Power Co. is more attractive than that of Mr. FORD.

We may contrast the two in their vital points: Mr. FORD would have the government finance the completion of the power project; the Alabama Power Co. will finance its own operations. Mr. FORD asks a 100-year lease, with further prior rights on power at the end of that period; the power company asks only a 50-year lease, with provision for recapture of the project by the government at the end of that period. Mr. FORD offers $5,000,000 for the nitrate plants, the Gorgas-Warrior steam plant, the lime quarry and other accessories; the power company will pay an equal amount for the same accessories omitting the nitrate plants. In addition the power company offers to furnish free to the government, or to anyone it may designate, 100,000 hp. as required for the production of fertilizers and munitions of war and for research in connection therewith. In our judgment the contrast is sufficiently impressive to warrant the belief that the Ford offer will not be acceptable to the government.

A Final Word On the Bonus

IT HAD NOT been our intention to comment again on the soldier bonus, but letters from subscribers, published elsewhere in this issue, led us to give final consideration to the subject. It is evident now that Congress gave quite as much heed to the wave of opposition as it did originally to the supposed demand for the bonus, and the prospect of legislation is very remote. That the country will have none of it is apparent even to those who are not accustomed to keeping their political ears to the ground. In Congress, what was first supposed might prove a strong political weapon has assumed the properties of a boomerang.

Those who disagreed with our stand on this question have not refuted our principal argument, which is that legislation for a cash bonus will be an economic blunder. It is beside the point to refer to the action of individual states that have already passed bonus legislation. There are others that have not and will not. Doubtless those that have will wish they had not if a federal tax is now laid to pay a national bonus. Some of our critics cite the compensation that was paid to those who lost on war contracts and to others who were financially disabled by the war, and argue that the ex-service

man should be similarly compensated for loss of money and position. It would not be difficult to cite many instances of civilians to whom the war brought financial loss and for whom there is no hope of compensation. War brings its fortunes and misfortunes that cannot possibly be equalized or balanced. The country is sympathetic with the disabled soldier and feels that everything should be done to relieve his sufferings and rehabilitate him, but it is not moved by the same sort of sentiment for the able-bodied survivor.

Nor do we share the assurance of our correspondent who asserts that "business was not in the trenches." We can imagine some business men waxing eloquent in response to that challenge! But granting that business wasn't in the trenches during the war, it is today knee deep in the mire of economic readjustment that will only be made deeper and stickier by a bonus award.

If the general idea of a bonus of $500 or $600 were acceptable, we still think that the proposed method of distribution would be inefficient. As the plan now stands, it is about as fine a scheme as can be devised for dissipating hundreds of millions of dollars by paying it out in such small doles and at such intervals that the most of it will be squandered.

Three of our critics raise a point which, while it has no bearing on the bonus, ought not to pass without comment. They question the independence of thought and action on the part of members of our editorial staff. The only reply that need be made is that the editor is not subservient to higher authority in determining the policy of CHEM. & MET., nor are members of the staff under the slightest coercion to agree with the editor's views. If, as in the present instance, the entire staff is in accord, its members have sacrificed none of their independence, nor have they bowed submissively to a tyrannical authority. Editorial independence is one of the first requisites of a virile magazine.

Royal Houses In Chemistry

IT CERTAINLY is a pleasure to see the young fellows coming along. Somebody with great imagination "binds time" in science by adding his contributions to the records of human progress and then passes them on for future generations. The subjects endure, but the names change. Occasionally, however, there is a strain among families of men in which the gift for research perseveres and when we see it manifest itself in successive generations, it gives us an agreeable thrill.

Research seldom provides riches or palaces or even the appearance of luxury or ease. The truly great look like other men, and with a few curious exceptions they are modest and kindly and generous; inspired, as are all good men, with a sense of their obligations to contribute as much as they can. Despite the apparent democracy, however, they are aristocrats of the first rank, and their spiritual abode is in the temple of fame.

There is, for instance, ARRHENIUS—SVANTE ARRHENIUS. He has already done a giant's work. His fame is secure. And we wish him many years of continued research and the abundant joys of discovery. The name itself has a classic tang, and it does not surprise the student when he finds electrolytic dissociation and even a happy suggestion on the origin of life on earth coupled with it. It looms above the boundaries of nations. He is ARRHENIUS the First!

We call him the First, because there appears above the horizon of the great domain of Science a second of the line, OLOF ARRHENIUS, the son of SVANTE, and OLOF has lately been at work with THEODORE W. RICHARDS in the Wolcott Gibbs Memorial Laboratory at Cambridge. He presents a very acceptable contribution in the January number of the *Journal of the American Chemical Society* on "Quantitative Analysis by Centrifuge." The method has been used for special purposes and now he makes it more general for the rapid determination of calcium, magnesium and phosphoric, sulphuric and nitric acids.

> The precipitate obtained in the usual way is shaken with the mother solution and then transferred to tubes 2.5 cm. in diameter at the top, and provided with a steep funnel below leading to a capillary tube about 4 cm. long (and for compact precipitates only 1 mm. in bore). The precipitate is allowed to settle in the capillary stem. Many of these tubes are then centrifuged together, until the precipitate in each has attained a constant height, which is usually the case in less than half an hour. This column is read with a mirror scale to avoid parallax in reading. These columns are reduced to a weight standard by comparison with a precipitate similarly obtained from a known weight of the substance similarly treated.

Only a modest contribution, to be sure, and there have been others before it, but this one is potent for the convenience of chemists. It is likely to find its way into many laboratories, and to stay there. We can imagine, 'way off in the next century, some chemist coming home from his laboratory earlier than usual, and a greeting awaiting him the more ardent and agreeable because he came before he was expected. "Who helped you through with your work so soon?" is a question that may be put. And an answer that may be given is "ARRHENIUS the Second!"

Import and Export Of Nitrogen

CROSS-HAULING of commodities to satisfy unnecessary and unwarranted individual preference is a demonstrated economic waste. A similar economic extravagance occurs in simultaneous import and export of equivalent material. It is, therefore, of importance to the nitrogen-producing and the nitrogen-using industries of America to determine whether there is not now going on some such international movement of ammonia and nitrate compounds.

During 1921 there was imported into the United States approximately 370,000 tons of Chilean nitrate, valued at $18,000,000. During the same year about 103,000 tons of ammonium sulphate, valued at $6,100,000, was exported. These two items represent the major transactions in international movement of inorganic nitrogen compounds in which the United States is interested. In the imported nitrate there was about 55,000 tons of nitrogen. In the exported sulphate there was about 20,000 tons of nitrogen. In other words, about 36 per cent of the nitrogen that is imported is represented by equivalent exports of nitrogen in other forms.

There is no doubt that not all of the nitrate can be replaced by ammonium sulphate, for there is a real function to be served in fertilizers as elsewhere by the nitrate nitrogen which is not so well served by ammonia nitrogen. Nevertheless it is time to take account of stock and determine whether we are, to the maximum practical extent, using ammonia nitrogen for the replacement of nitrate nitrogen. If we are not, then it would be better to use some of this domestic production of ammonium sulphate and import somewhat less of Chilean nitrate for this purpose.

The Inevitable Economic Reaction

THOSE who have studied internal conditions in Germany have for some time prophesied that it would be wholly impossible to continue there much longer upon the system of subsidizing labor and industry by government budgets. Apparently the reaction from that false economic system is coming now. In any event, certain evidence which is accumulating tends to show that a new basis of industrial relation with Germany will develop within the next few weeks, or at the longest within the next few months.

Industrial costs depend largely upon the cost to the manufacturer of money, men and material. Definite information from German sources indicates that forced loans to the government are tending radically to reduce existing reserves and to enhance money costs to industry. Freight rates advanced about 33 per cent on Feb. 1, and the tax upon coal was increased to 40 per cent at the same date, so it is reported. The wage index of the *Frankfurter-Zeitung* shows increase from July, 1921, to January, 1922, of surprising percentages for labor in various industries. Some of those which are quoted from that source are: Chemical industries, 46 per cent increase; metallurgical industry, 78; shoe and leather industry, 50; woodworking, 60; building, 85; foodstuffs industry, 67.

The internal purchasing power of the mark is quoted as having decreased from 5.35 in January, 1920, to 1.76 in October, 1921. The "all-commodity" index of wholesale prices in German marks stood at 3,814 on Feb. 5, 1922, as compared with 3,467 in the preceding month, 3,233 in December, 1921, 1,484 a year ago and 100 in the middle of 1914. This decrease in purchasing power of the mark for domestic transactions is quite believable when one learns of the decree that was to take effect Feb. 16, that bread should cost 75 per cent more after that date than before it. It is not surprising, in view of these facts and the multitude of others like them, that the wage problems of German industries are by no means easily solved.

Germany tried a system in industry quite as fallacious in its economic groundwork as the Soviet economics of Russia. It was reasoned that by large units of industry such efficiency could be gained that the government might properly subsidize the formation of such industry and might by indirection keep the nominal wage and the market price of commodities below the level which normal influences of trade would have caused them to reach. It has been amply demonstrated, however, that the government cannot thus long subsidize business. The budget of the government by any such system becomes so badly unbalanced as soon to be unstable; and with the removal of the subsidy the readjustment which follows is likely to be much more disastrous than the normal and gradual adjustment that results in consequence of unrestricted movement of wage and price levels.

American industry, which must inevitably in many lines compete with German production, can find some measure of comfort in these tendencies. But it is too much to hope that these economic laws will altogether do away with the difference in costs in Germany and in this country. To assume such a result as that is to assume that the German nation is capable of providing for itself as high a standard of living for its working classes as American conditions have provided for the American wage earner.

Quantitative Economics And Invention

ONE of the slogans during the war was: "Produce more, consume less." That was quantitative economics. Our production and consumption had been approximately equal, but to find the things necessary for prosecuting war it was necessary that total production be increased and consumption, apart from the prosecution of war, be decreased. This relatively new science of quantitative economics promises to be interesting, which the old science of political economy was not. It is a science made possible by the fact that we now have much statistical matter measuring the industrial activity of the country, when in the old days we did not have such information.

One of the applications of quantitative economics is to determine whether we can do things we are trying to do or hope to do. There is the application to this question of the "living standard" which the labor leaders have been insisting on. In this department of CHEMICAL & METALLURGICAL ENGINEERING of Dec. 14, 1921, reference was made to the very interesting findings of the National Bureau of Economic Research, showing the national income for a period of years, expressed in dollars, converted into income per capita and adjusted to the 1913 dollar, whereby the income was expressed in its commodity purchasing power. This showed that on an average the individual income would purchase but little more than before the war, hence a raising of the "living standard" of any large number of people was impossible.

Another application of quantitative economics is to the growth of individual industries. Many industries have grown in the past half century at remarkably great rates, showing practically a geometrical ratio of progression. For instance, for a long time the production of pig iron substantially doubled every 10 years, while the freight ton-mileage of the railroads doubled every 12 years. For a time the production of coal increased at a more rapid rate still. The production and use of passenger automobiles, pleasure vehicles, increased very rapidly for a time. Men interested particularly in any one industry wish to see it grow and continue to grow, but quantitative economics informs us that everything cannot grow rapidly unless there are new developments to make it possible. Men cannot be taken from iron ore mines to operate railroad trains, and from railroad trains to make automobiles and from automobile factories to dig coal.

Quantitative economics shows that as a nation we cannot take out more than we put in, yet that is what we want to do. The only way out is to produce more per capita, and that means inventions. Since 1913 inventions along this line have been much less important than formerly.

We are looking forward to a great improvement in industrial conditions in the next few years, but we cannot compass that simply by doubling up on everything. Undoubtedly a great many men could be found whose idea is that the industry in which they are particularly interested should, as a new normal, operate at one-half greater pace than in 1913. Obviously that cannot be done without improvements, without a corresponding increase in efficiency. We cannot have 50 per cent more men engaged in mining coal, consuming coal, moving freight, producing iron, consuming iron, and so on all along the line. The individual workers must produce more, then they can consume more.

Readers' Views and Comments

On the Heat-Treatment of Aluminum Bronze

To the Editor of Chemical & Metallurgical Engineering

SIR:—A. A. Blue's paper "On the Heat-Treatment of Aluminum Bronze" in your issue of Dec. 7, 1921, gives a good introduction to the subject. Unfortunately, he ceased his own efforts to heat-treat and test these interesting alloys before be succeeded in obtaining satisfactory results. As he admits that the results given in Table IV were obtained by an inferior method of testing and in part on unsound bars, it would seem that the paper would have been of more value and less misleading had this table been omitted. However, it has some value in pointing out the reason for the author's astonishing conclusion that "heat-treatment produces little or no effect on yield point," for when a bar of this alloy containing 10.39 per cent aluminum is quenched in water from 1,780 deg. F., and then gives 9 per cent elongation in a tensile test, it is positive proof that the heating or quenching operation was improperly performed. A proper quenching of this material would lower the elongation to not over 2 per cent at the maximum, and if not properly quenched, the yield point cannot be expected to be raised either in the quenched or in the quenched-and-tempered bars.

The present writer had been all through this stage of the game with aluminum bronze before he finally learned the various causes of poor results and how to avoid them. It is a simple matter to do some hasty work on almost any material, getting poor results, and then to write a paper about them condemning the material.

It is entirely possible to obtain strengths of 100,000 lb. per sq.in. even with cast aluminum bronze of proper composition, properly treated, in spite of Mr. Blue's failure to reach this figure. The writer has obtained this result, not merely from one test, but from an average of several tests of different heats. All conditions must be right, of course, to reach this figure in a casting, or some little defect will creep in somewhere and lower the result, but with forged material it should be a simpler proposition. It is also possible to double the yield point and proportional limit of 10 per cent aluminum bronze by proper heat-treatment, as the writer knows from personal experience with numerous tests over a period of years, some of the tests having been checked and corroborated by the Bureau of Standards. Such treatment results in elongations between 8 and 15 per cent and also gives a decided increase in tensile strength.

The conclusion that aluminum bronze is difficult to handle in the foundry is entirely correct, though the bearing of the paper on this point is hard to find. Still there are foundries where this alloy can be produced consistently.

One other point is open to criticism in this paper, and that is the author's indefinite use of the term "annealing," which he confuses with tempering or drawing after quenching. The structures shown by Figs. 12, 13 and 14, for instance, are evidently of quenched and tempered alloys, and could scarcely be the result of simple annealing, as might be understood from the title. There is, moreover, no mention in the paper of the important fact that simple annealing of this cast alloy, unquenched, increases its hardness slightly and spoils its tensile properties, decreasing both strength and ductility.

GEORGE F. COMSTOCK,
Niagara Falls, N. Y. Metallurgical Engineer.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the article written by A. A. Blue, "On Heat-Treatment of Aluminum Bronze," and published in your issue of Dec. 7, 1921, there are a few points and conclusions with which no one who knows aluminum bronze can agree.

The writer agrees with Mr. Blue's conclusion 2, that heat-treatment produces marked and consistent changes in Brinell and scleroscope hardness, but conclusion 3 is the opposite of what my experience and that of others show.

In Table II Mr. Blue tabulates hardness tests after various heat-treatments which are not readily comparable on account of variation in composition. Variation of 0.5 per cent Al is not tolerable in this region of Al-Cu alloys for comparative tests.

Table IV of his article gives puzzling results of physical tests after various heat-treatments. Most if not all of the figures in this table do not check with those obtained by other investigators—for instance, with results of H. C. H. Carpenter and C. A. Edwards. They are not consistent—e.g., test 158 gives tensile strength 61,000, yield point 19,000 and elongation 20.5 per cent for material as cast, and for the same material after quenching, test 161 reports tensile strength 69,500, yield point 20,000 and elongation 3 per cent.

Another anomaly can be seen on page 1048, where Mr. Blue gives the following properties for a bar quenched from 1,700 deg. F., drawn at 1,000 deg. F. and cooled in lime: Tensile strength 79,480 to 81,495, yield point 20,000 to 32,500 and elongation 20 to 22.5 per cent. From numerous tests I have found it impossible to obtain 20 per cent elongation by drawing aluminum bronze of this composition at this low temperature; 2 to 5 per cent is all that can be expected and the yield point would be correspondingly higher, 50,000 to 60,000 lb. per sq.in.

The theory of heat-treatment of aluminum bronze is simply this: By heating to proper temperature all of the alpha phase is absorbed; by quenching, this condition is retained, resulting in high tensile strength, yield point and hardness, and low elongation. By drawing at proper temperature above the transformation point, a desired amount of alpha phase is restored, resulting in an alloy of lower tensile strength, yield point and hardness than the quenched alloy, but higher in elongation. The higher the drawing temperature the lower the tensile strength, yield point and hardness, and the higher the elongation. The proper temperature for quenching is evident even from Mr. Blue's photomicrographs, Figs. 15 to 20. The proper temperature for drawing must be always above the transformation point, and the temperature of 1,000 deg. F. used by Mr. Blue cannot result in restoring any alpha phase and increasing the ductility; on the contrary, it may cause decomposition of beta phase into eutectoid, resulting in a still harder alloy. This increase in brittleness and hardness at low draws was noticed

by Mr. Blue is his impact, compression and hardness tests. Therefore, obtaining 20 per cent elongation after quenching from 1,700 deg. F. and cooling slowly from 1,000 deg. F., is an anomaly which alone would tell the investigator not to be satisfied with his tests.

In our experience there has been no exception to the fact that sound aluminum bronze of 90:10, or 89:10:1 (Fe) responds to the proper heat-treatment, and our representative figures for aluminum bronze as cast, and after heat-treatment, are as follows:

	Tensile Strength	Yield Point	Elongation	Brinell
As cast.....	65,000 to 70,000	25,000 to 30,000	20 to 25	90 to 100
Quenched.....	85,000 to 95,000	60,000 to 70,000	1 to 2	220 to 240
Quenched and drawn	80,000 to 93,000	50,000 to 60,000	4 to 10	187 to 200

From these figures it is evident that the heat-treatment does produce a considerable change in tensile strength and yield point, as well as in hardness and elongation. It is also evident that Brinell hardness and tensile strength correlate, which is not in accordance with Mr. Blue's findings. In our practice of heat-treatment of castings we use Brinell test for checking the heat-treatment and for judging the tensile strength and elongation of the material after heat-treatment. This practice, of course, was preceded by exhaustive tests proving that Brinell hardness and the other physical properties correlate sufficiently. Here it may be mentioned also that the results obtained on aluminum bronze test-bars cast to shape (1 in. diameter), and test-bars cut out of a casting, give approximately the same result —unlike other bronzes.

Mr. Blue's forging experiments are also insufficient and the forging is followed by erroneous method of heat-treatment. But even those, as well as our own experiments, indicate that by forging it is possible to combine a high tensile strength with high elongation. Mr. Blue states, "The results show some improvement in tensile properties, but an increase in brittleness in the heat-treated specimens." But this increase in brittleness is due not to forging, but to the faulty heat-treatment—viz., drawing at 1,000 deg. F. and cooling in lime. This treatment will result in brittle metal independent from previous treatment, and this Mr. Blue could have seen from the equilibrium diagram which he included in his paper.

BRUNO WOYSKI,
Chief Metallurgist.
Lumen Bearing Co.,
Buffalo, N. Y.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reply to criticisms by Messrs. Comstock and Woyski, I would say in the first place, the material used in the majority of the tests recited in this paper, including all of the tensile, impact and compression tests, was purchased from the Lumen Bearing Co. and a number of actual castings which were tested and failed in practical tests were treated by the Lumen Bearing Co. and another lot by Mr. Comstock personally. These castings behaved in the same manner as those treated in our furnaces and failed at the same loads. In order to indicate that these tests were not unreasonable, another type of bronze was later obtained which has stood up satisfactorily under the same tests.

Concerning the criticisms of testing methods, it may be mentioned that all of the tensile, impact and compression tests were carried out in the laboratory of the Carnegie Institute of Technology, under the personal supervision of Prof. F. M. McCollough, the head of the department, which leaves no doubt as to the fact that the figures reported represent the properties of the material tested.

It was the purpose of the paper in question, as pointed out in the first paragraph, to be of value to those interested "in what results they may expect to obtain from it under actual conditions of its everyday practical manufacture and treatment." Without, therefore, going into a detailed discussion of metallurgical considerations involved, the following should be mentioned:

In the last paragraph of Mr. Comstock's letter, unwarranted liberty has been taken with the original paper as regards Figs. 12, 13 and 14. The structures shown in these photographs were obtained, as noted in the caption attached, by "annealing," and not by "tempering or drawing after quenching," as Mr. Comstock supposes. The samples were heated to the temperatures indicated, and permitted to cool as noted, no quenching whatever being involved. Included in the same paragraph, Mr. Comstock states that no mention has been made of "the important fact that simple annealing of this cast alloy, unquenched, increases its hardness slightly and spoils its tensile properties." As a matter of fact, Figs. 22 and 23 show that simple annealing *decreased* the hardness, both Brinell and scleroscope, which was brought out in the text on page 1045, last paragraph.

Referring to Mr. Woyski's communication, the chief point of this criticism hinges upon the heat-treatments given, especially exception being taken to the use of a drawing temperature of 1,000 deg. F. We understood that a number of the castings treated by Mr. Comstock to make them suitable for our purposes were drawn back to this same temperature—i.e., 1,000 deg. F. Our understanding is that this also applies to similar castings treated and furnished by Mr. Woyski's company.

In conclusion, the matter is, of course, simply the old one of buyer and seller. We are interested not in what *may possibly* be done with aluminum bronze, but in what *can always* be done with it day after day, so that we may rely upon it in insuring our own customers in using our product. It failed to meet these requirements, first, when tried out in actual service tests; second, in the tests described in the paper in question, and, third, after the personal efforts of other metallurgists to make it do so. In view of the large amount of money and time expended in these tests, covering nearly a year's time, the results were distinctly disappointing. Therefore we were forced to the conclusion, as mentioned, that a number of the published figures concerning this material were unreliable as an indication of what it would do in a practical way. We know of no reason for changing this conclusion. Aluminum bronze has many novel features, and is an interesting material in the laboratory, which has, no doubt, led its enthusiastic adherents to make claims for it which actual practice will hardly justify. On the other hand, it possesses many features of technical importance, prominent among which should be mentioned its excellent bearing qualities. In fact, we use it regularly in a number of parts where only moderate stresses are involved, with complete satisfaction. However, for heavy duty work, as mentioned above, we have found another bronze to be more satisfactory and to be in better accord with the figures claimed for it, the following being an example: Tensile strength, 101,990 lb.; yield point, 62,250 lb.; 14.5 per cent elongation; 17.4 per cent contraction.

A. A. BLUE.
The Duff Manufacturing Co.,
Pittsburgh, Pa.

The Soldier Bonus

To the Editor of Chemical & Metallurgical Engineering

SIR:—Just a word about the soldier bonus to describe how the situation strikes one of that great mass of ex-soldiers who have so far said nothing but have quietly watched the agitation for and against.

Visualize the following, if you can:

The fair daughter of a corpulent, well-dressed individual, radiating prosperity, has just been rescued from a watery grave by the noble efforts of one of the corpulent gentleman's workmen at the risk of his life. The corpulent individual is moved to tears, and is loud in his praise of the hero. But wait! The corpulent gentleman, having given profuse thanks, now attempts to depart. The hero, however, demands a reward. The face of the corpulent individual changes immediately. No, he is too poor; it would ruin him; must he not buy his daughter more clothes for the ones that are spoiled?

Picture now the corpulent individual hounded by the hero for his gratuity. Is it not laughable, ridiculous, even painful to consider? Both have lost the last shred of the spectators' respect. From the sublime to the ridiculous!

It is difficult to conceive of anyone consoling either of these figures. However, of the two I must admit that my sympathies are decidedly with the unsatisfied hero.

To begin with, it was certainly bad taste for the "hero" to demand a reward, but was it not worse taste, on the business man's part, not to offer one?

The whole situation is disgusting in the extreme in that it has not only to a large extent debased the gratitude due ex-soldiers, but has shown American business in the light that European nations have viewed it for years, but to which true Americans have long tried to blind themselves.

Down with honor! Up with the DOLLAR $!

Philadelphia, Pa. N. F. WILSON, JR.

SAYS BUSINESS WAS NOT IN THE TRENCHES

To the Editor of Chemical & Metallurgical Engineering

SIR:—The reason our government is not more representative is because most of us are not interested enough to take the trouble to raise our voices in defense of legislation we favor or to protest when we are not in favor.

To be sure, business does not want the soldier bonus, but business was not in the trenches or the camps. I was not sent overseas and therefore do not feel entitled to the bonus. No sum of money would be enough to be considered "in full for services rendered." The men who helped build Hog Island were not paid the same wages as the men who "fought their way through the Argonne."

It is not for the members of the American Legion as such to make suggestions to solve this problem, for the country did not ask the soldiers how to carry on the war; it asked them only to fight. RICHARD RIMBACH.

Butler, Pa.

SAY EX-SERVICE MAN ASKS ONLY JUSTICE

To the Editor of Chemical & Metallurgical Engineering

SIR:—As readers of your magazine, we wish to take exception to certain statements made with reference to the soldier bonus. We do not believe that we are in the minority in supporting this measure, as public sentiment, wherever taken, has proved that the compensation of ex-service men is very popular. Ohio recently approved a state bonus by a 3½ to 1 vote. Several of the chambers of commerce, notably the Cleveland Chamber of Commerce, have approved the measure.

Speaking as one "having experience, if not authority," you mention that five members of your staff are opposed to the bonus. After your first editorial, it is doubtful if they would come out openly in favor of the measure and still hope to retain their positions.

The principal argument, and one which we have not seen satisfactorily answered, is that compensation was paid to those who lost on war contracts, to the railroads and to civilian employees of the government. The ex-service man, who lost not only money but also the advancement which came to those who remained in civil life, asks only for justice. JAMES C. WEBSTER,
V. M. BURROWS,
EDMUND WENDEL.

Cleveland, Ohio.

Colloidal State in Metals and Alloys

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with much interest Mr. Alexander's contribution and should like to congratulate you upon the very interesting manner in which he is dealing with this subject. The matter is one of great industrial importance and while being much interested in the colloidal aspect which the author introduces, I suggest that, as regards the experimental evidence which he considers, he should be more precise, when considering the work of other investigators, in dissociating between facts discovered by them and hypotheses put forward in explanation. On page 120, second paragraph, the author states that Dr. Jeffries "has shown that with metals in general the cohesion of the amorphous phase equals that of the crystalline phase," etc. Much as I admire the work of Dr. Jeffries, it is a fact that he has not shown experimentally that the amorphous phase exists, neither has he shown any dissimilarity in the properties of the two phases. What Dr. Jeffries has done is simply to postulate, along with other thinkers, that the amorphous phase exists and then, by further hypotheses, to deduce a dissimilarity in the properties of the two phases.

I write this in no hypercritical spirit, but simply with the desire to emphasize that little progress can be made in our attempt to put this subject on a sound basis unless we do dissociate facts from theories. This particular aspect of matters becomes very important indeed when one contemplates the very important new facts concerning metals, particularly aluminum, brought out in a paper by Dr. H. C. H. Carpenter, F.R.S., and Miss Elam, given in July before the Royal Society in London. They have been able to make tensile test-pieces consisting of single crystals and to explore their properties to a considerable extent. This new evidence, in the writer's opinion, indicates that the amorphous theory, so ably handled by many of our metallurgists and physicists, must be reconsidered—at any rate, many of the minor hypotheses concerning the properties of crystals and amorphous films upon which the amorphous theory was based are now shown to be untenable.

This subject, as I have said above, is of great industrial importance, and it is to be hoped that the author and other investigators will not let the matter rest until we have actually provided sufficient data for a really satisfactory visualization of the mechanism and effect of cold work upon metals. W. H. HATFIELD.

Sheffield, England.

Midwinter Meeting American Institute of Mining and Metallurgical Engineers

Dr. Bancroft Presents the First Institute of Metals Lecture—Important Papers and Animated Discussions on Manufacture of Fine Steel—Quality of Steel in Its Relation to Subsequent Use Also Considered—Arthur S. Dwight the New President

IN ACCORDANCE with custom, the American Institute of Mining and Metallurgical Engineers met Feb. 20 at the Engineering Societies Building in New York City for the midwinter meeting. Technical sessions occupied the mornings and afternoons of the first three days of the week, simultaneous meetings of various sections being the rule rather than the exception. Thursday was spent in a very enjoyable, well-directed and all too brief tour of various industrial plants at Harrison, Carteret, Chrome and Perth Amboy, N. J.

Arthur S. Dwight, widely known throughout the Rocky Mountain region as a lead metallurgist and in late years as the "man behind" a successful sintering machine, made his début as president of the Institute at the banquet held Wednesday evening, Feb. 22. As a measure of the interest manifested at all the meetings, it may be stated that the banquet attendance fell but a little short of the record number. Other social functions —smoker, dances, receptions and excursions—filled the time of the members to overflowing.

Institute of Metals Lecture

To our readers, perhaps the most interesting event was Dr. Wilder D. Bancroft's lecture on "Colloid Chemistry and Metallurgy." It was the first of a proposed series of annual lectures. Judging from the attendance and the enthusiasm displayed, the directors of the Institute of Metals Section have embarked upon a program which will have important and far-reaching effects.

Critical Commentary on Amorphous Theory

Defining colloid chemistry as the chemistry of bubbles, drops, grains, filaments and films, Dr. Bancroft immediately passed to a critical examination of Beilby's theory of films of amorphous metal. In fact, throughout the discourse the lecturer took the attitude of a skeptic and pointed out that many of the things of which metallurgists and metallographers talk rather glibly are things which may have been postulated to account for certain experimental results, and with actual proof either non-existent or at best very meager. He took the view that the advocates of Beilby's amorphous metal hypothesis have made an extraordinarily good case with no facts behind them, while the dissenters have never challenged their opponents' premises. Even though it may be true that direct proof of amorphous metal at crystalline boundaries may never be had, there is no reason for accepting it without question in view of the fact that amorphous metal is difficult to form, and being an unstable phase, it will easily revert to the crystalline and stable condition.

Beilby advanced his theory to explain the strengthening of metal by cold-work, but high strength electrolytic copper can be deposited with high current density, and it certainly is not amorphous. Beilby's reasoning seems to be this: "Glass is amorphous and brittle; therefore an amorphous material is always harder and more brittle than the corresponding crystalline aggregate," of course an absolute *non sequitur*. Cold-work is supposed to produce fragments of crystals too small to be crystals. However, it has been found long ago that electroplated copper 3 to 5 millionths of a millimeter thick has the properties of massive copper, and Dr. Bancroft doubts whether cold-work could produce fragments of this size. In fact, the lecturer feels that the properties ascribed to amorphous metal are more likely to be properties of an aggregate of extremely fine crystals.

As an instance of the metallographer's tendency to take things for granted Dr. Bancroft cited the belief in two diagrams for steel. The conclusion that cementite is the metastable state at room temperature is derived from bad reasoning from inadequate examination. The evidence is this: (*a*) Graphite is the stable phase above 1,000 deg. C.; (*b*) quenched gamma iron containing carbon produces graphite on annealing. Now (*a*) says nothing about the stable phase below 1,000 deg. C.; and as to (*b*), it is possible that graphite is intermediate to the final stable compound Fe_3C.

Solid Solutions

Jeffries and Archer's writings on hardening by slip interference appeal to Dr. Bancroft as the "best formulation of the causes of hardness we have ever had" and a distinct step forward. He expressed himself as being personally much delighted by their explanation of the hardening of duralumin and martensite. They were also on sound ground in insisting that Fe_3C does not dissolve in austenite as such—it is not necessary that it should. Bearing on this point, it should be remembered that the copper-tin equilibrium diagram indicates a series of solid solutions passing through the compound Cu_3Sn, and it is orthodox to say that some of these solutions contain the compound. However, it is possible to produce the compound Cu_3Sn, and it will not go into solution in bronzes; are there two different kinds of Cu_3Sn? As a matter of fact, modern metallographists play fast and loose with compounds and solutions, postulating them everywhere. There are six of them already in brass, and maybe there will be more if we do not own up to our ignorance of the essential structure of many things we see under the microscope.

However, it is very necessary that we should know more about the state of aggregation of alloy components. Take the familiar case of thoria and tungsten. If a fine thoria powder be shaken up with coarser tungsten particles, the fines coat the grains rather than accumulate in the voids and a composite briquet is therefore a poor conductor. Alloys between two metals, *A* a conductor and *B* a non-conductor, will naturally have electrical characteristics depending upon whether *A* is dispersed

in *B*, *B* is dispersed in *A*, or whether both metals are continuous and interlace. Yet discussions of conductivity of a series seldom mention this essential point.

State of aggregation of inclusions in steel is apparently of great importance to its endurance under alternating stress. Now is this generally true for other alloys? An increased endurance in metal would be a tremendous advance in metallurgy, and it therefore behooves us to investigate whether it is possible to make clean metal, and whether it is possible to make it commercially.

Corrosion Resistance Due to Surface Films

Colloid chemistry should throw much light upon the corrosion riddle. It is doubtless a hopeless task to produce an absolutely non-corrodible metal—even platinum is probably covered with an oxide—but it is necessary to make metals which corrode only to a limited extent. From its chemical behavior, metallic aluminum would be predicted to be perfectly useless, yet when exposed to ordinary service conditions it becomes covered with a coherent protective film which effectively slows down subsequent action. Nickel also forms a protective film; iron does not. What is the reason for the difference? Measurements of electromotive force are not very informing, since they give only the "tendency" for corrosion and since actual occurrence is the essential point. Thus all the bronzes have e.m.f.'s which lie between tin and copper and have a "tendency to corrode" more than copper but less than tin. As a matter of fact, if a certain group of brittle bronzes, containing 40 to 80 per cent tin, are made anodic in salt solutions, they stand up in a surprising manner, simply and solely because they immediately build up a film of stannic oxide which is coherent and protective. If we knew more about this film we might be able to put metallic tin into such a condition that it, too, would acquire it, whereupon a great boon would be conferred upon the canning industry. Similar studies would tell why copper-bearing steel corrodes less than copper-free steel in the atmosphere, but more rapidly in ground waters.

Electrometallurgy and colloid chemistry have many points of contact. If the electrolyte contains some substance which is absorbed by the metallic deposit, crystals of the latter cannot grow. For this reason, glue has made possible electrolytic lead refining; without glue, the lead is deposited as lovely but useless lead crystals; with it, a dense coherent deposit occurs. Similarly in electroplating. A burnished copper deposit can be taken directly from the tank; unfortunately it costs a little more than to do it the old way. Again, colloidal solutions, or, rather, peptized suspensions, are good things to avoid in electrometallurgy. As instances, the operating temperatures in sodium or aluminum furnaces must be above the melting point of the metal, yet below the temperature where the metal is peptized in the bath, a range which is extremely narrow. If the bath overheats, the metal "fogs," goes to the anode and burns.

Fine Steel From the Acid Open-Hearth

A series of very important papers relating to quality metal were presented before the Iron and Steel Section meetings, drawing forth an animated discussion skillfully directed by the chairman, Mr. Stoughton. Principal among these was "Acid Open-Hearth Process for Manufacture of Gun Steels and Fine Steels," by W. P. Barba and Henry M. Howe, the long-awaited report of work done during the war by the committee on steel ingots, National Research Council.

In summarizing the paper, Colonel Barba said that while the paper is complete in its discussion of principles, many of the almost numberless details of application have not been mentioned. Indeed, many of these details could with extreme difficulty be described—they must be acquired by personal attendance and constant observation on the furnace and pouring platforms. Roughly, half the paper is given over to a description of an adequate furnace and its manipulation, and the remainder to correct pouring practice. It is of first importance to have an adequate furnace—a furnace which will produce and withstand the high temperatures necessary for the reactions going on in the bath. Given this essential implement, one should select the raw materials carefully (having in view the uses for the final product), he should melt hot, refine hot and pour cold into ingots of proper size and shape (again having in view the uses to which the final product is to be put).

If the word "dirt" be used to denote various impurities and inclusions in steel which adversely affect quality steel, "dirt" occurs in two forms—"chemical dirt," the uniformly distributed reaction products, and "mechanical dirt," the occasional and fortuitous particles of foreign materials acquired from the containers. It is very easy to distinguish between these two kinds of dirt. Many American steelmakers have the necessary knowledge, skill and will to reduce all dirt to a minimum, but these same producers must educate the American purchaser to the point where he will appreciate the actual economy in paying the necessary high price for clean steel for special uses. Many consumers do not know that their rejections on final inspection would cease to worry them if they started with the proper metal. Others who want especially good steel for certain purposes do not know it can be had.

Pouring Practice

A visiting English metallurgist, Harry Brearley, was given a warm welcome when he commented upon this paper—especially as regards pouring practice. He emphasized that the temperature in the mold, rather than the temperature in the ladle, was that which was responsible for crystal growth and the physical excellence of the ingot. Thus it is easily possible to "pour cold" with a thin slow stream of very hot metal. Furthermore, it is easiest to judge the temperature by observing the top surface of the metal rising in the mold: it should freeze into a distinct crust and appear like a broken film of cream floating on milk. In Mr. Brearley's opinion, one of the important advantages of bottom casting was the ease with which conditions in the mold could be observed. Somewhat counteracting this was the undoubted fact that bottom-cast ingots ordinarily contained more dirt picked up from the runners. His firm minimized this by extreme care in preparation of molds and by cleaning them with a powerful vacuum cleaner immediately before pouring.

Another advantage of bottom-casting is that the method permits the mold to shape the ingot. When top-casting, the impact of the stream of hot metal always produces more or less commotion in the upper surface. If the flow of metal were stopped at any time and the top surface be examined, it would be found that there would be a thin fringe of metal ("swirl envelope") heaped up and chilled against the side of the mold. This continually formed swirl envelope is the real mold. It is always badly oxidized; the carbon in the advanc-

ing hot steel reduces the oxide partially, forming small quantities of gas bubbles close to the surface. These are later filled with rather impure mother liquor, squeezed into them by the solidifying primary crystals of purer metal, and can be strikingly shown by a sulphur print of a split ingot.

Flakes and Woody Fracture of Nickel Steel

Since the paper by Barba and Howe described the correct manufacture of nickel steel, Haakon Styri recalled the war-time trouble with flakes. In some plants it was observed that their first heats, made by addition of shot nickel shortly before tapping, were accepted. Only when they began using nickel scrap did flakes appear, and one explanation of the cause of flakes was that nickel steel was so much more viscous than carbon steel that its refinement was correspondingly difficult. Colonel Barba pointed out, however, that if the temperature of the furnace in the refining stage is as high as it should be, carbon steel and nickel steel act exactly alike; any difference of viscosity at this temperature is unworthy of mention. In his experience it was entirely immaterial when and how nickel was added—economy and convenience were the only considerations; indeed, for many years most acceptable gun steels were made by adding nickel oxide to the charge. Brearley also denied that nickel steel was necessarily full of slag inclusions, despite wide belief in the myth. To be clean it must be made right. Furthermore, its inherent toughness caused the inclusions which were contained to become very evident in a fracture. It ought to be axiomatic that an inclusion is a discontinuity in steel, and that discontinuities do not show until the metal is deformed. A metal which is brittle, for instance, will show a sharp break despite an actual fibrous or laminated structure. If wrought iron could be made brittle, it doubtless would lose its characteristic fracture. On the other hand, nickel steel, like normal wrought iron, is so tough that it must deform very considerably before fracture, and any discontinuities are sure to be sought out and much magnified into the appearance of fibers before ultimate rupture.

When introducing his paper on "Effect of Sulphur and Oxides in Ordnance Steel" W. J. Priestley of the U. S. Naval Ordnance Plant wished to distinguish between true flakes occurring in nickel steel made in the electric furnace and similar defects in open-hearth metal. The latter always contain slag inclusions, while a true flake has none. In his experience the microscope can indicate whether a gun steel is likely to develop woody fractures; forged open-hearth steels containing perhaps 0.04 per cent sulphur when examined in longitudinal section will show small round inclusions and much larger particles, elongated and drawn out in forging. It will also show woody fracture and lower ductility (elongation 18 per cent, contraction 40 per cent) when tested tangentially. Electric-furnace steels, properly refined under a carbide slag and with sulphur reduced below 0.015 per cent, show only the tiny round inclusions, tangential specimens will break with silky fracture and show higher ductility (elongation 24 per cent; contraction 53 per cent), results which would be looked upon as very remarkable indeed 10 years ago. Such steels, however, will develop true flakes if cast too rapidly at too high a temperature, chilled below a certain point in the mold, or even cooled too far in forging. Minute radial cracks will then appear near the center of the ingot or forging.

Degree of Reduction in Ingots

Ordnance makers at the outbreak of the war were still working to specifications framed 30 years ago when all heavy forgings were shaped under the hammer. On account of the somewhat superficial effect of a quick blow a reduction of 4 to 1 was required for gun tubes. Meantime the hydraulic press was introduced, so during the war the specification was modified to allow only 2½ to 1 reduction. Colonel Barba expressed the opinion that a ratio of 1¾ to 1 would be quite safe for 6-in. forgings made of best steel and with heavy presses; penetrative effect was not well known, so a greater reduction would be justified for larger pieces.

Degree of reduction has a considerable bearing upon the quality of the finished piece, and correspondingly upon the physical properties of test-bars. There are really three main dimensions to a forging; in a gun tube they might be called longitudinal, tangential and transverse to the direction of extension by forging. Tangential tests are most useful in studying quality of gun tubes, first, because they parallel service stresses, and second, because they best show defects and foreign inclusions. However, Priestley remarked that a tangential test-bar from a tube which had been reduced 7 to 1 would give a percentage contraction little over half that from the same steel reduced only 2½ to 1. To avoid this weakness, the forging should apparently be just sufficient to allow ingot structure to be broken up by subsequent heat-treatment, and yet not so great as to range the inclusions along definite planes. Thus it is that while commercial consideration might dictate that big ingots be used to make small articles, it was not always desirable from a metallurgical standpoint. One might infer from Colonel Barba's remarks, however, that heavy reduction of not too clean steel was most desirable for armor plate, since he observed that he would be suspicious of a plate if a bar cut from face to back would give more than 1 or 2 per cent elongation. He said that to be tough enough to keep shots out, a plate had to be laminated parallel to its face. Priestley, however, observed that there was room for difference of opinion on that point; armor plate made from deoxidized and desulphurized electric furnace steel would possess considerable ductility if tested transversely (from face to back). Such plate, when pierced by a shell, opened at one spot and segments curled back like an orange peel. If plates such as Colonel Barba described were penetrated, the shell seemed to punch out a clean button.

Test for Dirt in Steel

Such considerations led Brearley to propose a test for dirt in steel based upon the ratio of impact strength of longitudinal and transverse bars. If, for instance, an ingot be rolled under controlled conditions into a 5 x 1-in. bar and test-specimens be cut at varying angles to the direction of rolling, it would be noted that the tensile strength was substantially the same in all directions. Figures for ductility were also constant until the angle passed 40 deg., when they would show a drop. Notched bar impact, however, would be highest in a bar cut in a longitudinal direction, but progressively less as the angle increased up to 90. In his opinion the two impact values (at 0 deg. and at 90 deg.) never could be equal; in most commercial steels the ratio is not over one-tenth. However, in fine steel, such as for ball races, it should be at least one-half. He recommended this ratio as a measure of "dirt in steel."

Industrial Research and Patents

A Competent Patent Department Can Aid the Research Laboratory in Examinations Into the Literature and State of the Art, in Charting Lines of Inquiry Not Blocked by Patent Barriers, and in Protecting Embryonic Ideas Pending Their Commercial Development

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BUSINESS MEN are ordinarily quick to recognize a new order, but have they grasped the present opportunities offered by research? How many managers of manufacturing corporations know the value of systematic investigations along commercial lines? How many have definite plans for experimental development?

The Factory Laboratory

The man down in the plant as a rule must lower costs and handle the everyday problems of keeping the plant going. What he most wants to hear is the smooth hum of well-oiled machinery, to know that his work is being done on time and well. The very nature of his work tends to make him conservative; but it also shortens his perspective. He perhaps recalls some earlier financial loss due to misplaced confidence in an invention alleged to be valuable and looks suspiciously upon all inventors and researchers.

Nevertheless, because of the difficulties of maintaining quality and standards in the face of growing competition, and knowing somewhat of the investigations of the more progressive companies, the successful factory manager ultimately establishes an engineering department for developing new machinery and later a laboratory for handling the more scientific problems of the factory. Since the main problems in the factory manager's mind are cost, speed of production, quality and works control, a laboratory developed under factory supervision and representing the gradual outgrowth of the necessity for scientific plant control will reflect mainly the practical side of the work in equipment and personnel. The inventing business is viewed in the light of money returns, and the laboratory men become limited in their activities largely to the problems of correcting factory troubles. Spare time only is spent on research.

The works problems may be of no mean order and require the services of highly technical students, as well as skilled artisans. These laboratory men occasionally hit upon new ideas in the course of their investigations, but for lack of time and resources must carry on their experiments according to some haphazard method. Such investigations must be sandwiched in with routine tasks, and soon the edge wears off of the workers' enthusiasm. Ever-insistent foremen waiting to be shown how to correct their errors keep the research notebook in the desk drawer and the problem is laid aside for less crowded days. Still, if lucky, something good may be developed and the state of the art advanced to the glory of the haphazard inventor and the welfare of his employer, if the half-thought-out invention survives competition and the tests of time.

But such sporadic attempts are not research. Thoroughbred racers cannot do the work of draft horses, nor do the latter win many races. Research must be conducted by research men in proper surroundings and with research equipment. Patent the basic ideas of such laboratory work? It may never be thought of!

The Old-Fashioned Engineering Department

In the engineering department, the chief engineer dominates the inventing business. He is an inventor, made conservative by years of hard knocks. His new machines are eagerly sought, for his work is good. What are his methods? Being an inventor, he is possibly jealous of his pet schemes, intolerant of others' ideas. Surrounding him are embryonic mechanical engineers fresh from college or enthusiastic draftsmen, full of ideas, imaginative, perhaps intolerant too of the "old man's" conservatism. They suggest inventions to the chief, which as originally sketched out are probably poorly designed and not commercially feasible. With a hasty glance over the drawings, the chief turns them down. After a number of such rebuffs the youthful inventor concludes that imagination and vision are unwanted. Yet within some poorly thought out scheme may have been a germ of value, capable of development by the older and more practical engineer; but the scheme is dropped and forgotten. Years later, the engineer, perhaps subconsciously recalling the old idea, reinvents it and finds it worthy of development. He builds his machine for the market and then finds it patented by a rival.

It is almost axiomatic in the patent business that if one man does not invent a certain improvement today, another will tomorrow. The different workers in an art read the same literature, see the same machines on the market and learn of the same requirements of the trade. Is it any wonder that they invent the same things? The man first to the Patent Office is likely to win the field.

When that young man's suggestion was offered, the chief engineer, disregarding the patent situation, refused the idea merely because it was *impractical as then clothed*. A preliminary patent search might have shown that the idea was unprotected by patents, that it in fact found the weak spot in a competitor's armor, that it provided a passage to the market free from patent dominance. A little experimental work, sometimes a mere "paper patent," would have reduced the idea to practice and saved a valuable monopoly.

The amount of property, the wealth of ideas lost by such old methods, is large. With the same organization, the same brains around him, that engineer, by judicially investigating the new ideas, experimenting and modifying, selecting the wheat from the chaff, could produce far greater results. His fairness would bring around him a group of loyal enthusiasts. He, the older practical man, would serve as a balance wheel, the others would furnish the fuel.

"Of what use are these theorizing dreamers, these impractical scientists?" says the practical shop man. That question has probably been asked since Adam and Newton observed the different phenomena connected with the apple. Such a business man would not understand how Kekule's benzene ring formula could be of any practical use, yet most dyemakers do. But the dreamers keep on theorizing in spite of ridicule; they need no defence. Not only will their contributions to science be remembered, but they are fundamental to our modern civilization with its luxuries and comforts.

It must be obvious that real commercial progress calls for systematic research effort, but how make it pay? The answer lies in the solution of the further question: Is the laboratory merely doing the necessary routine factory analyses, solving the problems of quality and production, occasionally hitting upon some new method or product, partly accidentally or because there is a temperamental man in the laboratory who cannot be held down, or is the laboratory working within a well-defined channel, studying its problems from theoretical aspects, and yet keeping practical minded, with its weather eye on the patent situation in every move?

Essentials of a Laboratory[1]

From the experiences of various large laboratories it may be concluded that the company management needs to do but four essential things: Decide upon a research policy, equip a laboratory, appoint a director and give him a definite yearly appropriation. Then—back the research with dollars and patience. The director should not be required to produce remunerative ideas at first, perhaps for several years. The value of his work is cumulative and will increase rapidly as time goes on. It is of absolute importance that the laboratory should be entirely dissociated from the factory departments, yet be kept posted on manufacturing activities. To insure these conditions the director of research should report only to the management and have complete control of his work and expenditures within the stipulated limitations. Above all, he should not have to explain beforehand how a given investigation may lead to commercial results. There is no surer way to kill inventive progress than by requiring such proof. In fact, purely theoretical research, with no practical goal in sight, often leads to the greatest achievements. The original workers with vacuum tubes or high-frequency electric currents surely did not realize the wonderful commercial possibilities in their theoretical studies.

The laboratory should be divided into two divisions: (*a*) for manufacturing control and (*b*) for science, and the men for the two branches carefully selected according to their leanings toward practical or theoretical problems. If the laboratory is housed apart and equipped with a complete manufacturing outfit, its tests may be conducted on a manufacturing scale where necessary without interfering with the production department, which ordinarily has no enthusiasm for the notions of "impractical dreamers."

It is generally impossible to staff a laboratory with a large number of geniuses, but one must obtain well-trained men who have a taste for research. They must be men of imagination, inventors, with enough enthusiasm to keep buoyed up under the criticisms of the shop men. It is also considered a fact that the yield per man increases with the number of men who can co-operate. Most problems are so large as to require the combined efforts of men who are specialized in different fields. Hence each man should be encouraged to be frank and helpful in analyzing his co-workers' problems and in giving the best of his own inventive ideas as suggestions for the others' use. A properly worked out system of awards and recognition will do away with the jealousy and secretiveness so frequently associated with the inventive mind.

Since only a small percentage of the investigations started are likely to be successful, the director should be capable of properly organizing his department and the work, and strive to reduce to a minimum the proportion of unsuccessful cases. Generally the deeper the investigation goes into fundamental facts the greater the chance for success. The choice of research work must be determined by the laboratory men's ideas, and not by the too practical considerations of the management, but of course such work should all fall within certain well-defined lines laid down by the directors of the company.

Interrelations of Patents and Research

Assuming that such a research laboratory has been organized, where is it likely to fail? Often in spending large effort, money and time on ideas already appropriated by others' patents.

Not understanding the nature of patents, with their repetitions, their fine shades of meaning and their ambiguities—all legal problems—many researchers ignore the patents and do not consult this remarkable collection of literature. Yet where could one find a better story of any particular art than in the U. S. Patent Office archives? Others perhaps think of patents as legal barriers tending to prevent research. A patent is a barrier, however, to but a small field. Obviously one of those million and a third U. S. patents cannot stop investigations.

Other laboratory men, like true Americans, naturally abhor monopolies and keenly feel that research should be open, co-operative and always in the interest of the progress of the sciences. Hence, while loyal to his company's welfare, such a man may instinctively object to his ideas being patented.

There are several reasons for taking out patents. From the point of view of the owners of the company, these patents are to serve as defenses in keeping competitors from copying their products, or as offensive weapons to aid in holding a commercial field which the company developed. The laboratory worker surely need waste little sympathy on the leech in business who does no experimental work but spies out the accomplishments of his more progressive competitors and copies their products as closely as he dares. The researcher certainly would not like to feel that his work has gone for naught; that when he has finished his experiments a lazy competitor may appropriate his idea and use it to defeat the end for which he has been working. Patents to prevent such unfair competition are certainly justified. It has always been recognized in civilized countries that one has a right to his discoveries for a limited period of time, provided he keeps his bargain with the public by giving the latter a full disclosure of the invention in return for a short-term monopoly.

On the other hand, one need feel no apprehension

[1]For a clear discussion of this phase of the subject the reader should consult the book "Organization of Industrial Scientific Research," written by Dr. C. E. K. Mees, director of research for the Eastman Kodak Co., published by the McGraw-Hill Book Co., New York.

that the patent covering his particular accomplishment will prevent the progress of the science, since any progressive company which stands on its own feet, does its own experimenting and builds up a business on its own good will and prestige is never seriously handicapped by patents taken out on the other man's work. A patent validly covers only what is new. All that is old belongs to the public. Hence, in view of the large amount of known information preceding that particular piece of laboratory investigation, the patent obtained will not ordinarily be of large scope, but will serve merely to protect the particular field within which the investigation has been made. The competitor obviously is not prevented from developing other fields.

The laboratory worker might better look upon a patent as a written disclosure of a piece of research accomplished and leave the question of legal barriers for the patent attorney to decide. From a more personal viewpoint, the patent stands somewhat as an official certificate of the government that a given person has developed something new, that he has added to the sum total of scientific knowledge, that he is wide awake, progressive, a leader and not a follower.

What Is Patentable?

"What is patentable?" is a question which the research investigator should not attempt to answer. That is one weakness in the average laboratory. A scientist is likely to be overmodest and belittle the results of his work, or, rarely, the man in charge may not be enthusiastic for ideas which he did not personally develop. Again, many ideas when first suggested seem impractical. They probably are, as first thought out, and cannot be made workable without a certain amount of investigation and study. Nevertheless such embryonic ideas may be basically valuable as patent rights. If the laboratory director does not take up the suggested idea, it may lie dormant for years and then perhaps be forced to the front through some change in the commercial field. By this time one's competitors have reached the same stage of commercial development and it is more than likely that the idea will be developed and patented by an outsider.

It is the same with questions of interpretation of a patent. The laboratory man, not being skilled in patent matters, either considers a patent as a barrier to further work or ignores its fine points and may conduct his own work along lines which are prohibited. A patent expert, having a general survey of the whole patent field and knowing the commercial value of patent rights, is in far better position than the laboratory head to decide as to the patentable merit of the laboratory work.

Patent Department

In order that the laboratory may make the most of its opportunities, it must be alive to the patent situation; hence it must have a specialist on its staff or at its call who knows the value and scope of patents, who can advise on questions of infringement and obtain protection for the new ideas. In no way can this be better accomplished than by establishing a patent department. The scope and nature of this department obviously will depend on the size of the company, its research program and questions of finance. Let it be said here, however, that a company large enough to carry on research is too large to neglect its patent protection. This department may be headed, and preferably, by a patent attorney of experience and vision, who is located at the plant. For the smaller company, the department may be run by a younger man, but only under the supervision of an older attorney who is acquainted with corporate problems and who can develop an adequate system. Essentially, the department head must have intimate contact with the inventors and know their work and their problems. He should have full access to the laboratory files, attend laboratory conferences and otherwise be in position to follow closely not only what is being done but, perhaps more important, know what it is proposed to do. In addition, a thorough understanding of the company's program, its sales activities, its manufacturing problems, are all essential to his success in helping the laboratory's work.

Such a department head, or his supervising attorney, must not merely do what he is told to do, as must the outside attorney who has no personal interest in the company and is only called in when some one at the plant, unskilled in such matters, happens to think of the patent situation. The corporation attorney, on the contrary, shoulders the full responsibility of protecting the company's patent interests. For example, the department head may have to rewrite a piece of advertising to correct an improper use of a trade mark; he censors the printing of new labels; he studies competitors' catalogs and their advertising and otherwise keeps a systematic watch for infringements; he collects old records and proofs and establishes a model room showing the historical and inventive progress of the company, which may be invaluable as legal evidence in some future controversy; he is ready with advice to aid the engineer or the research director in choosing his lines of development; he may establish a suggestion system or other method of rewarding employees for their ideas; in fact, he must keep in touch with every phase of the company's business which spells progress.

Other Functions of a Patent Department

Other functions of the patent department involve blazing the trail and finding new paths for development. This requires vision and knowledge of company methods and policies, as well as the public's wants and competitors' activities. Perhaps some basic patent in a new field may be obtained. Every company is being constantly importuned to buy patents. This may in fact be such a large problem as to take much of the department's time. For example, one large corporation receives perhaps a thousand such letters in a year. It requires judgment of patent values as well as of commercial and manufacturing problems to know when not to turn down such offers. Again, the corporation attorney may see the possibilities in obtaining a license under some basic patent held by a competitor, or, on the other hand, in expanding the commercial development of a new field which requires extensive advertising by granting licenses to competitors, as has been done with such basic patents as control the electric lighting field. Another duty of the department is to seek the loopholes in the claims of a competitor's patent and advise the laboratory how to get around the apparent barriers. Such a task needs a man acquainted with corporate methods, full of vision and inventive imagination, a lover of research as well as one versed in patent law and capable of understanding and using discriminating English with all its finer shades of meaning.

When a new research idea is proposed to the patent department, one of the first questions is, Whose field is it? A public common, or land fenced in and culti-

vated, or virgin country? A preliminary patent search tells. The specialist hunts out all the related patents, digs up pertinent scientific literature and reports to the research director on both patentability and infringement. If the scheme is broadly new, all is clear sailing. Usually patents and publications tell of others' efforts along the same line—perhaps failures, perhaps success. What is the situation? If no patent claims are found to be infringed, one is fortunate. Otherwise a path of research must be mapped out, carefully turning this way to avoid a line of patents and that way to meet practical considerations of manufacture and market. This can be done only by patient study by both research and patent departments combined.

Two courses are open for securing patent protection on the new idea: To file a paper patent or to develop the idea by experimentation. Both have their advantages, but the experimental work should not be delayed if the patent is filed first. The original inventive idea may be crude and not acceptable to the manufacturing department. Yet if it can be made to work, the attorney asks no more, if he decides to file an application without delay. (Incidentally, if there is no patent department, the laboratory seldom thinks to take up the basic idea with an outside attorney at this stage.) The draftsmen take the crude idea and with the inventor's help draw up a design sufficient for patent drawings. A patent application is filed and the important date, in the eyes of the Patent Office, of completion of the invention is established. The laboratory or engineering department may then, at its leisure, work out the details of the scheme, design an appliance, build it, test it and get it ready for the market. When practical and complete, if the final product is radically different from the one filed in the Patent Office, a new application may be filed on the details of novelty over the first crude scheme; or the old application, if it has not gone to patent, may be abandoned in favor of a new one. The point is that the application pending in the Patent Office during this period of experimentation has given a certain degree of protection ordinarily sufficient to preserve the monopoly.

Department Problems and Equipment

When a patent department is established for a corporation which has never had such facilities, the attorney first finds a degree of suspicion and lack of co-operation which is surprising. This is due largely to the fact that previously the plant has been run on the theory that secrecy was the best policy; but those methods are fast becoming obsolete. However, he must advertise the value of patents and of his services to the inventors and possibly to the company management. The attorney will also find that the value of his services to the laboratory is directly in proportion to the degree of contact which he maintains with the inventors, either personally or through a personal representative. Periodical intimate talks with the different inventors are necessary. He must attend the laboratory conferences. A conference between investigator and the attorney and a short search through the patents and literature to find the related art will put the former on the proper line of attack with the least waste of time and effort.

A necessary part of the patent department's equipment is a patent file containing all of the U. S. patents and the available foreign patents relating to the art, as well as an accessible and adequate library. The number of patents relating to a given field is sometimes surprising; for example, there are over 12,000 U. S. patents relating to the abrasive industry. Such a file is particularly necessary these days owing to the handicaps under which the U. S. patent examiners work and their inadequate resources. Furthermore, the U. S. Patent Office takes no responsibility in granting an improper patent; the patent department must therefore see that its patents actually protect. Hence the specification writer must have a full survey of the field before him when he draws his claims and when he reports on questions of infringement.

The patent file serves an equally useful purpose for preliminary patent searches to advise the laboratory of the related art before experiments are started. The expense of having such searches made in Washington would of course be far greater than the cost of such a file. Moreover, since but a small percentage of the patents granted ever get into commercial use, and yet many of them are not only practical but possess ideas of merit, it is desirable to go over the disclosed art occasionally to bring the old ideas to the attention of the experimental worker.

It will be found that the patent department handles much chaff when considering the laboratory inventions. One large corporation finds that about one-third of the ideas proposed are of patentable value. I have found that the percentage may run considerably lower. It it not wise to ignore the simpler ideas, since these may ultimately develop into practical schemes.

As to the practical application of the outlined system, the following facts may be of interest: One large corporation within my knowledge originally filed less than four patent applications per year. After a patent department had been established it was found that the same body of workers produced seventeen patentably valuable ideas in three months' time. Another and larger corporation with a progressive research laboratory filed twenty-eight applications in one year before the patent department was established. After two years of patient work on the part of the patent attorney in studying the field and searching out the inventions, about fifteen applications were filed each month. Where such investigators had previously limited their activities largely to factory problems, the stimulus due to the patent department's activities helped to expand the laboratory's viewpoint and led to the development of commercial products which might never have been produced.

Vision

In conclusion, it might be well to state that one of the strongest patent monopolies in this country is held by a company which has in effect merged its engineering and patent departments and placed the research and inventive functions of the organization under the control of an executive committee for experimental work, made up of members of both departments. A member of this committee recently said of their new policy:

"It will not be possible to sell the old line of machines, as the users are supplied for years to come; hence it is now necessary to invent and design new machines so much better and cheaper than the old ones that it will be an economy for users to scrap the old and purchase the new."

With such vision, the engineers are eagerly pushing ahead to bigger fields and their company cannot help but succeed. Enthusiasm always wins.

A Study of the Saturated and Unsaturated Oils From Shale*

Results of Experimental Work on the Composition and Properties of the Lighter Fractions and Heavy Undecomposed Residues Resulting From the Pyrolytic Treatment of Crude Shale Oils

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IN PREVIOUSLY published papers on saturated and unsaturated oils from shale[1,2] the author has presented data which indicated the following facts relative to the saturation and decomposition of certain crude shale oils: As obtained from plant and laboratory retorts, these oils consisted of 12 to 40 per cent of constituents (saturated compounds) unabsorbed by cold concentrated sulphuric acid and 60 to 88 per cent of materials removed by treatment with this acid. The crude oils decomposed readily on distillation at atmospheric pressure and formed coke, gas and lighter oils containing 15 to 83 per cent more saturates by volume than the original oil. The decomposition occurred during the distillation of the heavier fractions, was greatest for oil which had been retorted with steam, and was practically completed by one distillation. The lighter fractions were more highly saturated and the saturation diminished as the specific gravity of the fraction increased. Distillations with steam, with inert gases, and under diminished pressure tended to prevent the cracking, but the oil obtained in all cases contained a lower percentage of saturates. The statements which concern the decomposition of crude shale oils and the effect on saturation are based on experimental work with five different oils from Colorado, Utah, and Nevada shales.

Further Study on the Pyrogenetics of Shale Oils

The effects of the decomposition as shown by these oils may be looked upon with favor by the refiner, since cracking improves the quality of the oil and increases the quantity of gasoline, which is the most highly saturated portion; but new problems are presented to the oil chemist, since an increase in saturation as a result of decomposition at atmospheric pressure is at variance with the usual conception of the cracking of petroleum oils. In the former papers it was suggested that this strange phenomenon might be caused by the decomposition of heavy unstable unsaturated compounds, but that more experimental evidence as to the composition of these materials was desirable. From both practical and theoretical standpoints it appears of interest and importance to determine to what extent this behavior is true of other crude shale oils, and to study the lighter fractions obtained by cracking and the heavy undecomposed materials with the hope of ascertaining more regarding the cause of this unusual example of pyrogenetics and of increasing our knowledge concerning the composition and properties of the constituents involved in the decomposition. It is the purpose of this paper to present the results of additional experimental work along these lines.

Decomposition of Crude Shale Oils on Distillation

Crude shale oils from other fields (see Table I) than those studied in the former papers have been examined to determine the amount of decomposition on distillation and the effect of the cracking on the content of saturates and nitrogen. The Scottish oil was produced in the plant of the Oakbank Oil Co., Ltd., and the Norfolk oil in an experimental retort on the property of the English Oilfields, Ltd.[3] The other oils were obtained by distillation in laboratory retorts operated at moderate temperatures without steam using shales representative of localities in the fields mentioned in Table I.

A portion (50 or 100 c.c.) of each of the crude oils was distilled from a Pyrex distilling flask the capacity of which was double the volume of the oil used. The distillation was conducted at the rate of about one drop a second until the formation of a hard coke. The water was measured by volume. The weight of the coke was obtained as the difference between the weight of the empty flask and the weight of the flask and contents after the distillation. The crude and once-run oils were measured both by volume and by weight. The percentages of gas were calculated by difference.

Tests were made on the crude and once-run oils for gravity and saturation by the methods used for the oils previously studied.[4] Six of the oils of most varied nature were analyzed for nitrogen both before and after the distillation. In making the nitrogen determinations the oils were first washed five times with an equal volume of hot water to remove soluble nitrogen compounds. The oils were then kept warm for 24 hours to insure a rather complete separation of the water. The nitrogen analyses were made by the following modification of the Kjeldahl-Gunning method: A sample of the oil (2 to 3 g.) is digested in a 650-c.c. Kjeldahl flask with 10 g. potassium sulphate, 0.3 g. anhydrous copper sulphate and 45 c.c. of 96 per cent sulphuric acid. After the oil has been completely decomposed, the flask is cooled and 300 c.c. of water added. The flask is again cooled and a small piece of paraffine introduced to prevent foaming. The usual excess of sodium hydroxide solution is run gently down the inside of the flask, a few pieces of zinc shot are immediately dropped in and the distillation is then made in the usual manner. The ammonia is distilled into 0.1 *N* sulphuric acid and the excess titrated with 0.1 *N* sodium hydroxide, using

*Contribution from the Research Laboratories of the Colorado School of Mines, Golden, Col.

[1]Read at the October, 1920, meeting of the Colorado Section of the American Chemical Society. Abstracted in *Shale Review*, November, 1920, p. 6.

[2]Chem. & Met. Eng., vol. 24, p. 876, May 18, 1921.

[3]The author is indebted to the above mentioned companies and to President V. C. Alderson of the Colorado School of Mines for the samples of shale and oil from England and Scotland.

[4]Chem. & Met. Eng., vol. 24, p. 878.

TABLE I—DECOMPOSITION OF CRUDE SHALE OILS ON DISTILLATION

Crude Distilled	Products Obtained by Distillation of Crude Oils — Percentage by Weight — Water	Oil	Coke	Gas	Changes Produced by Distillation of Crude Oils — Gravity Crude	Once-run	Saturates Crude Per Cent	Once-run Per Cent	Nitrogen Crude Per Cent	Once-run Per Cent	Add't'l Sats. Per Cent	Loss Oil Per Cent	Loss Nitrogen Per Cent
Utah No. 1	0.2	80.9	16.5	2.4	0.939	0.888	26.5	40.0	....	....	7.7	18.9	
Nevada	0.1	95.0	3.4	1.5	0.877	0.851	41.2	58.8	0.31	0.20	16.4	4.9	35.5
Colorado (plant)	0.3	89.5	8.4	1.8	0.920	0.904	16.0	30.0	1.41	1.16	11.3	10.2	17.7
Colorado (laboratory)	0.2	94.0	4.4	1.4	0.889	0.870	25.1	36.4	....	....	9.8	5.8	
Utah, No. 2	0.3	83.0	10.4	6.3	0.917	0.8745	23.0	45.6	1.45	1.04	16.7	16.7	28.2
Wyoming	0.3	93.5	4.1	2.1	0.899	0.868	20.0	36.0	....	....	14.9	6.2	....
Kentucky	0.0	91.1	6.2	2.7	0.919	0.899	30.0	40.5	....	....	7.7	8.9	
California	0.0	94.5	3.4	2.1	0.926	0.912	41.0	43.5	0.45	0.41	0.7	5.5	8.8
Scotland, Oakbank	0.07	95.24	3.76	0.93	0.876	0.858	38.0	57.2	0.85	0.65	17.6	4.7	23.5
England, Norfolk	0.1	87.2	8.2	4.5	0.992	0.970	7.0	14.6	0.88	0.81	6.0	12.7	8.0
England, Blackstone seam	0.2	78.0	12.1	9.7	0.986	0.852	8.8	55.0	*	*	40.8	21.8	....

*Unfortunately, our supply of this crude oil was not sufficient for the nitrogen analyses.

TABLE II—YIELD, GRAVITY AND SATURATION OF PRIMARY AND SECONDARY GASOLINE

	Colorado Crude — Retorted at Low Temperature Primary	Secondary	Colorado Crude — Steam Retorted Primary	Secondary	Colorado Crude — Retorted at High Temperature Primary	Secondary	Nevada Crude — Primary	Secondary	Wyoming Crude — Primary	Secondary
Yield, per cent	20.3	5.1	13.6	10.5	29.0	2.7	2.62	5.83	26.5	8.0
Gravity	0.783	0.779	....	....	....	....	0.820	0.785	0.787	0.790
Saturation, per cent	51.0	54.0	50.0	50.6	52.4	57.0	58.8	60.2	48.2	49.8

cochineal as indicator. These analyses were all made in duplicate and where the results did not agree within the limits of experimental error the determinations were repeated until the correct percentages were assured.

The results obtained by the distillation and analyses of these crude and once-run oils are given in Table I, which also contains for convenience similar data for four of the Colorado, Utah and Nevada oils previously studied (the first four oils in Table I). The "additional saturates" of Table I are the new saturates formed by cracking and are calculated from the volume of the saturates in a 100 c.c. of crude oil and the volume of saturates in the once-run oil obtained from 100 c.c. of this crude, by subtracting the first volume from the second. The percentage given is the amount of saturates formed by cracking expressed in percentage of the original crude oil. The "loss of oil" is the sum of the percentages of gas and coke, and does not include the water, since this was present in the crude oil and not formed by the decomposition. The "loss of nitrogen" is the total nitrogen lost in coke, gas and in the water-soluble compounds of the once-run oil, expressed in percentage of the nitrogen present in the crude oil.

Discussion of the Results in Table I

From the data in Table I it is evident that all the crude oils tested decomposed to some extent on distillation and that the decomposition was accompanied by an increase in saturation and a decrease in nitrogen content. There is, however, quite a wide range in the amount of these changes. The California oil, which in many ways resembles petroleum, is little changed in gravity, saturation or nitrogen content and forms but 5.5 per cent of gas and coke, while the Kimmeredge oil from the Blacktsone seam decreases 0.134 in gravity, has an increase of 40.8 per cent in "additional saturates" and forms 21 per cent of gas and coke. These two oils are probably extremes, while the others, which lose 5 to 19 per cent as gas and coke, decrease from 0.016 to 0.050 in gravity, yield 6 to 17 per cent of "additional saturates" and lose 8 to 35 per cent of the nitrogen, are probably more representative of shale oils as a class. However, crude shale oils from different strata in the same locality may vary in these respects, but at present no data are available on this question. It is also known that crude oils retorted from the same shale under different conditions vary considerably in degree of decomposition.[5]

[5]Chem. & Met. Eng., vol. 24, May 18, 1921, p. 878, Table III.

It is evident by a comparison of the results given in the last part of Table I that there is no quantitative relation between the "loss of oil" and the "additional saturates" or the "loss of oil" and the "loss of nitrogen." But where the percentage losses of nitrogen are high (17 per cent or more) there is a large yield of "additional saturates" (11 to 18 per cent) and where the nitrogen losses are low (8 per cent) the "additional saturates" are smaller (6 per cent or less). This suggests that the "additional saturates" may be formed by a decomposition of unstable nitrogen constituents. The rôle of the nitrogen compounds in the decomposition deserves consideration because 2 per cent of nitrogen in the heavy unstable materials, combined with carbon, hydrogen, and possibly some sulphur to make molecules as high in molecular weight as these materials probably are, would account for the greater portion of the unstable materials. Molecular weights such as $C_{31}H_{61}N$ require but 3 per cent of nitrogen. Many investigators have noted that petroleums high in nitrogen are easily decomposed by distillation at atmospheric pressure.[6] It is possible that this instability may be caused by the nitrogen constituents and that saturation tests before and after decomposition would show an increase in saturation similar to that of the shale oils. The stability of the once-run oils proves that they contain lighter nitrogen compounds not easily decomposed.

Light Oils Obtained by Cracking

Some information concerning the oils produced by cracking at atmospheric pressure can be gained by a study of the lighter fractions of both the crude and once-run oils, since the latter contain the light oils formed by the decomposition. For a number of the crude oils under investigation the percentage, gravity and saturation of the fractions to 410 deg. F. were determined. For the oils given in Table II these values were determined and then this fraction (primary gasoline) was excluded, the remaining fractions composited on distillation and this once-run composite distilled to 410 deg. F. The second light fraction thus obtained (secondary gasoline) consists of oils formed by cracking. The gravity, saturation and percentage of the secondary gasolines are tabulated in Table II with similar data for the primary gasolines. Table III gives similar data for other oils, but here the primary gasoline

[6]Mabery, *J. Soc. Chem. Ind.*, vol. 19, p. 504; *J. Am. Chem. Soc.*, vol. 41, p. 1691. Richardson, *J. Soc. Chem. Ind.*, vol. 19, pp. 122 and 123. Coates and Best, *J. Am. Chem. Soc.*, vol. 25, p. 1151. Peckham, *J. Frank. Inst.*, vol. 146, p. 45. Salathe, 13th Report Cal. State Mineralogist.

is included with the secondary as "total" gasoline and the distillation of one of the crude oils was made with steam. The yields are given in percentages by volume of the original crude oil.

Discussion of the Results in Tables II and III

The primary gasolines from the different shale oils vary in quantity (2.6 to 26.5 per cent) and saturation (42.4 to 60.0 per cent). For oils from the same sample of Colorado shale retorted under different conditions the quantity and saturation of the primary gasoline fraction are lowest for the steam retorted oil (13.6 per cent and 50.0 per cent respectively) and highest for the oil retorted at higher temperatures without steam (29 per cent and 52.4 per cent respectively). For the secondary gasoline the quantity and saturation vary with the field from which the shale was obtained and the quantity is also influenced by the method used in retorting. For the Colorado shale oil mentioned above this quantity was 2.7 per cent where the retorting decomposition was greatest and 10.5 per cent where the retorting decomposition had been diminished by the use of steam. For each shale oil tested the secondary gasoline fraction has a higher saturation (0.6 to 9.0 per cent) than the primary fraction. In other respects these light oils appear to be very similar in composition and properties. This might be expected, since both are decomposition products, the primary gasoline being produced by cracking in the retort and the secondary by decomposition in the still. Both are cracked gasolines and are about equal in quality. Since the prevention of cracking diminishes the yield and does not improve the quality of the gasoline, there is no reason as far as gasoline is concerned for the prevention of cracking either in the retorting of the shale or in the distillation of the oil.

TABLE III—YIELD, GRAVITY AND SATURATION OF PRIMARY AND TOTAL GASOLINE

	Utah Crude		Utah Crude First Distillation With Steam		Oakbank Crude	
	Primary	Total	Primary	Total	Primary	Total
Yield, per cent	13.6	26.2	13.5	21.2	12.0	15.75
Gravity	0.800	0.795	0.807	0.810	....	.....
Saturation, per cent	42.4	51.7	43.2	46.8	60.0	65.6

Unstable Materials of Crude Shale Oils

Since the decomposition which occurs during the distillation of crude shale oils is greatest for the heavy fractions and is diminished by distillations with steam, the unstable materials should be found in large quantities in the heavy residue remaining after the lighter oils have been removed from the crude by distillation with steam. Two samples of the heavy undecomposed materials were prepared in this manner. The first was obtained by distilling 4,000 c.c. of a crude Colorado shale oil to coke with steam and reserving the last fraction (200 c.c.) for the experimental work. The second was prepared by distilling 5,000 c.c. of the Utah crude No. 2 with steam but leaving a residue of 700 c.c. which was poured from the still while hot and is the "shale-oil residue" mentioned in the remaining portions of this paper.

The first sample, which for convenience will be designated as "cut ten," was a yellowish brown, sticky, semi-solid. It became much darker and slightly harder on exposure to air. When cooled slightly below room temperature the "shale-oil residue" was a black, lustrous solid, but very tenacious and sticky at higher temperatures. Tests were made on "cut ten" for specific gravity, saturation and solubility; and a portion was destructively distilled and the resulting oil examined. The results obtained with "cut ten" are given in Table IV. Solubility, saturation and fixed carbon determinations were made on the "shale-oil residue," using the methods for bitumens given in Richardson's "Modern Asphalt Pavement," 1910. A portion of this residue weighing 450 g. was destructively distilled at atmospheric pressure from a 1,000-c.c. Pyrex distilling flask. The yields of gas, coke and oil were measured and the oil fractionated into 10 per cent fractions, each of which was tested for gravity and saturation. The "shale-oil residue" and the oil obtained from it by distillation were analyzed for sulphur by the method of Waters[7] and for nitrogen by the Kjeldahl modification already described. The data obtained with the "shale-oil residue" and the oil produced from it by distillation are given in Table V.

Discussion of the Results in Tables IV and V

"Cut ten" and the "shale-oil residue" were found to contain 90 to 95 per cent of unsaturates and 83 to 88 per cent of malthenes; hence these heavy materials consist of a large proportion of unsaturated malthenes. The percentage of sulphur (0.37 per cent) in the "residue" is much lower and that of the nitrogen (2.05 per cent) higher than Richardson[8] gives for the malthenes of Trinidad asphalt (2.9 and 0.6 per cent respectively).

TABLE IV—DATA ON "CUT TEN" FROM STEAM DISTILLATION OF CRUDE SHALE OIL

Specific gravity	1.0216
Saturation, per cent	5.4
Solubility in carbon bisulphide, per cent	100.0
Malthenes, soluble in 84 deg., Bé. petroleum ether	88.0
Products of Distillation	
Water, per cent by weight (present as such in sample)	7.6
Oil, per cent by weight	65.0
Coke, per cent by weight	23.4
Gas, by difference	4.0

Changes Produced by Distillation	Gravity	Saturation Per Cent
Before distillation	1.0216	5.4
After distillation	0.959	50.0
Additional saturates		27.8

Results of Fractionation	Per Cent	Saturation Per Cent
Water, by volume	0.28	..
Oil to 410 deg. F.	14.0	60.5
Oil to 572 deg. F.	21.1	49.5
Oil to 680 deg. F.	59.4	40.2
Gas and coke (by difference)	5.2	

On distillation at atmospheric pressure "cut ten" and the "shale-oil residue" exhibit a greater decomposition, increase in saturation and loss of nitrogen than the crude shale oils. The "residue" formed 46.6 per cent of gas and coke, lost 72.8 per cent of the original nitrogen and formed 23.3 per cent of "additional saturates," while the Utah crude No. 2, from which this "residue" was obtained, yielded 16.7 per cent of gas and coke, 16.7 per cent of "additional saturates" and lost 28.2 per cent of the original nitrogen. These differences are, of course, caused by the higher content of the unstable materials in the "shale-oil residue." It is probable that the saturates of the "residue" do not decompose on distillation owing to greater stability, but the other materials evidently undergo almost complete decomposition, since 46.6 per cent is transformed into gas and coke, 23.3 per cent into "additional saturates" and 3.2 per cent is present as new unsaturates in the light highly

[7] *J. Ind. and Eng. Chem.*, vol. 12, p. 482.
[8] "Modern Asphalt Pavement," 1910, p. 170.

TABLE V—DATA ON "SHALE-OIL RESIDUE" FROM STEAM DISTILLATION

Specific gravity	1.015
Saturation, per cent	10.7*
Solubility in carbon bisulphide, per cent	99 8†
Malthenes, soluble in 84 deg. Bé. petroleum ether, per cent	83 6†
Carbenes, soluble in CS_2 but insoluble in CCl_4, per cent	0 26
Fixed carbon, per cent	10 6
Sulphur, per cent	0.37†
Nitrogen, per cent	2.05†

Products of Distillation

Water, per cent by weight	0.2
Oil, per cent by weight	53.2
Coke, per cent by weight	36.2
Gas, by difference	10 4

Changes Produced by Distillation

	Gravity	Saturation Per Cent	Nitrogen Per Cent	Sulphur Per Cent
Before distillation	1.015	10.7	2.05	0.37
After distillation	0.8578	54.0	1.05	0.34

	Per Cent
Additional saturates	23.3
Loss of residue	46.8
Loss of nitrogen	72.8

Results of Fractionation

Percentage-off.	Temperature Deg. F.	Gravity (Of 10 per cent fractions)	Saturation (Of 10 per cent fractions)
10	307	0.718	72.0
20	345	0.777	67.0
30	427	0.817	63.0
40	477	0.844	60.0
50	525	0.865	56.8
60	567	0.875	54.0
70	605	0.894	52.0
80	645	0.904	48.8
90	705	0.913	47.0
98.25	700	0.929	38.1
Composite of above		0.854	56.0

Products of Distillation

Oil, per cent by weight	97.8
Coke, per cent by weight	1.3
Gas, by difference	0.9

* Determined by the method on p. 544, Richardson's "Modern Asphalt Pavement," 1910. This result is probably too high. This method is inaccurate for some bitumens the saturates from which are sticky, or hard and resinous, and certainly not paraffines but possibly neutral esters or polymers of unsaturates which are soluble in the petroleum ether and not removed by the treatment with acid and alkali. See Brooks and Humphrey, *J. Am. Chem. Soc.* vol. 40, pp. 847 and 856.
† The average of two determinations.

saturated fraction of the oil boiling below 346 deg. F. The oil obtained by the destructive distillation of the "residue" resembles the once-run Utah oil No. 2 in that it does not decompose on distillation and in the distribution of the saturates, but the boiling point and specific gravity of the fractions are lower and the saturation higher than in the fractions of the once-run oil. Since the once-run oil from the Utah crude No. 2 contains less than 46 per cent of saturates, while that from the "residue" obtained from this crude contains 54 per cent of saturates, and since the secondary gasolines have a higher saturation than the primary gasolines, it is probable that the materials escaping decomposition in the retort crack on distillation with a higher yield of saturates than the materials that decompose in the retort. The most remarkable property of the decomposition of the "shale-oil residue" is the large yield of saturates, the greater portion of which consists of lighter oils (72 per cent of the first 10 per cent fraction).

Crude shale oils are apparently composed of comparatively light stable oils of higher saturation produced by decomposition during retorting and of heavy unstable materials of lower saturation that have escaped decomposition in retorting because of rapid removal as vapor and fog by the gases and lighter oils. The decomposition from kerogen to once-run oil tends to occur in two stages—a primary decomposition in which the insoluble kerogen is changed, possibly by depolymerization, into soluble heavy unstable materials similar to the "shale-oil residue"; and a secondary decomposition (not depolymerization) in which these unstable materials are broken down into lighter oils of greater stability and higher saturation such as constitute the once-run oils. Since the secondary gasolines and the light fractions of the oil from the "shale-oil residue" have a higher saturation than the primary gasolines, the primary decomposition must also yield light oils which contain a larger proportion of unsaturates than the light oils formed by the secondary decomposition; or the primary decomposition produces unstable materials lighter than the "shale-oil residue" which yield on secondary decomposition a larger percentage of unsaturates than the heavy "residue" examined in this work. Retorting with steam and inert gases tends to prevent the secondary decomposition[9] by carrying over larger amounts of the bitumen produced by the primary decomposition, and as a result the crude oil contains a higher percentage of the unstable unsaturated materials. Destructive distillation of shale or distillation of crude shale oil at slower rates or under any conditions which tend to prevent the removal of the primary products in the form of fog (heavy non-gaseous vapor) causes a more complete secondary decomposition and produces an oil of the once-run type. Much of the so-called high-temperature retorting apparently evolves the products so rapidly that the gases and lighter oils carry large proportions of the primary products out of the hot zone before the slower secondary decomposition has progressed far, and the crude oil is consequently more highly unsaturated. It is evident that physical conditions during retorting can be so controlled as to obtain a maximum of the bituminous products of the primary decomposition or an oil similar in quality to the once-run oils in which the secondary decomposition is complete, and that consideration of these two stages of the decomposition is important in the construction and operation of retorts on a commercial scale. Since the heavy primary decomposition products of shale may prove to be of commercial importance, these materials should be thoroughly investigated.

Summary

1. Crude oils from shales of wide geographical distribution and of varied chemical composition have been examined and their heavy fractions found to decompose on distillation at atmospheric pressure. The decomposition is accompanied by the formation of coke, gas and lighter oils which contain considerably more saturates and less nitrogen than the original crude oil. The increase in saturates appears to be associated with the loss of nitrogen rather than with the loss of oil.

2. The light oils obtained by the decomposition of crude shale oil are a little higher in saturation than the light oils present in the crudes before the decomposition but in other respects these light oils are similar.

3. The undecomposed bitumen from a crude shale oil was found to consist largely of unsaturated malthenes, high in nitrogen and low in sulphur. A sample of this material decomposed almost completely on distillation at atmospheric pressure forming coke, gas and lighter stable oils which contained a larger proportion of saturates, but a similar percentage of nitrogen to that in the once-run oil from the same crude as this bitumen. This unstable material is a primary decomposition product of kerogen and is the parent material from which the lighter, more saturated stable oils are formed by a further secondary decomposition. Crude shale oils as usually obtained consist of both primary and secondary decomposition products.

The author wishes to express his indebtedness to R. W. Boyd, who did the experimental work with the shale oils from California, Kentucky and England.

[9] Chem. & Met. Eng., vol. 24, May 18, 1921, p. 877.

Grain Growth and Recrystallization in Metals
II—Experimental Data and General Laws

Consideration of the Effect of Time and Temperature of Heating, Degree of Cold-Work, Original Grain Size and Obstructing Impurities on the Grain Growth of Metals and Solid Solution Alloys —Non-Uniform Conditions Have Powerful Effect on Results of Any Treatment*

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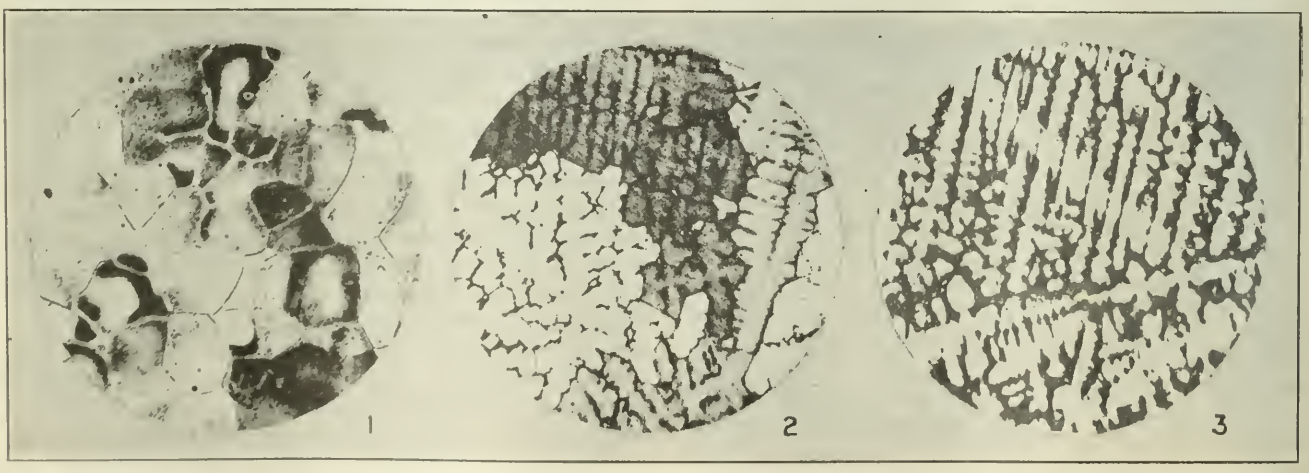
THE appearance of the grains of a cast metal on a plane surface cut through the metal usually gives no indication of the mechanism of their formation. Each grain appears uniform within its own boundaries and does not suggest that it has grown by a process of dendrite formation. That such is the case is revealed by examining an exterior surface of the metal which has been allowed to solidify freely and upon which the dendrites will usually be found in relief. An illustration was given in an article by the present authors entitled "The Crystalline Structure of Metals" (CHEM. & MET. ENG., May 4, 1921, p. 771). Fig. 1 is a micrograph of a cast brass containing 90 per cent copper and 10 per cent zinc. The structure approximates that of a pure metal, showing pohydedral grains uniform in appearance within themselves except for slight changes in etching tint due to concentration of the zinc near the grain boundaries. This effect is known as "coring" and regularly occurs during the solidification of alloys which in equilibrium consist of homogeneous solid solutions.

Cored Crystals

As the amount of impurity increases the coring effect becomes more marked. In Fig. 2 is shown a cast brass containing 70 per cent copper and 30 per cent zinc. Under equilibrium conditions about 35 per cent of zinc is soluble in copper in the solid state, but equilibrium is not attained during solidification and the structure shows marked coring with perhaps the separation of a second phase. The dendritic structure of the primary copper-rich grains is clearly shown. Fig. 3 shows a similar structure in cast Monel metal, which contains about 60 per cent nickel, 35 per cent copper and 5 per cent iron and manganese. Both this alloy and the 70:30 brass after working and annealing exhibit perfect solid solution structures, indistinguishable under the microscope from those of a pure metal. These illustrations show not only the tendency of metals to crystallize in the form of dendrites but also that the solid solution alloys are not homogeneous solid solutions in the cast state. This is important because the discussions below deal with grain growth in substantially pure metals and solid solution alloys which after a homogeneous structure is produced follow the same laws of grain growth as pure metals.

On solidification the amount of the added element in an alloy of the solid solution type influences the grain size. This is particularly true in case of sharp variations of temperature between different parts of the solidifying alloy. Whereas pure metals cast in iron molds or otherwise caused to solidify rapidly nearly always show smaller grains than when cast in sand molds or caused in any other way to solidify slowly, solid solution type alloys often show larger grains when cast in chill molds. There seems to be a certain temperature gradient and composition favoring the formation of large grains. The solidification of an ordinary steel ingot in an iron ingot mold seems to produce the proper conditions for large grains in the exterior of the ingot and considerably smaller grains in the interior. It should be remembered that the grain size of cast

*Part I, on Definitions, was published in CHEM. & MET. ENG., vol. 26, No. 8, Feb. 22, 1922, p. 343.



FIGS. 1 TO 3

Fig. 1—Cast 90:10 Brass (Bassett).

Fig. 2—Cast 70:30 Brass (Bassett).

Fig. 3—Cast Monel Metal (Merica).

FIG. 4—COARSE-GRAINED TUNGSTEN BRIQUET FUSED AT CENTER. × 25

metals is always large as compared with that ordinarily found in worked metals.

The effect of existing crystals on the crystallization of a liquid is well known. If a crystal of a salt is put in a saturated water solution of the salt and the temperature lowered, the existing crystal grows larger. The added material assumes the same orientation as the original crystal. If the temperature is lowered very gradually, no new crystals may form. This is only one of many cases illustrating that when a liquid solidifies, existing crystals form "nuclei" on which the liquid crystallizes. A good example of this rule was observed when a coarse-grained tungsten ingot was heated by the passage of electric current until the central or axial portion fused. Fig. 4 shows that the grains in the resolidified portion are continuations of the grains in the unfused portions.

When a fine-grained tungsten ingot was fused in the center, however, the metal resolidified in such manner that each grain in the resolidified portion was adjacent to about 100 of the original grains. The structure of such an ingot is shown in Fig. 5. (Sykes). This relatively coarse-grained structure is produced in spite of a rapidity of solidification perhaps seldom equaled in any other metal. The fusion of the ingot breaks the electrical contact and in about one minute the ingot cools from 3,400 deg. C. to about 50 deg. C. Such a cast structure does not show grain growth in the solid state even with long exposures at temperatures slightly below the melting point.

Normal Grain Growth in Solid Metals

Grain growth in the solid state in worked metals and solid solution alloys can be illustrated by the behavior of alpha brass. The structure of a 70:30 brass as cast is shown in Fig. 2. After hot-working or cold-working and heating to a temperature around 600 deg. C. the structure is that of a homogeneous solid solution composed of equiaxed grains. In worked brass the grains are nearly always twinned, although twins are not found in the casting. The history of change in grain size with change in temperature in a 68:32 brass after 50.9 per cent reduction in thickness by cold-rolling is shown in Figs. 6 to 13 inclusive (Bassett and Davis). No grain growth takes place until a temperature of about 275 deg. C. is reached and the cold-worked structure is completely replaced by small equiaxed grains at 400 deg. C. after 30 minutes' exposure. As the temperature increases the grain size increases.

The increase in grain size with temperature can be seen qualitatively in the micrographs and is plotted in Fig. 14. The shape of this curve is similar to that found for many metals by various observers, including Mathewson and Phillips[1] working on alpha brass; Mathewson[2] on copper-tin alloys with 2.4 and 8 per cent tin, and Mathewson and Thalheimer[3] for copper. Rapid increase in grain size begins at about 700 deg. C. for copper.

Although this type of curve is normal for many metals, there are many factors which may and often do cause marked deviations. McAdam[4] shows that cold-worked Armco iron annealed for either 7- or 14-hour periods has a fairly constant grain size up to about 800 deg. C., above which temperature there is a marked grain growth. His temperature-grain size curves are more flat at low temperature than the one shown in Fig. 14, but the increase in grain size above 800 deg. C. is more pronounced than in alpha brass above 600 deg. C. One of the authors has found that the normal grain size-temperature curve for briquetted and sintered tungsten powder[5] is more nearly a straight line than that of Fig. 14. Sometimes when abnormal growth occurs the curve may depart from the normal type entirely within certain temperature ranges.

The time of exposure at the various temperatures is an important factor in the resulting grain size, especially at the lower temperatures. In alpha brass a grain size is reached after a comparatively short time, say 30 minutes, at 650 deg. C., which does not change to any marked extent with longer exposures. If the temperature is 325 deg. C., the time necessary to establish apparent equilibrium grain size is measured in days. Fig. 15 shows the time necessary at various temperatures to produce a given amount of softening in alpha brass (Mathewson and Phillips). If, however, the temperature is raised to a little below the melting point, a fraction of a minute is often sufficient to produce a grain size which does not change noticeably on further exposure. Incandescent lamp filaments of tungsten operated

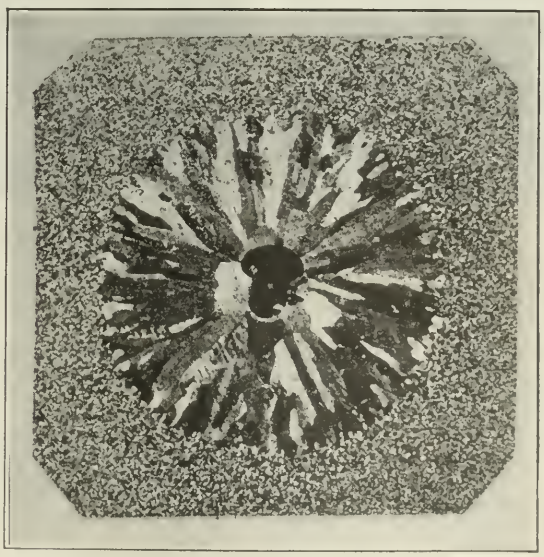


FIG. 5—FINE-GRAINED TUNGSTEN BRIQUET FUSED AT CENTER. × 6. (SYKES)

at a temperature of about 2,100 deg. C. usually exhibit growth until "burn out," which is sometimes as long as 90 days' total heating[5]. The same filaments can be heated to a temperature just below the melting point (3,400 deg. C.) and in a few minutes or sometimes in a fraction of a minute a

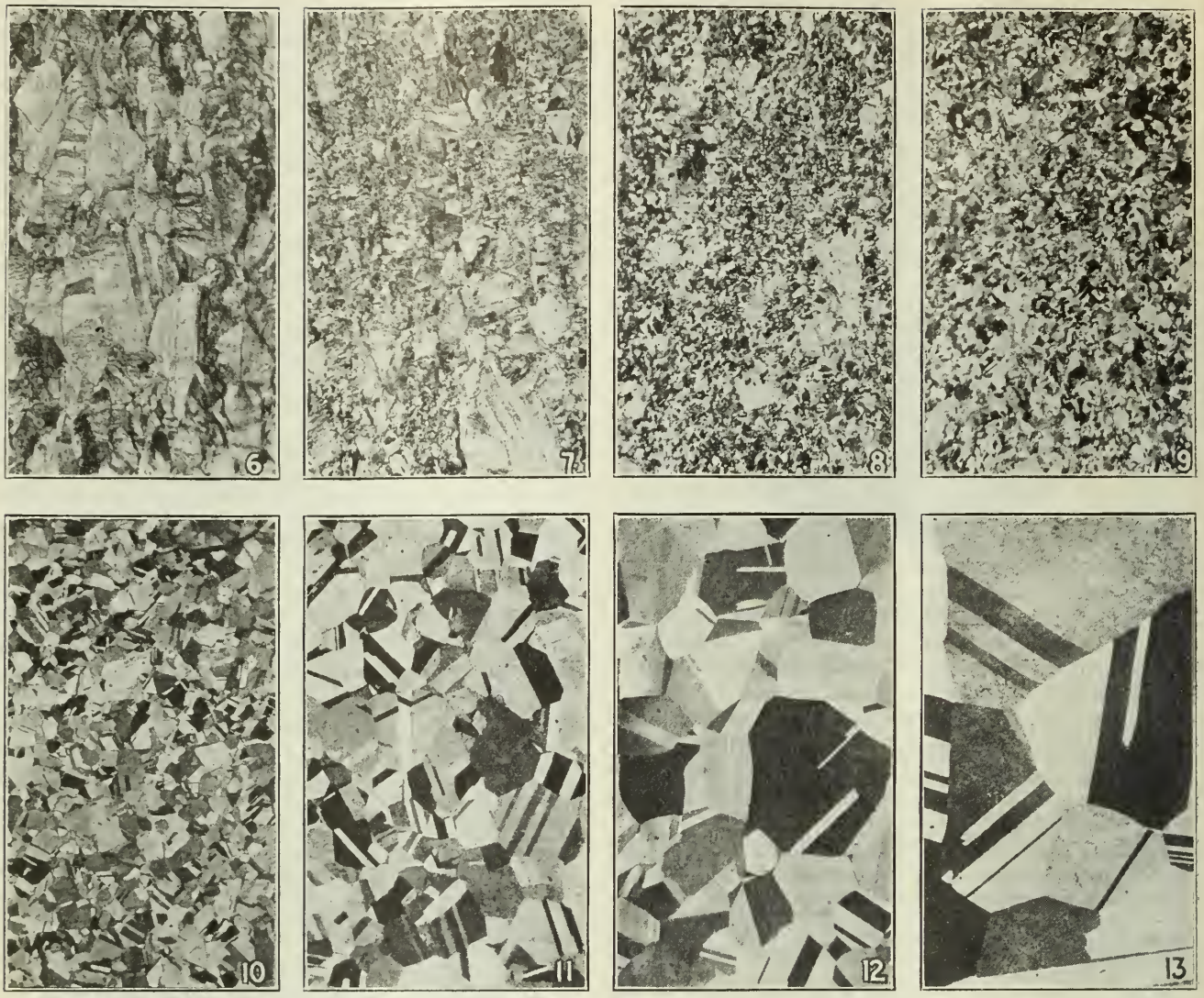
[1] "Recrystallization of Cold-Worked Alpha Brass on Annealing," Mathewson and Phillips, *Trans.*, A.I.M.E., vol. 54 (1916), pp. 608-670.

[2] "Metallographic Description of Bronzes From Machu Picchu, Peru," Mathewson, *Am. J. Sci.*, vol. 40, December, 1915, p. 546.

[3] "Comparisons Between Electrolytic Copper and Two Varieties of Arsenical Lake Copper With Respect to Strength and Ductility in Cold-Worked and Annealed Test Strips," Mathewson and Thalheimer, *Am. Inst. Min. Eng.*, vol. 55 (1916), pp. 446-485.

[4] "Grain Size of Iron as Affected by Temperature," McAdam, A.S.T.M., vol. 18 (1918), Part II Technical Papers, pp. 68-86.

[5] "The Metallography of Tungsten," Jeffries, A.I.M.E. (1919) vol. 60, pp. 588-656.



FIGS. 6 TO 13—EFFECT OF 30-MINUTE ANNEAL ON GRAIN SIZE OF 68:32 BRASS, REDUCED COLD 50.9 PER CENT. × 75 (BASSETT AND DAVIS)

Fig. 6—As rolled. Fig. 7—Annealed at 300 deg. C. Fig. 8—Annealed at 350 deg. C. Fig. 9—Annealed at 450 deg. C. Fig. 10—Annealed at 550 deg. C. Fig. 11—Annealed at 650 deg. C. Fig. 12—Annealed at 750 deg. C. Fig. 13—Annealed at 850 deg. C.

grain size will be produced which does not change noticeably when the filament is subjected to a lower temperature; at 3,000 deg. C. 30 seconds often suffice.

A severely cold-drawn nickel:iron alloy containing 56 per cent iron and 44 per cent nickel with a melting point of about 1,475 deg. C. was heated to 1,200 deg. C. for 30 seconds and a grain size was developed which did not change with longer exposure at that or lower temperatures. The same alloy required several hours at 725 deg. C. to produce a similar stability of grain size, although the grains were much smaller than those produced at 1,200 deg. C.

Armco iron containing only 0.02 per cent carbon was pressed cold and heated to 850 deg. C. At the end of 1 hour the average grain diameter was 0.0022 in. At the end of 10 hours this had increased to 0.0077 in. and after 168 hours the average grain diameter was 0.25 in. How much longer this growth would have gone on is not known, as the test was not continued.

The important conclusions from these observations are (1) that under some conditions of temperature, particularly at relatively high temperatures, a grain size is established in a very short time which is stable so long as the metal is not subjected to a higher temperature, and (2) that there is in some metals an intermediate temperature range (which is around 2,100 deg. C. for tungsten and 850 deg. C. for iron) at which grain growth continues for long periods and very large grains may be developed. This intermediate temperature range is not found in all metals. When it does obtain, an abnormal grain size may develop. Carpenter and Elam[6] report that large grains are developed in commercial aluminum sheet severely worked and annealed for 2 weeks at 550 deg. C.

Recrystallization

A great amount of work has been directed toward the study of the phenomena of recrystallization. Recrystallization has been defined in the first of this series of articles as the change from the strain-hardened to the un-strain-hardened condition. When recrystallization is complete the small unstrained grains grow into larger unstrained grains in accordance with the general rules just considered.

The greater the degree of strain-hardening the lower will be the temperature of recrystallization. Consequently with a metal of a given composition—i.e., a given degree of purity—anything which will increase the degree of strain-hardening will decrease the recrystallization temperature. The amount of deformation effected below the recrystallization temperature is one

[6] "Crystal Growth and Recrystallization in Metals," Carpenter and Elam, *J. Inst. Metals*, No. II (1920).

factor influencing the degree of strain-hardening. The general rule is that the recrystallization temperature is lower the greater the amount of cold-work.

Mathewson and Phillips show that in alpha brass, previously annealed at 800 deg. C., recrystallization after 4 per cent reduction in area by cold-rolling requires a temperature of 650 deg. C., and after 40 per cent reduction the temperature is 350 deg. C. for a 30-minute anneal. Carpenter and Elam[1] show that commercial aluminum sheet previously annealed for 6 hours at 550 deg. C. and then elongated 2 per cent at room temperature did not show recrystallization or at least complete recrystallization after 65 hours' heating at 500 deg. C. With 4 per cent or more elongation recrystallization was complete under these conditions of time and temperature. With severe cold work the recrystallization temperature may be lowered to 200 deg. C. or less. Usually in such cases the grain size is smaller the greater the previous deformation.

Grain size prior to cold deformation is an important factor in connection with the degree of strain-hardening and hence greatly affects the recrystallization temperature. The smaller the grains the greater is the strain-hardening effect of a given amount of deformation and the lower is the recrystallization temperature. Fine-grained metal elongated 1 per cent may have a lower recrystallization temperature than a coarse-grained metal elongated 5 per cent or more. This disparity in grain size prior to cold deformation may even produce such marked difference that a coarse-grained metal elongated as much as 5 per cent will not recrystallize at a temperature which will cause normal grain growth in an annealed but fine-grained sample of the same metal. For example, a severely cold-worked aluminum sheet heated for several hours at 250 deg. C. will recrystallize. The grains will be small. If the same piece is heated to 300 deg. C., grain growth will take

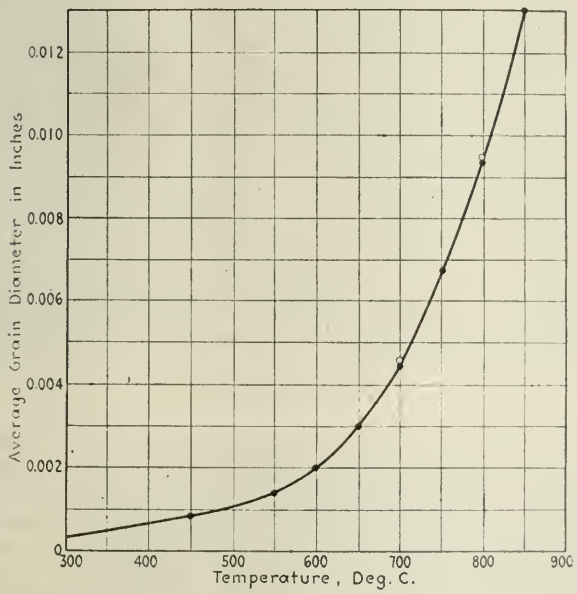


FIG. 14—EFFECT OF 30-MINUTE ANNEAL ON THE GRAIN SIZE OF 68:32 BRASS COLD-ROLLED 50.9 PER CENT. (BASSETT AND DAVIS)

place. A very coarse-grained sample stretched 5 per cent cold may show no signs of recrystallization at 300 deg. C.

Time of exposure at temperature is an important factor in the temperature of recrystallization (refer to Fig. 15). A cold-worked metal which might show only partial or no visible signs of recrystallization in 5 minutes might show complete recrystallization in an hour or more. So far as tests go it seems that the recrystallization temperature becomes lower the longer the time of exposure. When the temperature which will cause recrystallization with a few hours exposure is found, a slight decrease in temperature causes an enormous increase in time to produce recrystallization. So great is this effect that a temperature is found not far below the ordinary recrystallization temperatures which would necessitate an exposure of years to produce recrystallization.

The temperature of deformation is also a factor in determining the recrystallization temperature. The lower the temperature at which the deformation is effected the lower will be the recrystallization temperature. A possible exception to this general rule is iron worked at a temperature near 200 deg. C.

The purity of a metal is also an important factor in connection with the recrystallization temperature. As a rule a solid solution alloy has a higher recrystallization temperature than the solvent metal. For example,

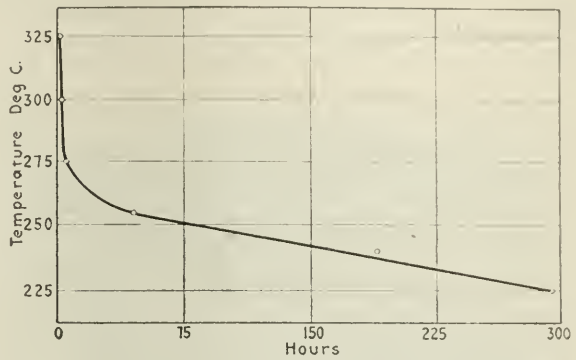


FIG. 15—CARTRIDGE BRASS (70:30) COLD-ROLLED 40 PER CENT. TIME NECESSARY TO DROP 3 POINTS IN SCLEROSCOPE HARDNESS. (MATHEWSON AND PHILLIPS)

severely strain-hardened alpha brass containing 34 per cent zinc has a recrystallization temperature of about 300 deg. C., whereas severely strain-hardened copper has a recrystallization temperature of about 200 deg. C. Impurities producing mechanical obstruction to grain growth also increase the recrystallization temperature.

The recrystallization temperature not only varies for different treatments of different pieces of the same metal, but it varies within the same piece of metal if a homogeneous condition does not exist. Since with mild cold deformation and large grains it is impossible to produce a condition even approximating homogeneity, such samples usually recrystallize over a considerable *range* of temperature. The greater the amount of strain-hardening the smaller this range will be—that is, the complete change in structure from strained to unstrained grains will take place within a small temperature range. Since the properties depend on the structure, there is a marked change with a small temperature change.

If we consider the temperature at which recrystallization is just complete, it is observed that the lower the recrystallization temperature the smaller the grain size. When some condition is varied which raises the temperature of complete recrystallization, such as the amount of deformation, the grain size after complete recrystallization is larger than with the lower recrystallization temperature. With a given recrystallization temperature there is a certain *minimum* grain size which can be produced. This minimum is less the lower the recrystallization temperature in any particular metal.

The disparity in grain size produced by varying the recrystallization temperature tends to disappear as nor-

mal grain growth proceeds above the recrystallization temperature. Equality of grain size is produced only at high temperatures. Figs. 16 to 21, of alpha brass cold-worked different amounts and then heated for 30 minutes at 550 deg. C., show how the grain size becomes smaller as the recrystallization temperature decreases. The grain sizes of the more severely deformed samples were still smaller at temperatures only slightly above recrystallization. If all were heated to about 800 deg. C., the grain sizes would be approximately equal.

The history of recrystallization can be studied by subjecting strain-hardened metal to various temperatures and cooling and examining with a microscope after recrystallization has commenced but before it is completed. This has been done by Chappell[7] on iron, Mathewson and Phillips[1] on alpha brass and Carpenter and Elam[8] on aluminum. In all cases recrystallization begins at the old grain boundaries, preferably at the junction of three original grains. The new grains grow into the original grains with about equal ease.

Because new grains first appear at old grain boundaries, it is too commonly considered that new grains do not appear in the interior of the original grains. By referring to Fig. 9 and comparing it with Fig. 6 it will be obvious that many of the grains in the former must have formed in the interior of the old grains. A case which has been observed frequently is the recrystallization of coarse-grained tungsten after working. The original grains in a particular case were 0.25 in. in diameter. The ingot was worked below its recrystallization temperature about 50 per cent reduction in area and then heated quickly to a temperature well above that of lowest recrystallization. The grains then measured 0.008 in. in diameter. *Most* of the new grains were formed inside the original grains.

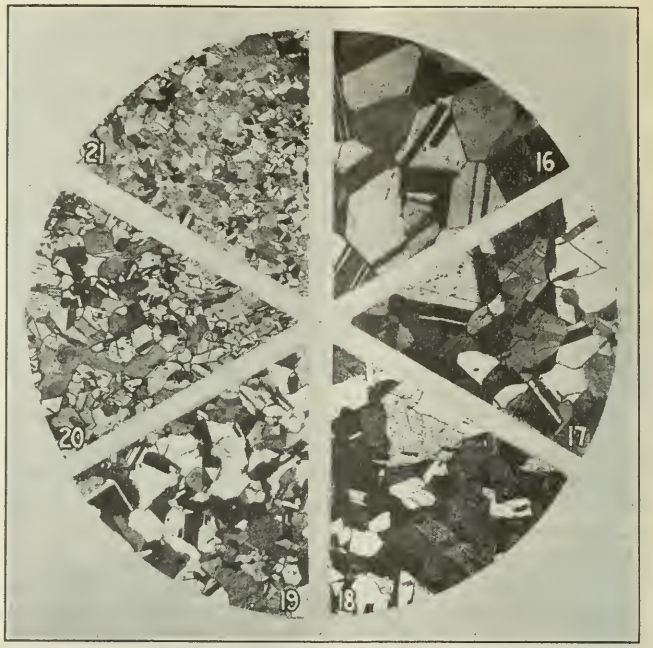
Compressed Powders

Grain growth in the solid state in compressed metal powders has been studied most extensively with tungsten[5]. The metal does not consolidate until a temperature is reached far above that of recrystallization after severe cold-work. In tungsten the density of the compressed briquet is usually about 60 per cent that of the consolidated metal. The temperature at which the density becomes normal is about 2,400 to 2,600 deg. C., which is at least 1,000 deg. C. above the temperature of lowest recrystallization after severe cold-working. After the briquet has consolidated it consists of very small grains, which, however, are larger than the original particles of powdered metal. Higher temperatures normally produce larger grains, the same as in recrystallized metals. Special cases of abnormal grain growth in compressed tungsten briquets will be considered in connection with "germination."

Obstruction

Any foreign matter in a metal affects the grain growth characteristics. The foreign matter may be in solution in the metal, it may be present as a mechanical inclusion or as a separate phase or constituent of an alloy. A good example of mechanical obstruction to grain growth is thoria (ThO_2) intentionally added to tungsten for the purpose of retarding the rate of grain growth or of producing smaller grains at any given stage in the life of a lamp. The effect of such obstruction is to introduce resistance to grain growth in approximate proportion to the amount of surface of the obstruction particles. A given amount of obstruction material therefore offers more resistance to grain growth the smaller the particles, or with given sized particles the greater the amount of obstructing material the greater will be the resistance to grain growth.

[7]Chappell, *J. Iron and Steel Inst.* (1914), No. 1, pp. 460-496.



FIGS. 16 TO 21—ALPHA BRASS HEATED 30 MINUTES AT 550 DEG. C., AFTER VARIOUS AMOUNTS OF COLD-WORK. × 60. (MATHEWSON AND PHILLIPS)

Fig. 16—Reduced 4 per cent. Fig. 19—Reduced 15 per cent.
Fig. 17—Reduced 8 per cent. Fig. 20—Reduced 23 per cent.
Fig. 18—Reduced 12 per cent. Fig. 21—Reduced 50 per cent.

Thoria is introduced as thorium nitrate into the tungstic oxide before the latter is reduced by hydrogen to tungsten powder. The heating changes the thorium nitrate to oxide. Thoria is present in such small particles that they are not visible except under a high-powered microscope. With 0.75 per cent thoria present a polished section may cut about 5,000 of these small particles per square millimeter.

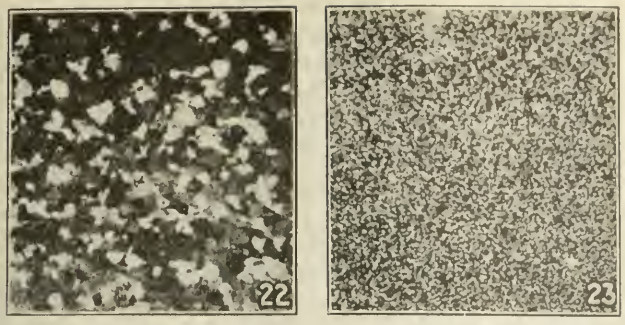
Many cases of directional obstruction are encountered in worked metals. Slag in wrought iron sometimes obstructs grain growth more in a direction perpendicular to that of working than in the direction of working. When a tungsten briquet containing approximately 0.5 per cent thoria is sintered at a high temperature, the grains are, as nearly as can be measured, equiaxed. The thoria particles are also equiaxial in shape. When the metal is worked at a temperature near 1,300 deg. C. the thoria globules elongate into fibers which do not change materially when the metal is heated to a very high temperature. The tungsten grains developed in drawn wires containing thoria are nearly always longer in the direction of working than in other directions. It is obvious that threads of thoria will obstruct growth more in a perpendicular than in a parallel direction to their long dimensions[8].

Gradients

The examples of grain growth given above are typical of the results ordinarily obtained and may be considered "normal" grain growths. Such growth usually results when the metal is reasonably uniform in structure and is uniformly heated. There are many instances of grain growth which seem to be in direct contradiction to the laws of normal growth. A careful study of these cases usually reveals that some non-uniformity either in structure or in temperature has been responsible for the apparent paradox.

The most important type of structural non-uniformity is that due to variable strain and may be referred to as a *strain gradient.* There are two types of strain gradient to be considered—"general" and "local." A

[8]Although the thoria fibers are so small that they cannot be seen even with a high-powered microscope, their presence in fibrous form is indicated by the behavior of a coiled wire, when the tungsten is removed by HCl at a dull red heat. The thoria remains in the form of the original coils. When unworked wire is treated with hot HCl gas, the thoria remains unattacked chemically, but is found after the treatment in a compact mass on the bottom of the boat or other receptacle.



FIGS. 22 AND 23—STEEL (0.05 C) HEATED 7 HOURS AT 650 DEG. C. AFTER LOADING. × 6. (SAUVEUR)

Fig. 22—Stressed cold to 40,000 lb. per sq.in.
Fig. 23—Stressed cold to 38,000 lb. per sq.in.

general strain gradient consists in a gradual variation in the degree of strain over a considerable distance in the metal, such as is produced when a bar is bent or when a Brinell impression is made. A general strain gradient is the result of a grossly non-uniform mechanical deformation, but no deformation, however uniform, can be effected without introducing local variations in strain from grain to grain or in different parts of the same grain. These are referred to as local strain gradients.

A second type of structural non-uniformity consists in a non-uniform distribution of material which mechanically obstructs grain growth, and may be designated an "obstruction gradient." Obstruction gradients are generally local in character.

Variations in temperature within a piece of metal are referred to as *temperature gradients*. Temperature gradients always exist during heating or cooling, and are greater the faster the change in temperature. The outside of a piece of metal is always hotter during heating than the inside, unless the heat is generated within the metal, as by the passage of an electric current, in which case the inside may be very much hotter. In ordinary muffle heating the rate is so slow that only small temperature gradients exist, and if the temperature distribution in the furnace is good, the metal may be considered substantially free from temperature gradients. When temperature gradients exist they often play an important rôle in grain growth.

Certain combinations of non-uniformity of structure or temperature give rise to what may be termed "exaggerated grain growth"—that is, the production of grains of abnormally large size. Any case of the development of abnormally large grains may be called *germination*.[9] The temperature range within which the abnormally large grains are formed is called the germinative temperature.

Some typical examples of germination will be considered.

An important type of exaggerated growth was reported by Prof. A. Sauveur,[10] in soft steel containing about 0.05 per cent carbon, given a preliminary normalizing treatment by heating to about 900 deg. C. and cooling in air. Test-pieces were then subjected to definite degrees of strain by stretching in a tensile machine. Prof. Sauveur expressed the strain in terms of the stress to which the specimens were loaded. This is not, of course, an accurate measure of strain if materials of different stress-strain characteristics are being used, but where all experiments are carried out on the same material the stress does indicate the strain. A specimen stretched by a unit load of 40,000 lb. per sq.in. and then annealed for 7 hours at 650 deg. C. showed a marked increase in grain size (Fig. 22). A similar specimen loaded to 38,000 lb. per sq.in. and annealed in the same manner showed no grain growth, nor did germination result if the specimens were loaded to 42,000 lb. per sq.in. or more (Fig. 23).

Similar results are shown qualitatively by making a Brinell impression in a piece of mild steel and then heating it 7 hours at 650 deg. C. The strain is, of course, greatest immediately below the impression and decreases gradually as the distance from the impression increases. In a certain zone marked by coarse grains the strain is just right to produce germination.

Prof. Sauveur bent another bar of mild steel cold and gave it the same heat-treatment. Fig. 24 shows how germination took place in a certain zone between the axis and outside of the bar. Another very clear illustration of the facts is seen

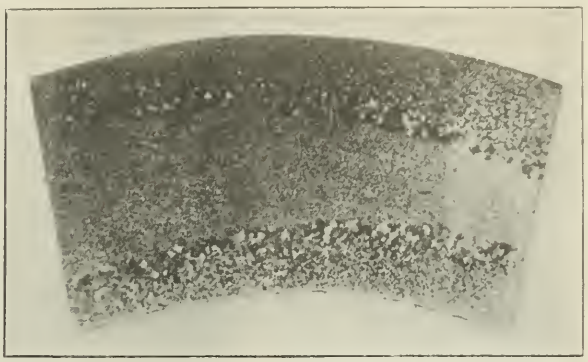


FIG. 24—STEEL (0.05 C) BENT COLD AND HEATED 7 HOURS AT 650 DEG. C. × 6. (SAUVEUR)

in Chappell's[7] tapered bar shown in Fig. 25. The strain increases continuously toward the small end of the bar. It will be noted that, as the degree of strain increases, the point at which grain growth begins is sharply marked. With still further strain, however, the grain size decreases in a gradual rather than abrupt manner.

Prof. Sauveur concluded that there is a critical strain which produces germination. He was unable to produce marked grain growth in Armco iron containing only about 0.02 per cent carbon or in steels containing over about 0.12 per cent carbon. He reports, "It would seem therefore that we must also recognize the existence of a critical carbon content (0.04 to 0.12 per cent) above or below which ferrite grains will not grow on annealing below the range, even if they have been critically strained." The effect of carbon is undoubtedly one of mechanical obstruction to grain growth, so that, translating this last conclusion, we may say that there is a critical amount of obstruction for exaggerated grain

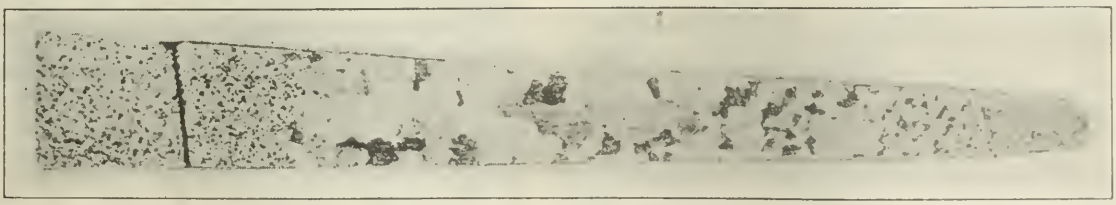


FIG. 25—STRAIN GRADIENT PRODUCED BY STRESSING TAPERED BAR, SUBSEQUENTLY HEATING TO 870 DEG. C. × 5. (CHAPPELL)

[9] "On Grain Growth," H. M. Howe, *Trans.*, A.I.M.E., vol. 56, p. 582.

[10] "The Metallography and Heat-Treatment of Iron and Steel," A. Sauveur, pp. 265-271.

growth. It is now known that some coarsening will occur in steels containing less than 0.04 and more than 0.12 per cent carbon, but the maximum effect is obtained in the range named by Sauveur. It is also now recognized that "critical strain" applies to only one set of conditions as to annealing temperature and obstruction. For each degree of strain there is a critical temperature for germination.

This law is well illustrated by Ruder's results on silicon steel[11] (essentially a solid solution alloy). Pieces of silicon steel sheet were annealed at 1,100 deg. C. and then subjected to various amounts of cold deformation by stretching. Pieces with each degree of strain were heated for 10 hours at 750, 800, 950 and 1,100 deg. C. The results are expressed qualitatively in Table I, where the amount of strain is expressed as per cent elongation. Only three degrees of grain growth are indicated. A blank space indicates that no growth has occurred. "Coarse" indicates very large grains, and "medium" indicates that some growth has occurred, but that the grain size is not so great as where "coarse" is reported.

TABLE I.

Degree of Strain, Per Cent	Annealing Temperature, 750 ° C	800 ° C	950 ° C	1100 ° C.
0.625	.....	.....	.....	Coarse
1.25	.....	.....	Coarse	Medium
2.5	.....	Coarse	Medium	Medium
5.0	Coarse	Medium	Medium	Medium
6.75	Medium	Medium	Medium	Medium

Table I shows that the germinative temperature increases as the degree of strain decreases and that when

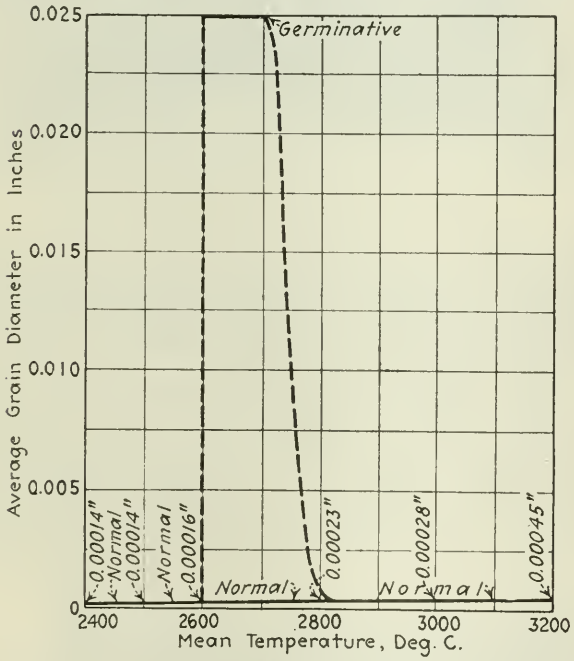


FIG. 26—GRAIN SIZE VS. TEMPERATURE FOR BRIQUETTED TUNGSTEN CONTAINING 0.75 PER CENT THORIA

the annealing temperature is well above the germinative temperature the grain size produced is less than with the same degree of strain but an anneal at the germinative temperature. An additional fact not brought out in the table is that as a rule the grain size produced at the germinative temperature is larger the higher the germinative temperature—that is, the less the strain.

This series shows the effect of rate of heating through the germinative temperature on grain size. For example, in the 800 deg. C. series the 2.5 per cent elongation sample was at its germinative temperature. Consequently in the 1,100 deg. C. series the 2.5 per cent sample was heated rather rapidly through the temperature range around 800 deg. C. and the grain size is smaller in spite of the fact that it was maintained 10 hours at a temperature 300 deg. C. higher. If the

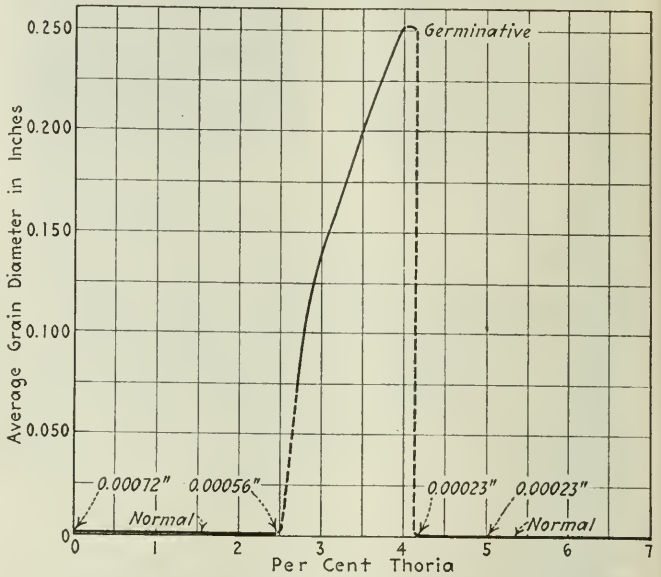


FIG. 27—EFFECT OF THORIA ON GRAIN SIZE OF TUNGSTEN

heating had been slow or if the steel had been maintained at the germinative temperature a long time during heating to 1,100 deg. C., the grain size could not have been smaller than in the 800 deg. C. series and might have been larger.

An example of exaggerated grain growth in tungsten was reported by one of the authors.[12] The normal grain growth-temperature curve for these tungsten briquets in shown by the straight line in Fig. 26. Exaggerated growth can be produced by using metal with a certain obstruction to growth and varying the temperature, at the same time maintaining a temperature gradient. Fine-grained tungsten powder containing 0.75 per cent ThO_2 was briquetted and heated to 2,600 deg. C. by the passage of electric current and held 30 minutes. The portion of the rod near the surface was very fine grained, that at the axis somewhat coarser and the intervening portion was very coarse grained. The axis of the rod was the hottest and the surface the coolest. A briquet of this metal heated quickly to 3,200 deg. C. develops a fairly uniform grain size throughout the briquet and only about one one-thousandth the size of that produced at 2,600 deg. C.

The results of a set of tests on briquets made of very fine tungsten powder containing 0.75 per cent thoria are shown in Fig. 26. Between 2,600 and 2,800 deg. C. there are two curves plotted, one marked "germinative" and the other "normal." The "normal" curve was obtained with briquets of a separate lot of coarser tungsten powder containing 0.75 per cent thoria. Owing to the coarseness of the tungsten particles, no germination took place and consequently the curve is normal. In the fine-grained powder the curve is normal up to 2,600 deg. C. and above 2,800 deg. C.[13] It will be observed that the grain size produced by germination is of a different order of magnitude from the normal grain size.

Many variations in grain size can be produced in the fine-grained tungsten powder briquets by varying the rate of heating to temperatures above that of germination.[5] By heating very slowly to 3,200 deg. C., for example, an average grain diameter of 0.03 in. was produced. By heating to 2,600 deg. C. for 20 minutes and then raising the temperature quickly to 3,200 deg. C. and holding 10 minutes an average grain diameter of 0.007 in. was produced. By heat-

[11] Discussion of Papers "On Grain Growth" and "Grain Growth Phenomena in Metals"; *Trans.*, A.I.M.E., (1916), vol. 56, p. 589.

[12] "Grain Growth Phenomena in Metals," Zay Jeffries, *Trans.*, A.I.M.E., (1916), vol. 56, p. 571.

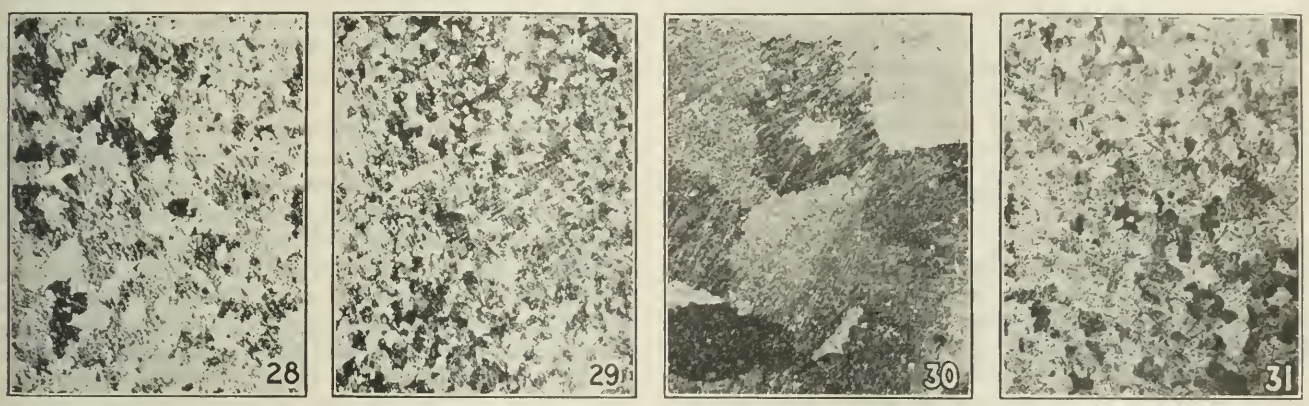
[13] Although the "normal" curves for the two grades of tungsten powder are somewhat different, the variations are not sufficient to indicate on the scale used for ordinates.

ing quickly to 3,200 deg. C. and holding 30 minutes the average grain diameter was 0.00045 in. A study of the history of the formation of the large grains always reveals the fact that in the early stages a few grains reach a size considerably larger than their neighbors. Growth is relatively slow during this stage. As the large grains become larger the rate of growth increases, provided the smaller grains remain unchanged.

When germinative conditions are encountered, rapid heating to a temperature above the germinative range is often the surest and easiest way to prevent the formation of large grains. In the few cases where large grains are desired the rate of heating is again all important.[5]

Germination can be produced in tungsten powder by incorporating the proper amount of obstruction matter (thoria) and heating to a certain temperature by the passage of electric current. Six lots of tungsten powder were prepared containing 0, 1, 2, 3, 4 and 5 per cent thoria. These were briquetted and heated for 12 minutes in an atmosphere of hydrogen at 3,200 deg. C. by the passage of electric current. A temperature gradient obtained from the axis (hottest portion) to the surface of the briquet. The resulting grain sizes produced are shown graphically in Fig. 27. Although the greater amount the grain size after solidification is very large. With still greater amounts of obstructing material the grain size again becomes small. The rate of freezing was the same in all of the tests and the only variable was the amount of obstruction material. Enlarged photographs of this series are shown in Figs. 28 to 31. Because of the "coring" tendency during freezing of solid solution type alloys, a "concentration gradient" might exist. A concentration gradient would produce a freezing temperature gradient which might promote the formation of large grains. In the examples just considered, however, the concentration gradient by itself was not sufficient to produce germination; a certain amount of obstruction was necessary. The same amount of obstruction did not cause germination in commercially pure aluminum. The striking resemblance of the 4 per cent copper series, at least qualitatively, to the series in which the thoria content was varied in tungsten will be noted.[14]

Germination may also be produced by a temperature gradient in a severely strained metal or in iron passing through the allotropic transformation. A condition of grain size contrast which leads to germination may also



FIGS. 28 TO 31. CRYSTAL SIZE PRODUCED ON SOLIDIFICATION OF Al: Cu ALLOY CONTAINING INCREASING AMOUNTS OF OBSTRUCTION MATERIAL

obstruction to grain growth is greater the greater the amount of thoria, there is a critical combination of obstruction, temperature and temperature gradient which produces a germinative condition. This series is particularly important, because it shows how the germinative temperature may be made non-existent by raising it hypothetically to a temperature above the melting point of the metal. The 5 per cent thoria sample can actually be melted without first producing large grains.

Another case of germination in drawn tungsten wire is very interesting.[5] The tungsten metal in question has a small amount of non-metallic obstruction in very small particles. The wire was drawn in the usual way, so that the strain-hardening is very great. If this wire is heated quickly to a temperature near the melting point of tungsten, a fine-grain size is produced. If, however, the temperature is raised gradually by means of an electric current, the structure is very coarse. In fact the grains usually extend across the whole cross-section of the wire and may be as much as 0.5 in. in length. These large grains form in a time not exceeding about 10 seconds. This coarse-grained structure is desirable in certain lamps to prevent undue sagging at high temperatures.

Germinative conditions are not confined to the growth of grains completely in the solid state. The present authors have found that mechanical obstruction introduced in slight amount into a liquid aluminum alloy containing 4 per cent copper produces a moderate refinement of the grain. When introduced in certain develop in a severely strained metal on heating above the recrystallization temperature. In this connection it has been observed that germination often *follows* the first structural changes on heating. For example, a strained metal may recrystallize normally and the recrystallized grains may, at a little higher temperature or on longer exposure, coalesce to form abnormally large grains. In cases of germination due to obstruction and temperature gradients there may be some growth below the germinative temperature.

One method of utilizing the principles of grain size contrast and temperature gradients to produce excessively large grains has been described by Ruder for silicon steel[15] and Schaller for tungsten. Ruder has treated a strip of silicon steel about 1 x $\frac{1}{8}$ x 14 in. in such a manner that it consists mostly of a single grain. Schaller has produced some grains about 7 in. long in tungsten wire of small diameter. The process consists essentially in starting with a material with grains so small that much growth takes place on heating. A small area of the piece of metal is heated to a high temperature in such a manner as to develop large grain locally. The piece of metal is then moved through the heated zone at a rate

[14] "Grain Growth in Metals," Zay Jeffries, *J. Inst. Metals* (1918), No. 2, p. 109.

[15] *Trans.*, A.I.M.E. (1913), vol. 47, p. 569; *J. Ind. Eng. Chem.* (1913), vol. 5, p. 452.

comparable to the rate of absorption of the small grains by the large.

Macromechanism of Grain Growth

Grain growth in the solid state takes place by the gradual absorption of some of the grains by others. This may be referred to as "boundary migration." It was formerly held by some metallographists that whole grains gradually changed orientation until two adjacent ones had the same orientation, after which they suddenly merged. The boundary did not move, according to this view, but disappeared as a boundary on account of the common orientation.

Rosenhain[4] long ago showed that growth in lead took place by boundary migration. One of the present authors[5] reported the results of an investigation showing conclusively that growth in iron took place by boundary migration. Carpenter and Elam[6] have described a most satisfactory method for studying the progress of grain growth in a tin alloy containing a small amount of antimony. When this alloy is etched and heated into the grain growth-temperature range and then cooled to room temperature, the original grain boundaries as well as the new boundaries are visible. Inasmuch as each heating and cooling reveals the new boundaries and does not efface the old ones, as many sets of boundaries as desired can be obtained. Photographs taken after each heating give a splendid record of the history of growth. Carpenter and Elam's results give additional proof that growth takes place by boundary migration.

Laws of Grain Growth

1. The grain size of cast metals is usually smaller the more rapid the rate of solidification.

2. The grain size in cast metals which undergo no phase change in the solid state cannot be changed appreciably by heating below the melting point.

3. Grain growth in the solid state may occur in (*a*) worked metals, (*b*) compressed powders, (*c*) electrodeposited metals, (*d*) in iron when it changes allotropic form and (*e*) in alloys in which a new phase is formed in the solid state.

4. The recrystallization temperature is lower (*a*) the greater the amount of deformation, (*b*) the smaller the grains prior to deformation, (*c*) the purer the metal, (*d*) the lower the temperature at which the deformation is effected and (*e*) the longer the time of heating.

5. In any given metal the grain size after complete recrystallization is normally smaller the lower the recrystallization temperature.

6. Above the recrystallization temperature the grain size is normally greater the higher the temperature and the longer the exposure.

7. The higher the temperature the more rapid the grain growth. At a temperature near the melting point a few seconds is often sufficient to produce grains which may not change further on extended exposure.

8. Certain conditions of non-uniformity sometimes give rise to the formation of abnormally large grains. This is called germination.

9. The non-uniformities giving rise to germination are: grain size contrast, strain gradients, temperature gradients, concentration gradients, and obstruction gradients.

10. The presence of foreign matter or a second phase introduces mechanical obstruction to grain growth. Resistance increases as the quantity of foreign matter or other phase increases and as the particle size decreases.

11. The presence of a certain amount of obstruction matter promotes germination.

12. The higher the germinative temperature the larger will be the grains and the quicker will they form.

13. The more rapid the heating through the germinative temperature range, at least within limits, the finer will be the grain size.

(*Part III, on Underlying Causes, will be published in a Subsequent issue.*)

The Non-Metallic Mineral-Filler Industry

A branch of the mining industry of which comparatively little is known, yet which has been quietly developing to meet a growing demand, is the mineral-filler industry. A discussion of the commonly used non-metallic mineral fillers and their uses in industry is given in an interesting paper by W. M. Weigel, mineral technologist of the U. S. Bureau of Mines, presented before the New York meeting of the American Institute of Mining and Metallurgical Engineers.

The term mineral filler is generally applied to a mineral used in its natural state after mechanical preparation only (such as grinding, milling and washing), without undergoing any chemical change and without exerting any chemical action on the substance with which it is incorporated. The common mineral fillers are white clay, barytes, mica, talc, whiting, ocher, silica, graphite and slate.

Sedimentary or transported white clays are the only clays used to any extent as fillers; the residual white clays, or kaolins, go to the ceramic industry. The principal centers of the clay-mining industry in the Southern district are in the vicinity of Langley, S. C., and in the central part of western Georgia. Clay as a filler is used largely in paper, rubber, oilcloth, paint, and, to some extent, in phonograph records, polishes, textiles, matches and soap. For rubber and phonograph records, the color is not important as long as it is light, but for all other uses whiteness and freedom from grit or quartz are the prime requisites.

Barytes is produced in Georgia, Tennessee, North Carolina and Alabama, Georgia ranking first and Tennessee second in production. It is used as a filler in paper, putty, textiles and phonograph records, but mostly in the paint and rubber industries. In paper, it is used mainly where a high gloss or finish is desired in supercalendered paper and in cardboard. On account of its high specific gravity its use is limited to articles for which it is peculiarly adapted. For paint and paper, fine grinding and pure white color are demanded. For the other uses, fine grinding is desired, especially for rubber, but color is of secondary importance. The content of quartz grains should be reduced to a minimum.

Whiting, the common name for finely ground marble or limestone, is one of the most widely used fillers. True whiting is ground chalk; other ground calcareous materials are substitutes. Production is now confined to Georgia, Tennessee and North Carolina. Both the dry- and wet-ground materials are used in rubber, paint, a few grades of paper, linoleum, oilcloth, shoe polish, putty, tooth powder, roofing, artificial stone and asphalt paving. Other fillers discussed are mica, graphite, talc, silica and ocher. Within the past few years the production of ground mica from schists has been developed, largely because of the rapid increase in the manufacture of ready roofing, which uses most of the low-grade material.

The German and American Synthetic-Ammonia Plants*—IV

Design and Operation of Apparatus Used for Synthesis of Ammonia at Sheffield, Ala., and at Oppau, Germany—Description of Different Processes for Removing the Ammonia—Comparison of the Costs of Construction and Production

By R. S. TOUR

THE purified gases at Oppau enter the circulating system at about 200 atmospheres pressure, there mixing with the gases in circulation, and all pass on to the ammonia catalyst bomb for synthesis. The gas passes through three heat interchangers, two detached and one within the lower half of the catalyst bomb, after which the heated gas passes down through the catalyst bed, back through the heat interchangers, and then through a mist or dust trap, and finally goes to the ammonia absorption installation.

The ammonia synthesizers are arranged in sets, each consisting of the catalyst bomb or ammonia converter with heat interchangers and mist trap. Each set has a rated capacity of about 20 tons of ammonia per day. There are 15 such sets in the main installation at Oppau. They are arranged in a row, set partly below ground level, along, but outside of the wall of the building housing the pumps and special apparatus of the ammonia absorption and circulating systems. The valves, gages, pyrometers and other controls for the ammonia-converter sets are all located within the building. Over the row of converter sets is a protecting steel structure with a 70-ton traveling crane and between the respective converter sets is a brick wall. Thus a separate enclosure is built up for each set.

Construction of the Ammonia Converters at Oppau

The following important features are to be noted in the construction of the converter itself. The shell is 3½ ft. in outside diameter and 40 ft. high, and is made up of two 20-ft. sections bolted together at the middle. Continuous throughout the length of the two sections is a close-fitting steel liner which serves to protect the pressure casing from the action of the gases. The casing is a steel forging, with wall 5 in. thick, perforated radially with ⅛-in. holes spaced about a foot apart. These serve to release gases diffusing through the liner, but allow the casing to carry all of the necessary mechanical stresses. To decrease still further the action of the gases, a later modification of the converters carries an additional liner small enough to leave an annular space between it and the outer liner, and during operation nitrogen under pressure is flushed through this space. Within the liners there is about 2½ in. of heat insulation built up of radial refractory brick. In the upper part of the enclosed chamber is the catalyst container, while in the lower is a heat exchanger. The catalyst is held in an annular space within a tube about 1½ ft. in diameter and around a 4-in. pipe leading the gas from the heat interchanger directly below to the top of the catalyst. The gas passes down through the catalyst and back through the heat interchanger.

The heat interchanger within the converter consists of a nest of about 150 half-inch, thick-walled tubes fastened into headers at each end and carrying baffle plates every few inches throughout their length, which are outside and at right angles to the tubes. This nest is placed within the converter shell in such a way as to carry the inlet gas up through the tubes and the catalyst exit gases through the baffled spaces outside the tubes. After assembling and charging the converter shell, the heads, which in reality are tapered plugs making a steel to steel seat, are forced into position by a hydraulic ram and are bolted into place with sixteen 3½-in. bolts while the ram pressure is still on. The whole bomb (catalyst and heat interchanger) is well lagged by an external insulator so adjusted that air may be circulated between the lagging and the shell for temperature control.

These complicated constructions are necessary for three distinct reasons: (1) The tensile strength, proportional limit, and the other important structural properties of steels, although slightly increasing up to a temperature of about 350 deg. C., rapidly and dangerously decrease with increase of temperature above that value. (2) Hydrogen at high temperature quite readly diffuses into and through steel and within the steel combines with carbon to form methane, which is not diffusible, thus causing blisters, blowholes and dangerous imperfections. (3) Ammonia at temperatures of formation or decomposition has a powerful action on iron, probably to break down completely its crystalline structure, probably by nitrification.

The two detached heat interchangers carry the same type of tube nests as previously described, but the shells are not built for internal heat insulation or nitrogen circulation. The casings are less than 3 ft. in outside diameter by 25 ft. high, forged in one piece and equipped with liners. The mist trap at the exit of the interchangers is of much the same construction as that described for the water scrubbers. The inlet or cooler gases pass through the heat interchangers around the outside of the tubes, while the hot returning gases pass through the tubes. This is the most efficient path.

Operation of the Converters

The catalyst bombs are charged with about 20 cu.ft. of a catalyst developed for the particular operating conditions at Oppau and consisting of practically pure iron specially prepared with an addition of some promotor. The material as used is about ½-in. mesh. Such a catalyst charge, when in use, produces about 20 tons of ammonia per day, or one ton per day per cu.ft. of catalyst. Operating at 5 per cent, this calls for a space velocity of 40,000 cu.ft. of free gas per hour per cu.ft. of catalyst, and a time of contact (allowing

*For Parts I, II and III see Chemical and Metallurgical Engineering, vol. 26, Nos. 6, 7 and 8, pp. 245, 307 and 359, Feb. 8, 15 and 22, 1922.

33 per cent voids) of about one minute within the bed of catalyst.

The matter of the proper speed or space velocity at which to operate a catalyst is of great importance. As the speed is increased the percentage of ammonia in the exit gas is decreased, though not in as great a proportion; thus there is a greater total yield in weight of ammonia. Although this yield of ammonia controls the capacity of the catalyst, still the percentage of ammonia controls the temperature rise due to the exothermic reaction and this is the important factor in the operation of the heat exchangers and in the temperature maintenance of the system. And further, the percentage of ammonia controls the number of times a given quantity of gas must be recirculated before complete synthesis, and therefore governs the size of all the apparatus in the entire circulating system.

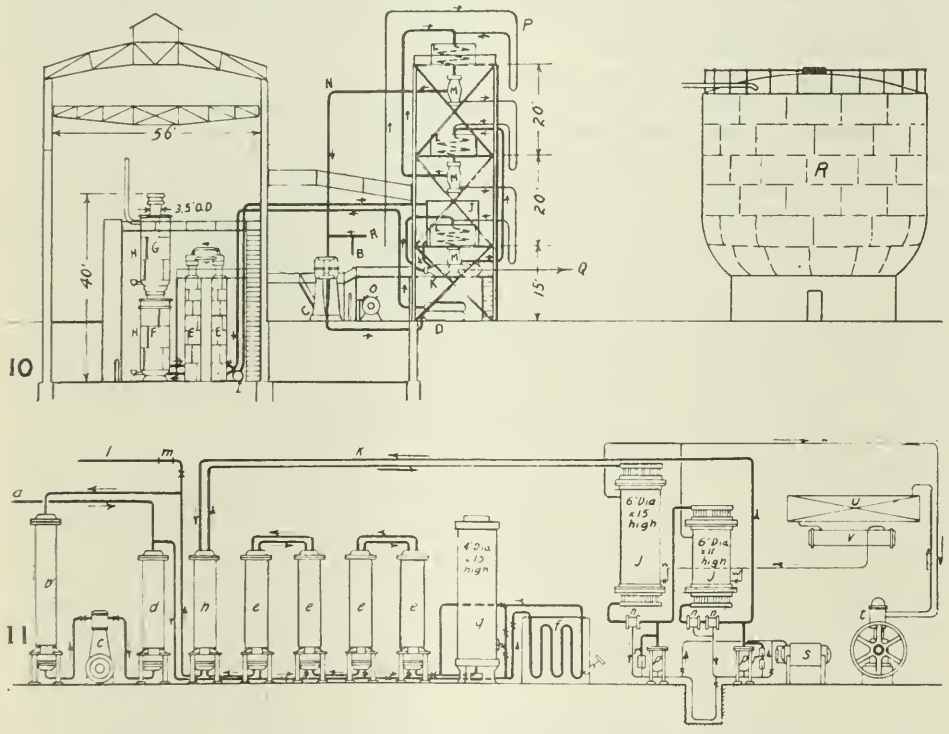
The concentration of ammonia produced at Oppau sometimes reached 5 to 6 per cent, but the general average in operation is probably about one per cent less than this figure. It is noteworthy that this represents a relatively incomplete attainment of equilibrium. The rise in temperature due to the exothermic reaction is 75 to 90 deg. C., for a concentration of 4 to 5 per cent of ammonia. This represents the heat available for maintaining the temperature of the system and also supplying the temperature head for heat interchange.

With only this small heat development the system at Oppau is no doubt not self-maintaining in temperature and addition of heat by internal combustion within the bomb is resorted to. The combustion device is also used to start the system when cold. Oxygen (or pure air) under pressure and hydrogen (or the reaction mixture) are supplied through a burner and igniter of special and very neat construction, which projects through the top of the catalyst bomb and maintains a flame in the direct path of the gases just before entering the catalyst bed. The moisture formed by combustion passes on through the catalyst with the reaction gases. One per cent of moisture by combustion will represent a rise in temperature of about 75 deg. C.

Effect of Moisture on the Catalyst

The effect of moisture on the catalyst is a point to be considered very seriously. Since at Oppau water scrubbing is used to remove ammonia from the gases after reaction, all the circulating gases carry some moisture. Saturation at room temperature calls for about 0.01 per cent by volume, but even this makes entirely unusable certain catalysts which, with dry gases, might be highly active and desirable. The type of catalyst developed at Oppau can remain in action in the presence of moisture, still its activity in such an atmosphere is greatly decreased and its operating temperature must be increased. The extent of the inhibition of catalysis depends on the moisture content. The ammonia equilibrium for 200 atmospheres pressure and 500 deg. C. calls for 17.6 per cent of ammonia, with probably 10 per cent of ammonia available from the catalyst when operating on pure gas and at the velocities in use at Oppau. Actual operation with moisture results in less than one-half this amount and further. this reaction reduces the heat generation within the bomb and the temperature head across the heat interchangers, thus making it increasingly more difficult to maintain the necessary temperature. To obviate the effect of such a cycle considerable experimenting is being done at Oppau, looking toward the development of an electrical heater to operate in place of the oxygen burner. Such a new device would have, as additional advantages, increased safety, no loss of pure hydrogen, and better temperature regulation.

In addition to the 15 converter sets, there is still available for operation at Oppau an older installation from which the present plant was developed. This consists of 8 much



FIGS. 10 AND 11. APPARATUS FOR AMMONIA SYNTHESIS AND REMOVAL AT OPPAU AND AT SHEFFIELD

Fig. 10. Ammonia converters and absorbers at German plant.
A. Purified gas inlet to circulating system.
B. Pure nitrogen for adjustment of composition.
C. Circulating compressors.
D. Water and oil traps on compressor exit.
E. Heat exchangers.
F-G. Converter bomb (F heat exchanges. G catalyst chamber).
H. Insulator and ventilator around bomb.
I. Mist trap exit converter system.
J. Cooler before absorption.
K. Mist trap exit cooler.
L. Absorbers.
M. Separating bottles after absorbers.
N. Gas return after absorption.
O. Water pumps for absorbers.
P. Water injection to absorbers.
Q. Aqua ammonia exit to storage tanks.
R. Aqua ammonia storage tanks.

Fig. 11. Ammonia converters and liquefiers at American plant.
a—Purified gas inlet to circulating system.
b—Equalizer (return receiver for unconverted gas).
c—Circulating compressors.
d—Filter. e—Heat exchangers.
f—Heater (gas fired brick furnace).
g—Converter bomb.
h—Cold exchanger.
j—Liquefiers.
k—Gas return from liquefiers.
l—Gas vent for purging system.
m—Venturi meter.
n—Separator (liquid ammonia).
p—Catch pot. r—Klinger gages.
s—Receivers (liquid ammonia).
t—Compressors—refrigeration.
u—Condenser. v—Receiver.
w—Expansion valves.
z—Suction return to compressors.

smaller converter sets, the catalyst bombs being only 1½ ft. in outside diameter by 30 ft. tall. These bombs are started by external heating applied by combustion of producer gas in a surrounding jacket. Some of this heating is also maintained during operation. This is obviously a dangerous procedure. This old installation connects into the main feeder lines and the exit manifold of the large installation, the ammonia gases passing to the next step, that of ammonia removal.

Ammonia Synthesis at Sheffield

The purified gases entered a high-pressure vessel or mixing chamber in the circulating system at less than 100 atmospheres pressure, there to mix with the gases in circulation. The mixture passed on through 4 heat interchangers, thence through a heater for starting or maintaining the temperature of the system, then through the catalyst bomb at 500 deg. C. and finally back through the heat interchangers.

There was but one set of interchangers and catalyst bomb in the operating unit (Unit No. 1) at Sheffield and this was located in the same building as the purification apparatus and equipment. The ammonia converter itself consisted of a chromium-vanadium forging 4 ft. in inside diameter, 15 ft. high, with walls 3 in. thick. Within this shell was a nest of ninety 2-in. boiler tubes, which were to be charged with 50 cu.ft. of catalyst. The gas entered at the bottom of the shell, passed up around the tubes, then down through the catalyst and out at the bottom of the shell. The heads of the converter were designed to make a special type joint with the shell, making use of the internal pressure to keep the joint tight; this device, however, proved troublesome and unsuccessful. Otherwise the entire construction was very simple compared to the bomb at Oppau. Within the converter, no arrangement was made to protect the bomb from the action of the gases, or to keep it cooler than the operating temperature.

The heat interchangers consisted of forged steel shells 2 ft. in inside diameter, 14 ft. high, with 3-in. walls. Within each shell there was a nest of tubes of very special construction. Each tube element of the nest consisted of 3 concentric tubes, thus having two annular spaces between them. The two gas flows interchanging heat passed each other through these annular paths. No use was made of the volume around the tube elements. This arrangement is ingenious and leads to a high coefficient of heat transfer per unit of transfer surface, but also leads to high friction per unit of heat transferred. Larger apparatus per unit of transfer surface is also required. By a system of valves in the interconnections between interchangers, any one of the interchangers could be bypassed during operation.

Heating of the Gas

A heater, similar in type to a standard steam superheater, was situated so as to heat the circulating gases just before they entered the catalyst bomb. The gas flowed through a series of high pressure tubes connected with flanged joints in a gas-fired furnace of three passes. This heater was the source of much trouble due to bursting tubes and leaking joints and prevented any continuous testing of the circulating system as a whole. This type of heating is subject to two inherent objections: (1) The heat transfer surface must operate at a high temperature and at the same time retain its strength. (2) The efficiency of a furnace furnishing heat at such a high temperature level is necessarily very low. These two objections can be overcome only by internal heat application, which can be accomplished in two ways: (1) Internal combustion of hydrogen by injection of oxygen, and (2) electrical resistance heating directly in the gas path. These have been discussed somewhat under the Oppau description. Electrical heating during Sheffield operation could not have been more expensive than the method in use.

During attempted operation, the catalyst bomb was charged with a special catalyst "composed of iron, sodium and nitrogen." During the development of this catalyst, laboratory experiments with pure gas had indicated that at a space velocity of 5,000 cu.ft. of free gas per cu.ft. of catalyst about 8 per cent of ammonia might be expected in the gas. This catalyst was especially sensitive to poisons, and traces of oxygen-carrying impurities such as O_2, CO_2, H_2O, and CO permanently and rapidly deteriorated its activity. Such a catalyst may be highly active on pure gas, but commercial operation can not be expected to maintain the necessary purity of gases. In fact, at Sheffield, it is doubtful if the desired purity was ever obtained. Operation was so intermittent that statements as to the actual percentage of ammonia converted by the catalyst would be misleading.

Ammonia Removal at Oppau

The ammonia content of the gas is removed by water scrubbing the gas without releasing its pressure, the remaining gas recirculating while the absorbing water is discharged as aqua ammonia. The gas mixture with 4 to 5 per cent of ammonia leaves the converter sets and passes to a main which feeds 8 absorber sets, located on the outer side of the pump house building and opposite the converter sets. In order to secure more favorable temperature conditions for absorption each set first passes the gas through a cooler of 12 coils in parallel, thence to a mist separator and on to the elevated water absorbers. There are 3 absorbers in each set placed one above the other at 20-ft. levels. Each absorber consists of 12 spiral concentric coils connected in parallel, and submerged in a water bath in order to take up the heat of solution generated within the coils. At the exit of each absorber is located a trap to separate the gas and liquid. The water flows downward through the set of absorbers as a whole and the gas upwards, the absorption taking place in three stages, with separation of gas and liquid between stages. In the uppermost stage (third gas and first water stage) water is injected with the gas and the mixture of gas and liquid flows downward through the coils by gravity. The solution from the third gas stage after separation feeds downward to the second and then on to the first. The gas from the first and lowest stage flows to the entrance of the second stage, then on to the third. This arrangement affords a counter supply of solvent although the necessary parallel flow is obtained within the coils of each stage. A newer type of absorber has been installed and used for the last stage of one set of absorbers. This consisted of towers similar to those used in the cuprous formate scrubbing system and provided true counter-current flow at least in the last stage of absorption.

There are 6 steam-driven water pumps (totaling about 800 hp.) for the absorbers. This pump capacity will furnish sufficient water to the absorber sets to give as a final product commercial aqua ammonia of a strength of 25 per cent. Considerably less water

may be used and solutions of much higher strength obtained, but upon release of pressure these evolve gaseous ammonia and leave a 25 per cent aqua. The solution leaving the last separator of the absorber system is discharged to high pressure ammonia receivers, which in turn are discharged when full into closed low pressure reservoirs. Considerable nitrogen and hydrogen gases are dissolved in the aqua and these, released in the reservoirs, are washed with a counter current flow of water to remove ammonia and are returned to the gas holder just previous to the compression stages of the process. The aqua ammonia is finally stored in three large tanks of about 750,000 gal. capacity each.

The high pressure gas in passing through the absorber system gives up most of its ammonia to the water, only about one-fourth of one per cent remaining in the gas. This ammonia content will depend on the temperature at which the last gas stage of absorption was maintained and on the ammonia concentration of the aqua emerging from this last stage together with the gas. Evidently the more water used for absorption the less is the residual ammonia in the gas. However, the hydrogen and nitrogen dissolved and the power required will increase with the increase of water and this represents some small loss in the efficiency of the system.

Ammonia Removal at Sheffield

The intention at Sheffield was to remove the ammonia from the gas by refrigeration at temperatures of —30 or —40 deg. C.; the ammonia was discharged as liquid anhydrous ammonia, while the residual gas was to recirculate back to the converter set. There were two ammonia liquefiers in the installation, each consisting of 7 spiral concentric coils fed from a common manifold and discharging into a common manifold. Inclosing these spirals was a shell 6 ft. in diameter by 15 ft. high, in which the necessary refrigeration was maintained. A standard-type ammonia installation furnished the refrigeration, the ammonia from the condensers expanded directly into the liquefier shells, and the compressors withdrew the evaporated ammonia from the top of the shells. The two liquefiers operated in series on the high pressure gas, although the refrigeration on the outside of the coils operated in parallel in the two shells. The high pressure gas on leaving each of the liquefier coils passed through a mechanical separator where the liquefied ammonia was separated and drained to a pot while the gas passed on through the separator, and thence to a cold interchanger. This apparatus was identical with the heat interchangers previously described and served to cool the incoming gases to the liquefiers by means of the cold gases leaving the system.

To maintain temperatures of —30 or —40 deg. C. it is, of course, necessary to expand the refrigerating ammonia to a considerable vacuum and it is required that the refrigerating compressors operate at that vacuum on the suction stroke. This, in turn, means that the compressors have a much smaller refrigerating capacity in view of the large volume of the refrigerant. It was soon found at Sheffield that although the compressors had the necessary rated refrigerating capacity when operating to make ice under commercial conditions, still they had less than 20 per cent of the refrigerating capacity necessary for the ammonia removal. Additional compressors were, therefore, at once moved over from Units 2 and 3 at Sheffield, together with all spares, and all were connected in the line for operation in Unit No. 1.

The operation of single-stage ammonia compressors with ratios of compression of the order of 20 to 1 must, in general, lead to serious inefficiencies and mechanical difficulties. The operation of two liquefiers in series on the gas with refrigeration on each at the same low temperature level is also inefficient. The first liquefier in the series could be operated to advantage at a higher temperature level and leave only the second liquefier to meet the low temperature requirement. The Nitrate Division in its redesign of the Sheffield plant has laid out a simple installation with standard equipment to operate with compound compression of refrigerant for the low temperature liquefier while the first liquefier operates within a nearly normal ice making cycle.

The total refrigerating capacity may be considerably reduced, although the problem is not greatly simplified where ammonia liquid is not the necessary product of manufacture. In such cases the condensed liquid leaving this high pressure system may be expanded into a liquefier shell, thus effecting considerable refrigeration. This refrigeration would be necessarily independent of the main refrigerating installation in view of the gases dissolved in the synthesized ammonia.

Separation of Condensed Ammonia

The separators for removing the condensed ammonia from the high pressure gas at Sheffield consisted primarily of a vertical baffle plate at right angles to the horizontal flow of ammonia laden gases. No data were obtained as to the efficiency of these simple separators, but general indications were that the ammonia removal was incomplete. The separated ammonia drained from the separator into a high pressure receiver from which it was discharged at intervals into liquid ammonia reservoirs.

The removal of the condensed ammonia from the high pressure gas is a subject requiring serious consideration. Much of the ammonia condenses in the gas as a fine mist difficult to precipitate or agglomerate into larger particles for separation. These in turn are difficult to separate from the gas stream. An analogous but much simpler case is the separation of water from wet steam, which is accomplished in the industry by various types of apparatus, all of which depend on the difference in specific gravity between the suspended water and the steam. In the latter case, ordinary practice involves a ratio of specific gravities of the order of 150 to 1, whereas in the case of removing ammonia from the high pressure gas the ratio is but one-tenth as great. In view of the low specific gravity ratio, high velocities are probably essential in mechanical separation. Other requirements, no doubt, are low friction of the gas stream over the separating surfaces, and immediate removal of the separated liquid from contact with the gas. All the above has been kept in mind in the development by the Nitrate Division of an ammonia separator for use at Sheffield should the plant ever again operate.

The Germans, in developing their process, had seriously considered and experimented with refrigeration as a means of ammonia removal, but they finally turned to water absorption as the easiest solution of the problem. In so doing, they gave up several distinct advantages of refrigeration: (1) Circulation of pure dry gases in which desiccation is maintained by the precipitation of anhydrous ammonia within the gas.

(2) Production of pure anhydrous ammonia is accomplished without any further steps of distillation. The first of the above is the most important in view of the fact that moisture in the system decreases catalytic activity and reduces the capacity of the entire installation, as has been previously discussed. The second is important only in connection with the utilization of the ammonia. On the other hand, water absorption of ammonia has the advantage of practically complete ammonia removal, and decided reduction in power consumption.

Circulating System at Oppau

The gas is circulated through the converter sets and through the absorption system by 10 double-acting circulating pumps. These are steam driven and direct connected at 90 deg; the pump cylinder is vertical and the steam cylinder horizontal. In normal operation the differential pressure necessary to circulate the gases is about 5 atmospheres, though it has, at times, risen to 10. The circulating pumps are located in the cycle just after the absorbers and ahead of the converter sets. At the inlet side of the circulating pump the pure make-up gas is added and also the composition of the gas in circulation is adjusted by the addition of the pure nitrogen that was spoken of earlier in this paper.

The question frequently arises as to whether it is desirable to have the circulating pump precede or follow the point in the system where the make-up gases are added. In the latter case, the pump must directly handle the volume of make-up gas, together with the volume of circulating gases. However, the total pressure of the circulating system is higher by the amount of the differential pressure, since the pressure of the make-up is fixed by the pressure of the purification system. The pressure desired in the circulating system should determine the location of the circulating pump; the total quantity of energy expended is but slightly different in the two cases.

The speed of circulation of the gases as it affects the catalysis of the ammonia has been discussed in connection with space velocity under ammonia synthesis. For a given installation, operation may develop any one of the following limitations to increase the speed of circulation: (1) Insufficient heat transfer to maintain the temperature of the ammonia converter sets, (2) insufficient capacity of the purification system to supply the necessary gas for the increased yield, (3) insufficient capacity of the ammonia-removal installation to take care of the increased yield, and (4) excessive friction to gas flow in the apparatus of the circulating system. These general engineering aspects of the process are of fundamental importance, but their discussion is not within the purpose of this paper.

Inert Gases

The inert gases, methane and argon, are present to the extent of 0.5 to 0.7 per cent in the make-up entering the circulating system at Oppau, and tend to accumulate as the hydrogen and nitrogen are being removed in the form of ammonia. Some method of removal of this accumulation must be employed. The simplest method for continuous operation is to allow a fraction of the circulating gases to escape continually. Purging a quantity of gas from the circulating system equivalent to 5 per cent of the entering make-up gas will maintain a concentration of inert gases of 20 times that in the make-up. Likewise, 10 per cent purge will allow a concentration of 10 times that entering the system. The effect of inert gases on the catalysis of ammonia is very decided due to the lowering of the equilibrium, but on the other hand, the loss of purified hydrogen and nitrogen in the purge is costly, although the hydrogen may be burned under boilers. In operation the choice as to the proper purge is generally fixed by the unavoidable leakage in the system. Thus, at Oppau, this was never below 10 per cent of the makeup gas, therefore the concentration of the inert was never above 5 to 7 per cent and no additional purge was necessary.

Circulating System at Sheffield

At Sheffield the gas exit from the liquefiers passed to the circulating pumps, the make-up gas connecting in at the exit of the pumps. The circulating pumps themselves were vertical, double acting, motor driven, but due to the sensitiveness of the catalyst, were not lubricated and therefore not equipped with piston rings.

This led to rather low volumetric efficiency. The pumps had been designed for a maximum differential of 50 lb. Due to the many right-angle elbows and tees, numerous valves, and the special construction of the heat interchangers, the friction in the system accumulated to 150 lb. and still less gas was circulated than was necessary. This caused considerable difficulty with the pumps and their motors. Engineering experience offers very little information for the calculation of friction of gas flow under the conditions existing in the synthetic ammonia process. Some preliminary experiments conducted by the Nitrate Division indicate that it varies with the square of the velocity and therefore that a formula of the standard type may apply.

There are no facilities for adjustment of composition in the circulating system at Sheffield, but during operation such adjustment was found unnecessary in view of the high losses, which at times amounted to 50 per cent. These losses of course prevented accumulation of either hydrogen or nitrogen in the system, as well as accumulation of the inert gases.

The pipe connections throughout the system were all made up with copper gaskets, which worked very satisfactorily where there were no undue strains on the joints. The apparatus in the circulating system was arranged very closely and there was no allowance for the expansion due to the extreme range of temperature. The strain thus set up always developed leaks. There were many valves in the heat interchanger connections and in other hot parts of the system and although these valves were water cooled, still the differential expansion between the stem and the block caused difficulties. Operation on this portion of the system was, however, so intermittent and of such short duration that no opportunity was given to cure the difficulties encountered, although the matter has been taken up with great care in the redesign of the plant and in the development of joints and valves.

The last installment of this article, in which the costs of construction and production at Oppau and Sheffield are compared, will be published in a subsequent issue.

Heat Balance in Coal Distillation

An investigation to determine the amount of heat evolved or absorbed through chemical reaction in the destructive distillation of coal is being conducted by the Bureau of Mines. Such information will give the by-product coking and gas industries a more accurate knowledge of the thermal requirements of their ovens and retorts.

Explosion-Proof Process of Solvent Recovery

Descriptive Study of Lewis Recovery System in Which the Explosion Hazard Is Eliminated by Using Cleaned Flue Gas as the Drying Medium—Theoretical Consideration of the Relation Between Recovery and Recirculation in the Condensation-Recirculation Process

By B. F. DODGE
Chemical Engineer

ONE of the strongest objections to the use of flammable solvents in industrial operations and to most of the solvent recovery processes is the fire and explosion hazard. In many of the processes proposed or utilized in the past an attempt has been made to keep the average concentration of the solvent vapor in the air-vapor mixture outside of the explosive range. This is generally unsatisfactory and many such attempts have resulted in disaster. To keep the concentration below the explosive range means that a large amount of gas must be handled which is very dilute in solvent vapor. It is well known that the installation costs and operating costs of a recovery plant increase rapidly as the concentration decreases. Furthermore, unless extreme care is exercised in the design of the ventilating equipment, pockets are apt to form where dangerous concentrations are present. On the other hand, attempts to work above the explosive range almost always result in failure, because it is inevitable that somewhere in the recovery plant the explosive range is being passed through and furthermore the explosive range must be crossed in starting or stopping the operation by which the drying of the goods is performed.

It has long been recognized that this hazard could be overcome by replacing the air as a carrier by some inert gas such as nitrogen or carbon dioxide. The cost of producing such a gas, however, has militated against its use. This objection has been met by a process developed by Dr. W. K. Lewis of the chemical engineering department of the Massachusetts Institute of Technology, who has used a cleaned flue gas as the inert drying medium. Lewis pointed out that it is only necessary to remove part of the oxygen from the air to make a good inert gas, and the simplest way to remove oxygen from air is to allow the oxygen to react with carbon or hydrocarbons as in an ordinary combustion reaction. Consequently, by the term "flue gas" is meant any gas produced by depleting the oxygen of the air by reaction with carbon or hydrocarbons.

Before referring to the process itself, it may be well to discuss briefly the flammability of gas mixtures, in order to show that the presence of flue gas prevents explosion even though a considerable percentage of oxygen may be present.

Limits of Flammability of Gas-Air Mixtures

It is a well-known experimental fact that mixtures of so-called flammable gases with air are only flammable between certain definite concentration limits. This does not mean of course that they will not burn if heat is continuously supplied from an external source, but rather that they will not support combustion of themselves. The experimental determination of the upper and lower limits is difficult because of the many factors involved. The results that appear in the literature vary, but in Table I are given the limiting values for some common gases, expressed as volume per cent of the gas.[1]

TABLE I—FLAMMABILITY LIMITS OF SOME COMMON GASES AND VAPORS, EXPRESSED AS PER CENT BY VOLUME.

Gas	Lower Limit	Upper Limit
Hydrogen	8.5— 9.5	66.3—75.5
Methane	5.5— 6.3	12.7—13.5
Ethylene	3.4— 4.1	14.5—14.6
Ether	1.6— 2.8	7.5— 7.7
Alcohol (C_2H_5OH)	3.7— 4.0	13.6—13.7
Benzene	1.4— 2.5	6.3— 6.5
Pentane	1.3— 2.4	4.8— 4.9
Carbon monoxide	14.3—16.5	74.0—75.0

Oxygen is, of course, necessary for the explosion of a gas mixture, and consequently explosions can be entirely prevented by replacing the oxygen by some inert gas such as carbon dioxide, carbon monoxide, nitrogen or mixtures of them. A very important corollary of this is that it is only necessary to replace a part of the oxygen to obtain a non-explosive mixture and the permissible per cent of oxygen is surprisingly large. For example, it is found experimentally that, with a mixture of methane and air, if the oxygen is reduced to 13 per cent by replacing part of it with carbon dioxide, no ex-

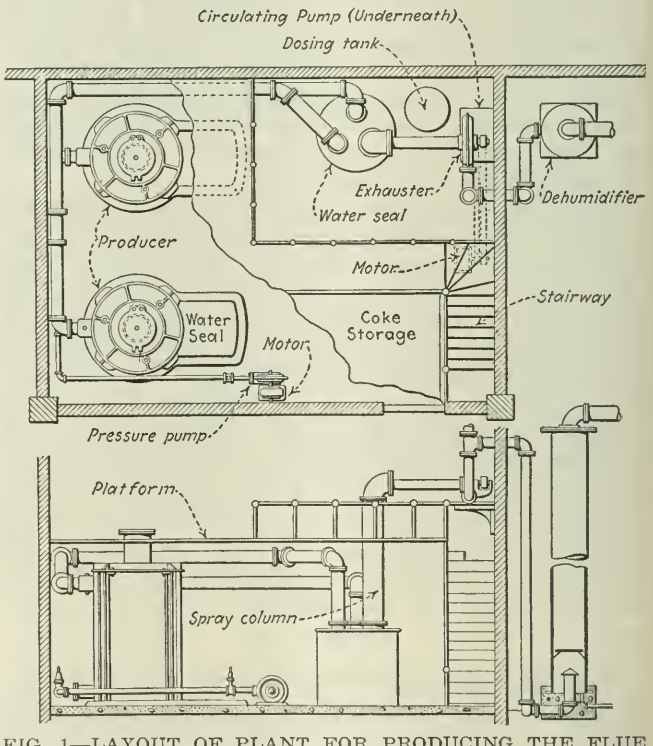


FIG. 1—LAYOUT OF PLANT FOR PRODUCING THE FLUE GAS FROM COKE

[1] "Untersuchungen über die Explosions Grenzen brennbarer Gase und Dampfe"—Paul Eltner.

plosive mixture is possible with any percentage of methane. On the basis of the theory of flammable limits, we are able to calculate the permissible per cent of oxygen for a number of gases. Without going into the details of the theory it may simply be stated that no explosive mixture of gasoline or of benzene and air is possible if the oxygen is maintained below about 12 per cent.

Producing the Inert Gas

The inert gas is cheaply produced by burning coke in a special type of producer or by burning fuel oil in a small brick oven. The gas from the producer or oven, consisting mainly of carbon dioxide, nitrogen and water

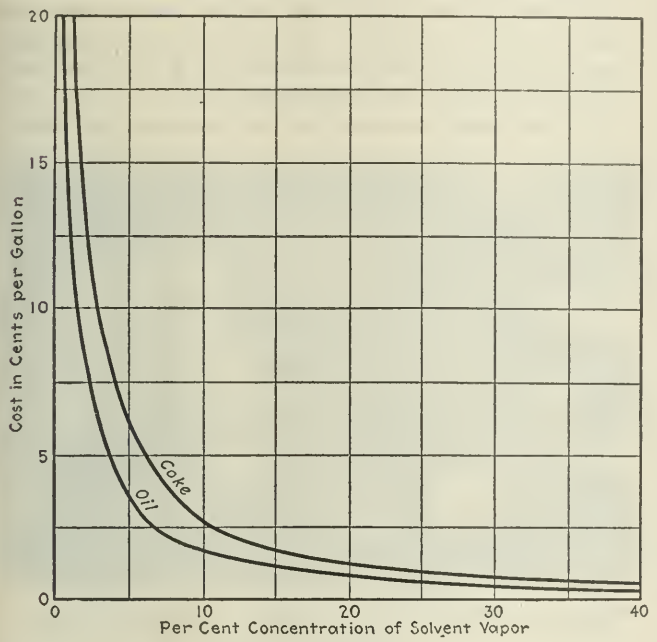


Fig. 2—Relation Between Cost of Fuel for Flue Gas (expressed as cents per gallon of solvent recovered) and the Concentration of the Solvent Vapor (expressed as volume per cent).

vapor, is cooled, cleaned and dehumidified in a spray chamber or coke tower, after which it is ready for use as the solvent drying medium. If the oil or coke is high in sulphur, it may be necessary to include a scrubbing outfit to remove sulphur dioxide. The choice between coke or oil is largely an economic question depending on their relative cost, as either will yield a clean gas of low oxygen content (0 to 2 per cent). Fig. 1 shows a layout of a plant for producing the gas using coke as the fuel.

The reaction of air with coke can be controlled to produce either carbon dioxide or carbon monoxide as desired. In producer gas practice, carbon monoxide is the main product desired, but for use as an inert gas, carbon dioxide is the more desirable. A study of the equilibrium relations among carbon, carbon dioxide and carbon monoxide and of the rates of reaction shows that the conditions for maximum carbon dioxide production are low temperature of the fuel bed, a shallow bed (as shallow as is consistent with no air holes) and a fairly low velocity of gases through the bed. The producer should be set in an iron shell to reduce the inward leaking of oxygen if run under suction, or outward leakage of gas if under pressure. With proper design of the producer and proper control of the firing and draft, a gas can be consistently produced that contains 18 to 20 per cent of CO_2 and 0.1 to 1.5 per cent of O_2.

The use of flue gases from an ordinary boiler is not desirable because of the high and fluctuating oxygen content and the presence of soot, which is difficult to remove in a simple manner. The use of coke gives a gas that is practically free from finely divided solid or liquid particles, and an oil burner can be operated in such a way as to give a clean gas with a low oxygen content. In small installations the recovery of the heat in the flue gases does not pay, but for large installations it is sometimes advantageous to generate the flue gas in a coke-fired or oil-fired boiler, although bearing in mind that the primary object is the generation of the inert gas.

It can readily be calculated that 1 lb. of coke and 1 gal. of fuel oil will yield about 120 cu.ft. and 1,600 cu.ft. respectively of dry gas at 70 deg. F. The cost of the flue gas per gallon of recovered solvent is a function of the concentration of the solvent vapor that can be obtained in the gas, and since the latter is relatively high in most cases, the cost is practically negligible. Fig. 2 gives a comparison of calculated fuel costs to produce the gas, assuming coke at $18 a ton and fuel oil at 7c. a gallon. The cost can be reduced and the recovery increased by the simple expedient of recirculating part of the flue gas from the recovery plant.

Application to Various Processes of Solvent Recovery

The gas may be applied to any compression, refrigeration or absorption process of solvent recovery without any change in the recovery equipment. The recovery obtained is just as high as when air is used as the medium.

In using flue gas it is necessary that the drying operation be carried out in a well-inclosed space so that

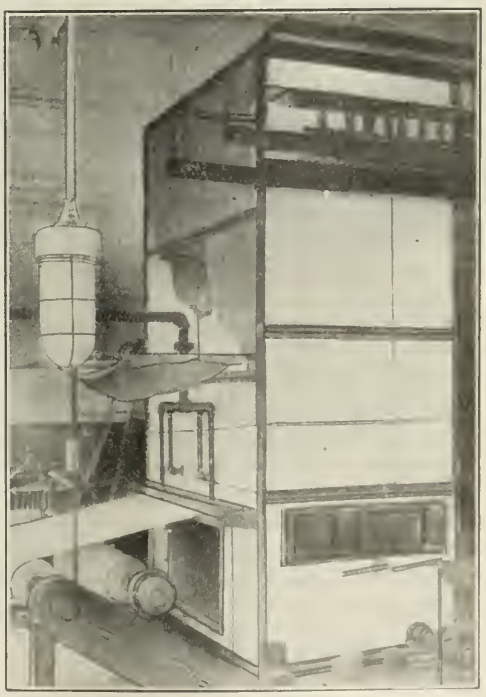


FIG. 3—HOODED IMPREGNATOR FOR CORD TIRE FABRIC IN ACTUAL USE

leakage of air in, or of the flue gas out, will be a minimum. This has led to the development of efficient hoods for various machines in which solvent is used, with the result that greater production has been attained, the operators are effectually shielded from the injurious ef-

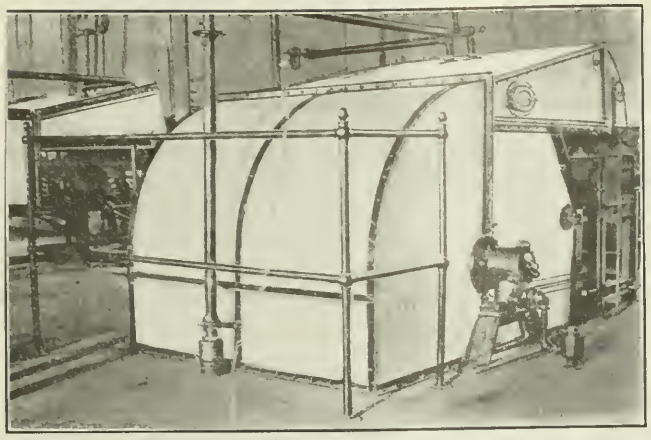


FIG. 4—DRUM SPREADER EQUIPPED WITH HOOD FOR USING FLUE GAS PROCESS OF RECOVERY

fects of solvent fumes. Furthermore, the better control of the drying conditions results in a more uniform product. To treat further of this very important phase of solvent recovery is beyond the scope of this article. Attention is called, however, to Figs. 3, 4 and 5. Fig. 3 shows a hooded impregnator for cord tire fabric and Figs. 4 and 5 show the types of hoods that have been applied to drum and flat spreaders used for the rubberizing of fabrics. Figs. 4 and 5 are rear and front views respectively of a hooded drum spreader.

Condensation-Recirculation Process Using Flue Gas

The method of solvent recovery based on condensation in a water-cooled condenser followed by recirculation of the gases leaving the condenser to the point where the solvent is being evaporated can be shown to possess a number of advantages, particularly as regards initial cost of equipment and operating and maintenance charges. The commercial development of this method has been retarded by two factors—viz., (1) the difficulty of obtaining sufficiently high concentrations, and (2) the fire and explosion hazard. The first difficulty has been met by the design of efficient hoods as discussed above, and the second by the use of flue gas as the carrying medium for the solvent vapors.

With a recirculation system of this type it is impossible to recirculate all the gas leaving the condenser, if the solvent-using operation is a continuous one, because small leaks will occur where the material being treated enters and leaves the drying chamber. In the development of this process the main problem was to determine if enough of the gas could be recirculated to give a high recovery without allowing the oxygen content to become high enough to introduce any explosion hazard. This process was first studied from a theoretical standpoint and found to be feasible, after which the theory was substantiated on a plant scale.

A study of the effect of inert gas on the flammability of gas mixtures established the fact, as previously shown, that there was no explosive mixture of benzene or of gasoline possible if the oxygen content was reduced to 12 to 13 per cent. To allow a factor of safety, it was decided to limit the oxygen to 5 to 6 per cent in the gas entering the drying chamber.

In a recirculation system of this type an equilibrium

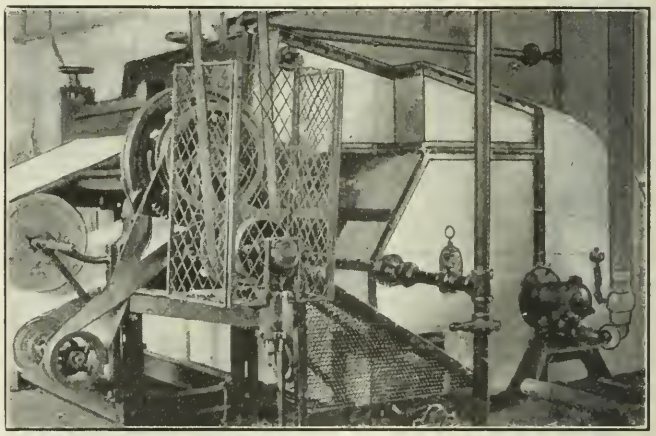


FIG. 5—ANOTHER VIEW OF HOODED DRUM SPREADER IN USE

oxygen concentration will be attained when just as much oxygen is being purged from the system in a unit of time as is entering the system. Consequently, the main factors affecting the per cent of permissible recirculation will be the amount of leakage in or out of the system, the amount of oxygen in the fresh "make-

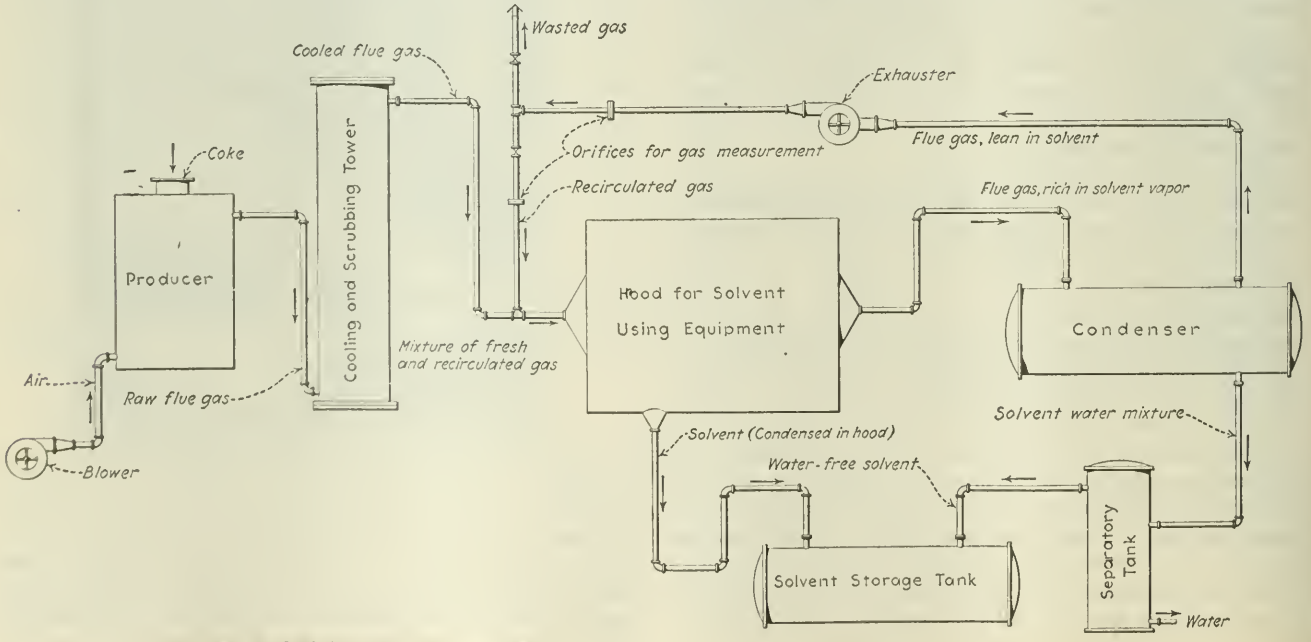


FIG. 6—FLOW SHEET OF CONDENSATION-RECIRCULATION PROCESS USING FLUE GAS

up" flue gas, and the permissible oxygen in the system. All the leakage will occur in the hooded drying chamber and the assumption was made that practically all the leakage was inward. On this basis a general equation for recirculation may be developed. Reference to the flow sheet of the process, shown in Fig. 6, will aid in understanding the factors involved.

Developing an Equation for Recirculation

Solvent is being evaporated under a hood, which is assumed for sake of illustration to be inclosing an equipment for impregnating a fabric with a rubber compound. Some air leaks into the hood at the point of entrance and exit of the fabric. The flue gas, rich in solvent, goes to the condenser, where part of the solvent is condensed. The gas, now lean in solvent but containing very appreciable amounts, divides, as shown, into two portions. One portion is recirculated back to the hood, receiving an addition of fresh flue gas as shown, and the other portion is wasted to the atmosphere. It is desired, of course, to recirculate as great a fraction of the gas from the condenser as possible, but this is limited by the leakage and the permissible oxygen content. The following quantitative treatment of the problem was a valuable aid in predicting the result of large-scale experiments:

Let f = fraction of the gas recirculated.
O_r = fraction of oxygen in the recirculated gas.
n = mols of air leaking into the hood per mol of total gas fed to the hood.
O_g = fraction of oxygen in the fresh flue gas.
S = fraction of solvent in the gas leaving the condenser.
m = mols of gas leaving the condenser per mol of gas fed to the hood.

Then, on the basis of 1 mol of total gas fed to the drying chamber,

mfO_r = mols oxygen recirculated.
$mO_r(1 - f)$ = mols oxygen purged from the system.
$(1 - mf)$ = mols fresh flue gas.
$O_g(1 - mf)$ = mols oxygen entering with the fresh flue gas.
$\frac{n}{5}$ = mols oxygen leaking in.

Equating the input and output of oxygen we obtain:

$$\frac{n}{5} + O_g(1 - mf) = mO_r(1 - f) \qquad (1)$$

m is best expressed as a function of the other factors in the following manner:

In m mols of gas leaving the condenser there are $(1 - s)m$ mols of non-condensible gas which is made up of the non-condensible gas recirculated, plus the air leaking in, plus the fresh flue gas.

In the mf mols of gas recirculated, there are smf mols of solvent. Therefore, there are $(1 - smf)$ mols of non-condensible gas entering the drying chamber.

Equating the non-condensible gas leaving the condenser to that leaving the drier, we obtain:

$$(1 - s)m = 1 - smf + n$$

or,

$$(1 - s)m + smf = 1 + n$$

and,

$$m = \frac{1 + n}{1 - s + sf}$$

Substituting this value of m in (1), the equation becomes

$$\frac{n}{5} + O_g\left[1 - \frac{f + fn}{1 - s + sf}\right] = \frac{O_r(1 - f)(1 + n)}{1 - s + sf}$$

Solving for f, we obtain:

$$f = \frac{O_r + O_r n + O_g s - O_g + \frac{ns}{5} - \frac{n}{5}}{\frac{ns}{5} + O_g s - O_g - O_g n + O_r + O_r n} \qquad (2)$$

The approximate value of the per cent recirculation for a wide variety of conditions can be predicted by substituting in this equation. It is found, in this way, that a fairly large percentage variation in the oxygen content of the fresh flue gas has only a small effect on the recirculation whereas variation in the leakage seriously affects the recirculation.

Table II gives the results of some calculations made with the aid of equation (2).

TABLE II—PERCENTAGE RECIRCULATION AND PERCENTAGE RECOVERY CALCULATED FOR DIFFERENT VALUES OF O_r AND n

Case I. $n = 0.10$, $O_g = 0.01$, $S = 0.12$, O_r variable				Case II. $O_r = 0.05$, $O_g = 0.01$, $S = 0.12$, n variable			
$O_r \times 100$	$f \times 100$	Per Cent Recovery A*	Per Cent Recovery B†	$n \times 100$	$f \times 100$	Per Cent Recovery A	Per Cent Recovery B
2	0	70	20	2	91	97.3	92.8
3	27	78.1	41.6	5	79	93.7	83.2
5	60	88.0	68	10	60	88.0	68.0
7	73	91.9	78.4	20	30	79.0	44.0
10	82	94.6	85.2	25	17	75.1	33.6

*The concentration of solvent vapor is assumed to be such as to give a 70 per cent recovery by simple condensation without recirculation.
†The concentration of solvent vapor is assumed to be such as to give a 20 per cent recovery by simple condensation without recirculation.

Referring to Case I in the table, it is seen that the percentage recirculation is greatly influenced by the allowable percentage of oxygen in the recirculated gas, increasing rapidly as the oxygen is raised. If the concentration of solvent vapor is high, say over 35 per cent, the percentage recovery is good even with a small recirculation, but if the concentration is as low as 15 per cent a higher percentage recirculation must be maintained to obtain a good recovery.

Case II shows the effect of leakage on the percentage recirculation, the other factors being fixed. As would be expected, the allowable percentage recirculation ($f \times 100$) becomes rapidly lower as the leakage increases. This in turn affects the recovery, and again the effect is much more marked for the case of low concentration of solvent vapor (B) than for the case of high concentration (A). It is obvious that the process can be applied only to cases where concentrations of solvent vapor may be obtained that are appreciably greater than the equilibrium concentration at the temperature at the exit of the condenser, which means that the solvent must be evaporated at a temperature well above room temperature.

In one case to which this process was to be applied —namely, the impregnation of cord tire fabric—O_r was chosen to be 0.05 (5 per cent of permissible oxygen in recirculating gas), n was assumed to be about 0.1 on the basis of the leakage tests that were available, O_g could easily be kept to 0.01 and s was about 0.12. Substituting these values in equation (2), $f = 0.60$. In other words, 60 per cent recirculation could be used under these conditions. Inasmuch as about 80 per cent recovery is obtained in the simple condenser without recirculation, the total recovery with recirculation should be $80 + (0.60 \times 20) = 92$ per cent, or nearly as much as could be obtained with a more complicated equipment. It was found in actual practice that between 60 and 70 per cent recirculation could be used under approximately these conditions, thus bearing out the value of the preliminary theoretical study. The leakage is actually less than 0.1 on the average, and it seems probable that about 75 per cent to 80 per cent recirculation can be used with a well-designed hood.

Lewis Recovery Corporation,
Cambridge, Mass.

Legal Notes

By Wellington Gustin

Chemical Company Liable for Death of Horses Where It Filled Dedicated Street With Refuse

In the action by Harry Shapiro against the Albany Chemical Co., it was shown that the chemical company had dumped a tarry and caustic material into the street adjoining its property in such a manner that its nature was not apparent. The plaintiff's horses, while being driven along such street, became mired in the material, where it had a depth of about 5 ft., causing the death of the animals. The company was sued for negligence and damages were recovered. (189 N. Y. S., 736.)

On appeal the Appellate Division of the New York Supreme Court confirmed the company's liability. It says where a city extended its conduit through a street, dedicated as a public street but never accepted as such, with consent of the chemical company abutting thereon, and not claiming to own the street, which extension involved the use of the street to a greater or less degree, the company, which filled the street with a tarry and caustic material carried in a pipe from its works, is liable to an employee of the city for death of his horses, which became mired in such material when he was directed to go on the premises and remove a pump. The company was under obligation to exercise its right in the street consistently with the fact that it had been dedicated for public use, and that title to adjoining property had passed on the strength of that condition.

Circuit Court of Appeals Affirms Decree Holding Wooster Patent No. 933,011 Void

The United States Circuit Court of Appeals recently affirmed the decree of the District Court in the matter of the Duryea Manufacturing Co. vs. Agrippa Manufacturing Corporation and others, whereby the Wooster patent, No. 933,011, was held void for anticipation by the old Pearce & Beardsley patent by about 25 years. (273 Fed. Rep., 522.)

After a period of experiments the Duryea Co. produced a woven cotton belting which it saturated with a solution of asphaltum and placed upon the market with very favorable results. A patent covering the belting was issued in 1909. In 1917 or 1918 the defendant corporation began to manufacture a similar product and placed it on the market, and plaintiff asked that defendant be enjoined and give an accounting.

The defense was that defendant used the old Pearce & Beardsley patent of 1886, No. 348,993, in the manufacture of its product.

The claim of the Wooster patent is for belting consisting of an absorbent woven fabric body portion which has been saturated with a solution of asphaltum and dried. The old Pearce & Beardsley patent was for a new article of manufacture of all kinds of cloths and fabrics other than for paper and treated with a compound of bisulphide of carbon and maltha substantially as set forth in the patent.

Maltha is described as a soft asphalt, and proof showed that the process of saturating as described by Pearce & Beardsley and the saturation under pressure described by Wooster are substantially the same. The earlier patent describes the process of manufacture with almost the same degree of exactness as that of the plaintiff's patent. True, there had been no general marketing of the product under the first process, but the court said the proof of manufacture under this patent, though slight, indicates a disclosure to the world and made such patent more than a prophetic suggestion, as was urged by plaintiff. Plaintiff's only act beyond the patent of Pearce & Beardsley was the creation of a market for its output, but, says the court, this fact alone, standing by itself, cannot be a ground for sustaining the validity of its patent, which discloses nothing new to the world except the idea of pressure to obtain "saturation," which is obviously only one of a number of means of accomplishing the results.

Contracts of c.i.f. Shipments Construed

In an action by Willets & Patterson against Abekober & Co., Ltd., the plaintiff was a California corporation and defendant was a Japanese corporation. The latter sold the former 750,000 lb. of soya bean oil, payment in full being made for same, but when the oil arrived in San Francisco there was a shortage of 79,555 lb. The purchaser then brought this suit to recover back the proportionate amount of the purchase price paid. (189 N. Y. S., 525.)

Upon an appeal in the case by the plaintiff to the Appellate Division of the New York Supreme Court the sole question presented for determination was whether the plaintiff had shown the existence of the cause of action as set forth in his pleadings, which was an action upon the contract. The trial court held that this contract was simply a c.i.f. contract, and that the perils of the voyage from Japan to San Francisco were at the buyer's risk, and for failure to show that this shortage existed at the time of the delivery to the carrier the plaintiff had failed to show any right of action.

The higher court says the law is well settled that a simple c.i.f. contract requires the seller to deliver to the carrier, and upon such delivery the obligation of the seller is at an end, and the risk is thereafter with the buyer. However, it says these contracts of sale are to be construed according to the intention of the parties to the contract. A straight f.o.b. contract is satisfied by the seller's delivery to the carrier for the purpose of shipment, the risk of transportation resting upon the buyer. If, however, there be anything in the contract which shows that such was not the intention of the parties, the contract will be construed according to their intention.

Intention of the Parties

This same court earlier held, in the case of Standard Casing Co., Inc., vs. California Casing Co. (188 N. Y. S., 358), that in a contract to ship from California to New York, reserving the right of inspection to the buyer at New York, the liability of the seller was shown by this provision to extend to a delivery in New York City, notwithstanding the contract provided for a price f.o.b. San Francisco. In yet another case it was held, notwithstanding a named price f.o.b. at point of shipment, that the right of inspection at the destination of the transportation indicated an intention that the delivery was not to be deemed complete until such destination was reached. Other facts or circumstances may show the intention of the parties.

In the case at bar the sale contract contains the provision "net landed weight." The court construed this to mean the weight at San Francisco must accord with the contract requirements as to weight.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

American Electrochemical Society Announces Spring Meeting Plans

A tentative program for the spring meeting of the American Electrochemical Society which is to be held in Baltimore, Md., April 27 to 29, has been announced. Headquarters will be established at the Hotel Emerson. The technical sessions will be held Thursday, Friday and Saturday mornings and will include three symposiums: Electric Furnace Cast Iron, Gases of the Electrochemical Industries and Electromotive Chemistry. By "electromotive chemistry" is meant that branch of electrochemistry which has to do with the production of electromotive forces by means of chemical processes and in a broader sense would include related phenomena as the "photo-electric effect," and allied electronic effects. On the theoretical side, papers on the electrolytic theory of oxidation and reduction, on concentration cells of various types, on potentials at liquid junctions, electrical phenomena in living protoplasm and on the electron theory may be expected. On the industrial side, the practical application of the theoretical aspects of the subject and in particular papers on primary and secondary batteries should provide material for discussion.

The plans under way provide for visits to industrial plants, a complimentary smoker to be given by the chemists and engineers of Baltimore, a golf tournament, a boat trip, an illustrated lecture by Prof. W. R. Wood on "Fluorescence" and an entertainment program for the ladies.

Mysterious Explosion Causes Casualties and Fire at Zapon Plant

The explosion of a tank car supposed to contain mixed acid caused the death of two operators and started a fire which destroyed two of the storage warehouses at the plant of Richards & Co. in Stamford, Conn., on Feb. 24. The Stamford plant is the home of Zapon artificial leather and the lacquer works of Richards & Co.

According to Edward D. Williams, superintendent of the plant, the car of acid, which had been received recently from an acid plant in New Jersey, had been spotted and connected to the line leading to storage tanks. The two operators had phoned to the acid office to have the air turned on the car. Apparently, the explosion occurred just after the air was turned on, although this can never be definitely established. The car sample was destroyed in the explosion so that the analysis of the acid is unknown. Mr. Williams and other plant officials could offer no explanation as to the cause of the accident.

The fire which followed the explosion destroyed two warehouses containing cotton linters, pigments, shipping containers and miscellaneous supplies. Plant officials expect to be operating normally inside of a week.

Patent Office Relief Assured

The President signed the Patent Office relief bill on Feb. 18. Since the bill carries only the authorization for the appropriation, the reorganization and installation of additional personnel must await the actual granting of the money. It is probable, however, that the appropriation can be carried in a forthcoming deficiency bill. The change in patent fees does not become effective until April 19.

Farmers Unite in Protest on Potash Duty

Senator McLean of Connecticut has presented to the Senate a petition of 25,000 New England farmers protesting against a duty on potash.

New Committee Finally Begins Hearings in Long-Delayed Dye Investigation

The initial sessions of the hearing on the Senate resolution calling for investigation of certain activities on the part of domestic dye manufacturers and on the part of importers of foreign-made dyes were devoted largely to a repetition by Senator King of the various charges made by him heretofore in the Senate. He also has covered most of the points made by former Senator Thomas, whose mantle Senator King has assumed. The du Pont Co., the Chemical Foundation and the Textile Alliance were given special attention.

When the committee met for its first hearing, Senator Reed stated that he found it would be impossible to give any time to the investigation. Senator Ernst of Kentucky also was excused from serving. He explained that his law firm is counsel for the Grasselli Chemical Co. and that while he is of the opinion that he could serve without prejudice, he pointed out that the connection was likely to be a source of embarrassment, not only to him but to the sub-committee. This made it necessary for Senator Shortridge of California, the chairman of the sub-committee, to lay the situation before the Judiciary Committee and request the assignment of two of its members to sit with him in the conduct of the investigation. Senator Sterling of South Dakota and Senator Ashurst of Arizona were designated and are sitting with Senator Shortridge.

Frelinghuysen Defends Dye Industries

The delay in getting the investigation started rather nettled Senator Frelinghuysen of New Jersey, who pointed out vigorously that charges are resting over the head of an American industry and that it is entitled to the prompt consideration of its side of the case, if it is not to be handicapped in its contest with the German monopoly which is seeking to dominate the American market. Senator Frelinghuysen demanded, in effect, that Senator Moses of New Hampshire be called upon to prove the charges which he had made against the American dye industry. He promised to lay before the committee evidence as to the activities of the representatives in this country of the German trust and of importers. He said the domestic industry had been built up not only to save the domestic textile industry during the war but to enable the Allies to overcome Germany's initial superiority in chemical warfare. "Germany nearly won," said Senator Frelinghuysen, "by reason of our lack of vision and statesmanship in failing to protect the American dye industry."

The Position of the Textile Alliance

An important statement was made to the committee by F. R. Coudert, attorney for the Textile Alliance. Extracts from his statement follow:

"The Textile Alliance, Inc., is a New York State, non-profit, membership corporation, whose voting members and directors are nominees of trade associations representing practically the entire textile trade of the United States.

"In October, 1919, and several times since the Textile Alliance, Inc., without solicitation on its part, was requested by the Department of State to undertake—and it did undertake—the purchase and distribution of reparation dyes accruing to the United States.

"In October, 1921, a protest was filed with the Department of State against the continuance of this arrangement by Kuttroff, Pickhardt & Co., Inc., a New York corporation, owned and managed by American citizens of German birth, who formerly in their corporate or private capacities were agents of the Badische Anilin- & Soda-Fabrik, one of

the six constituent members of the German dyestuff monopoly. The State Department on Dec. 14, 1921, abrogated the arrangement with the Textile Alliance, Inc., stating that there was no dissatisfaction with the work of the Alliance and that there was no objection by the department to the Reparation Commission continuing the allocation of reparation dyes to American non-profit organizations. Later, letters were given by the department to Kuttroff, Pickhardt & Co., Inc., and to other former representatives of the German dye monopoly, stating that the department had no objection to the Reparation Commission allocating reparation dyes to them.

"As a result the Reparation Commission refuses to continue to supply reparation dyes to America until the Department of State shall decide who the recipients of the American portion shall be.

"If the allocation be divided among profit-seeking corporations connected or formerly connected with the German monopoly, the effect will inevitably be to re-establish the control, not only of reparation dyes but of all German dyes, in the hands of the German monopoly or those representing it.

"The Textile Alliance, Inc., does not seek to continue this work itself and would prefer to have it in the hands of a government department."

Expert Testimony to Be Called

Senator King filed a list of names with the committee asking that each be subpœnaed to appear and to produce books, papers and correspondence and accounts. Among those included in the list are Thomas O. Marvin, chairman of the U. S. Tariff Commission; Julius Klein, director of the Bureau of Foreign and Domestic Commerce; General Amos A. Fries, chief of the Chemical Warfare Service; H. E. Howe, formerly chief of the National Research Council; Charles L. Parsons, secretary of the American Chemical Society; B. R. Price, National Aniline Co.; E. A. Mason and F. L. Fleisch, Textile Alliance, Inc.; Charles H. Herty, president Synthetic Organic Chemical Manufacturers' Association; R. C. Jeffcott, president American Dyes Institute; Samuel Iserman, Chemical Company of America; Irenee du Pont and other representatives of the E. I. du Pont de Nemours & Co. and of the Allied Chemical & Dye Corporation.

Faults in Design, Not Materials, Caused Collapse of R-38

That the accident which wrecked the giant dirigible R-38 at Hull, England, Aug. 21, 1921, was caused by structural weakness in the design of the airship rather than defects in structural material is shown by the report of the Aëronautical Research Committee to the British Air Ministry. The report admits the presence of a certain amount of softened duralumin in the airship, but insists that faulty material did not contribute to the accident. In a summary of its conclusions the committee says that it has reached the following conclusions:

1. That the accident was due to structural weakness in the design of the airship.
2. That during the final flight no loads were imposed in excess of those which might have occurred during the normal navigation of the ship in weather which might reasonably be encountered.
3. That, having regard to her size and speed, R-38 was considerably weaker than R-33.
4. That the provision of specially powerful control surfaces of new design virtually accentuated this weakness.
5. That no calculations were made of the stresses due to the aërodynamic forces to which the ship would be subjected.
6. That in consequence, the calculations made by the design staff, taking specific account only of the forces and movements due to the distribution of weight and buoyancy, including gas pressures, were misleading.
7. That, owing to instability of the ship, combined apparently with overbalance of the control surfaces, the movements of the controls necessary to keep the ship on any particular course were comparatively larger.
8. That the structure was not improbably weakened by the cumulative effect of reversals of stress of magnitude not far short of the falling stress.
9. That for the progressive development of airships in size and speed reference to first principles in design is necessary, and that it is not sufficient to place exclusive reliance on comparison with existing ships.
10. That the existing methods of calculation at present in use for determining the scantlings of structural members of an airship are insufficiently accurate for this purpose and that more exact methods, the outline of which can at present be indicated, should be developed.
11. That research by both model and full-scale experiment is essential to determine and verify the forces to which an airship is subjected.
12. That the terms of the requirements laid down in time of war for R-38 were extremely drastic and that the limitations involved by the size of the shed in which the airship had to be built imposed too severe a task on the designers.
13. That at the time when the design was originally laid down information as to aërodynamic forces existed which should have led to a more detailed consideration of the effects of these forces and to consultation with the Advisory Committee for Aëronautics as to the dangerous loads foreshadowed by the early model experiments on aërodynamic pressures.
14. That in spite of the presence of a certain amount of softened duralumin in the airship, faulty material did not contribute to the accident.
15. That on the assumption made, the structure was designed with great skill and the necessary calculations were carefully carried out by methods admitted as sufficiently accurate in other branches of engineering practice.
16. That the weather at the time did not contribute to the accident.

The report includes a comparison of R-38 with R-33 from which design data were taken.

Paint Company Operating Novel Pigment-Making Process

The Pacific Color Manufacturing Co., which was organized a year ago to develop the patents of H. D. Swartout, has brought the first unit of its plant at Chilliwack, 70 miles east of Vancouver, B. C., to the producing stage. The process that the company employs for making pigments consists of dissolving galena in dilute nitric acid contained in duro-iron retorts, of special design, heated by steam. The resulting nitrate of lead is drawn off into vats, where the lead is precipitated in different forms by various reagents, giving the desired pigments, while the oxides of nitrogen and any nitric acid that distills over are recovered. The insoluble residue is drawn off from time to time through valves at the bottom of the retorts. The patents cover reagents, temperatures and retort design.

The galena is obtained in the form of concentrate from the Florence Silver Mining Co., which is operating a silver-lead mine at Ainsworth, in West Kootenay. The contract with the mining company calls for a concentrate containing not less than 60 per cent of lead. The first carload delivered contained 67.8 per cent of lead, 8 per cent of iron, and 3 per cent of zinc. The company is using 5 tons of concentrate daily, but expects during the next few months to install another battery of five retorts, which will double its output. The nitrate solution, after the precipitation of the lead salts, will be evaporated and sold for fertilizing purposes.

Soap-Making and Therapeutics Related in Colloid Chemistry

The Lehigh Valley Section of the American Chemical Society was addressed by Martin H. Fischer of Cincinnati at a regular meeting held Feb. 17 at the Hotel Allen, Allentown, Pa. Dr. Fischer chose as his subject, "The Theoretical and Practical Aspects of the Colloid Chemistry of Soaps," his remarks on the application of colloid chemistry to soap making being illustrated by a large exhibit of samples. The speaker also pointed out the relation between the "salting out" of soaps to the neutralization of mercury and lead poisons in the human body by the use of sodium and potassium salts.

Destruction of Dirigible Emphasizes Need for Helium Plants

That no small part of the responsibility for the Roma disaster may be laid at the door of Congress is an opinion very generally held among technical men in Washington. There is unusual frankness on the subject and much space has been given by the newspapers to statements pointing out that helium should have been available for use in this aircraft. The failure of Congress to provide the small appropriations asked was said to be the only reason that sufficient helium was not available. It is pointed out that a valuable natural resource is being allowed to go to waste, although its complete practicability has been proved by the operation of the C-7, which has made upward of fifty trips without any loss of the helium with which it is filled. Representative Lanham, of Texas, has given notice that he will urge that $800,000 be made available at the earliest possible moment for the government's helium plants.

Military Affairs Committee Considers Merits of Muscle Shoals Offers

The most interesting development of the week in the Muscle Shoals negotiations was the transmission to Congress of the offer of the Alabama Power Co., accompanied as it was with the comments of the Secretary of War which emphasized its favorable features.

A detailed statement of the situation with regard to the Gorgas-Warrior plant was made to the committee by J. H. Burns, who until recently was in charge of the Nitrate Division of Ordnance. He explained that the Alabama Power Co. had in operation at the time of the war a 20,000-kw. plant located on the Warrior River. So as to be assured power for the chemical end of the project before power could be made available at Muscle Shoals, a plan was worked out whereby the Alabama Power Co. was to furnish 30,000 kw. provided the government increased the facilities at Gorgas.

"The Alabama Power Co." he said, "agreed to put up this additional plant at cost plus 6 per cent, and definitely agreed that the company would buy back the plant from the government at a specified time at a fair value, to be determined by a board of arbitrators.

"The arrangement was an expedient to get quick power in order to get explosives at No. 2 plant. It seemed to be the very best solution that could be made of the problem at that time. This arrangement with the Alabama Power Co. was a great help to the government in the early days of the war, as it gave us power at the No. 2 plant in May, 1918, a few months after the plant was started and we were never short of power as a result of that connection. Our own steam plant at Muscle Shoals was not accepted finally until long after the armistice.

"Since the time limit provided in the contract has not been reached, no negotiations for the return of the plant have been undertaken. In case the sale is not consummated to the Alabama Power Co., the government must remove its portion of the plant and leave the land in satisfactory condition."

In explaining the difference between the Alabama Power Co.'s contract and that with the Air Nitrates Corporation, Major Burns said: "The American Cyanamid Co. cannot buy Plant No. 2 unless it is willing to make as good a proposition to the United States as the United States is able to get from any other person. It is my judgment that the American Cyanamid Co. would not give the United States as much as Mr. Ford is offering to give. Therefore I feel that the American Cyanamid Co.'s option will not be an impediment."

Ford Bound to Conduct Research

From the beginning of the hearing it has been evident that the committee attached great importance to lack of definiteness in the Ford offer in the matter of fertilizer manufacture. Even the Secretary of Agriculture qualified his approval of the Ford proposal by specifying that its terms must be found binding so that the plant will be operated continuously for the manufacture of fertilizer. In an effort to meet this objection, Mr. Ford has agreed to alter the contract so as to give a definite guarantee to produce a complete fertilizer at a given minimum annual tonnage. In his testimony before the committee, W. B. Mayo, chief engineer of the Ford Motor Co., made it very clear that it had been Mr. Ford's intention from the first to produce a complete fertilizer. It was his idea, however, that the contract should not make it binding to produce fertilizers at a loss. He agreed that Mr. Ford's company is bound by the proposal to conduct experiments and research work throughout the 100 years. "The only valid reason for discontinuing," said Mr. Mayo, "would be that it had been proved by every possible effort to be an absolute impossibility to make the product there with a profit."

Fertilizer Interests Point Out Existence of Surplus of Ammonium Sulphate

C. H. MacDowell, president of the National Fertilizer Association, in his recent testimony declared that there is no necessity for the manufacture of nitrate for agricultural purposes. He said that coke ovens and city gas works have a capacity of 550,000 tons of sulphate of ammonia annually and that after the fertilizer and other domestic demands are met there still would be an exportable surplus of about 150,000 tons.

The need for maintaining Nitrate Plant No. 2 in readiness for an emergency was emphasized by Mr. MacDowell, who was in charge of the chemical division of the War Industries Board for a time during the war. At that time the country was mainly dependent on Chile for its nitrogen. Stocks fell so low at one time during the war that they were sufficient only for 4 weeks requirements. As a result of that grave experience, he said, there is every reason why the plant should be retained in standby condition ready for operation.

Surplus of Ammonium Sulphate Only Temporary, Says Whitney

Particular significance was attached to the testimony of Milton Whitney, chief of the Bureau of Soils, in view of the fact that some of the arguments made before the committee have been based on the existing price of ammonium sulphate. The inference drawn from Dr. Whitney's remarks by some members of the committee is that decided increases in prices may be expected as the use of fertilizer returns to the normal rate.

"We have an overabundant supply just now of nitrogen in all of its forms," said Dr. Whitney, "because the farmers did not purchase last year. Under normal conditions we have been keeping up with the demand for fertilizers, but there has been an impossibility of getting nitrogenous material in sufficient amount for any great expansion in their use. I have had this matter up with the fertilizer manufacturers. If they were to be successful in getting a demand for 2,000,000 tons of fertilizers in the wheat and corn states, we then could not get the nitrogen to supply it.

"With the demand for fertilizers increasing 7½ per cent per annum, it is becoming more and more difficult to get adequate supplies of ammonia. We have plenty of phosphoric acid and we are searching very diligently for potash; anyway we can get it from the European sources. Nitrogen is the limiting factor. If we have the fixed nitrogen products, we must change our fertilizer system in order to use them to the best advantage."

Fertilizer Investigation Proposed on Charges of Muscle Shoals Lobbying

A resolution to investigate an alleged fertilizer trust which is said to be lobbying against acceptance of the Ford offer to lease the Muscle Shoals plant was introduced in the Senate by Senator McKellar of Tennessee on Feb. 17. The proposed investigation would be conducted by the Senate Agriculture Committee to determine whether there is a fertilizer trust, whether the industry is controlled by a combination of corporations and whether it has employed lobbyists to influence Congress against accepting the Ford offer.

Industrial Developments of the Week

Glass. — The American Window Glass Co. has resumed operations at its plant at James City, near Kane, Pa., following a shut-down since early in December.

The B-R-C Bottle Co., Cedar Grove, La., has resumed operations at its plant after a period of curtailment. Employment will be given to about 200 men.

The Owens Bottle Co., South Glassboro, N. J., is operating its bottle-blowing plant at full capacity, with three-shift working forces.

Paper. — The American Writing Paper Co., Holyoke, Mass., has resumed production at its local Gill division plant, following a period of curtailment. Operations will be on a basis of 60 tons of paper per day.

The J. C. Blair Co., Huntingdon, Pa., manufacturer of paper specialties, has advanced production to a full-time schedule of 54 hours a week. The plant has been running on a short-time basis since last year.

Leather.—The E. C. Mills Leather Co., Middleville, N. Y., is operating at a capacity schedule at its tannery.

Tarlow Bros., Brockton, Mass., are maintaining operations on a full capacity schedule.

McAdoo & Allen, Philadelphia, Pa., are increasing production at their welting plant at Quakertown, Pa. and are arranging for early expansion, providing additional floor space and increased working force.

Refractory.—The National Fire Brick Co., New Philadelphia, Ohio, has resumed production at its local plant, following several weeks idleness.

Iron and Steel.—The Pittsburgh Steel Co., Pittsburgh, Pa., has resumed operations at six furnaces at its open-hearth plant.

The Berwick Rolling Mills, Berwick, Pa., have reopened the finishing department at their local plant, following a period of curtailment, and will give employment to about 200 additional men.

The Hanna Furnace Co., Cleveland, Ohio, is making repairs at its furnace at Dover, Ohio, and placing the unit in readiness for blowing in. It has been closed down since December, 1920.

The Carnegie Steel Co., Pittsburgh, Pa., is operating two of its Lucy furnaces full, for the production of ferromanganese and spiegeleisen.

The Follansbee Bros. Co., Pittsburgh, Pa., is operating on a full time schedule at its steel mills at Follansbee, W. Va., recently reopened.

The Illinois Steel Co., Chicago, Ill., has placed another furnace in blast at its Gary, Ind., works, making a total of eleven stacks now active, comprising six at Gary, four at the South Chicago works and one at Joliet, Ill.

The Jones & Laughlin Steel Co., Pittsburgh, Pa., has seven blast furnaces operating full for the production of iron. It is planned to place another furnace in blast at the Woodlawn works for the production of ferromanganese at an early date.

The Inland Steel Co., Chicago, Ill., has adopted a capacity schedule in its sheet department. The structural mill, continuous mill and nine open-hearth furnaces are also active. It is proposed to resume operations at the plate mill at an early date.

Metals.—The El Paso Smelting Works, El Paso, Tex., is making ready to resume operations at five of its lead furnaces, which will be more than have been in service for a number of years past. The company is also planning for early resumption of operations in the copper furnace department.

The Nevada Consolidated Copper Co., Ely, Nev., has arranged for the immediate resumption of production at its local smelters on a 60 per cent basis. The mines, also, will be reopened.

The Anaconda Copper Co. is increasing production at its Great Falls, Mont., electrolytic plant from 2,000,000 to 4,000,000 lb. of copper per month. This will be increased to a maximum of 7,000,000 lb. as soon as sufficient concentrates from the mines are available.

Powder.—E. I. du Pont de Nemours & Co. are giving employment to about 500 operatives at their Carneys Point, N. J., plant, under full-time operation.

Connecticut Valley Section, A.C.S.

The Department of Chemistry of Smith College was host to the Connecticut Valley Section of the American Chemical Society on Feb. 4, 1922. The members were given opportunity to inspect the college laboratories and to visit the mills of the McCallum Hosiery Co., the Nonotuck Silk Co. and the Florence Manufacturing Co.

The speaker of the day was W. T. Bovie of Harvard University, who addressed the section on "The Structure of Protoplasm."

Personal

HARRY BREARLEY, works manager of Brown Bayley's Steel Works, Sheffield, England, and well known for his writings on steel metallurgy, is in the United States for a brief stay.

J. A. CULLEN has been assigned to cement experiment work at the Columbus Station of the U. S. Bureau of Mines.

H. A. DOERNER has been assigned to rare-metal work at the Reno experiment station of the Bureau of Mines. Mr. Doerner was formerly connected with the Denver office of the Bureau of Mines. For several years past he has been engaged in commercial work.

F. B. FOLEY, metallurgist, Minneapolis Station of the Bureau of Mines, has been in Washington recently. He presented a discussion of "The Annealing and Hardening of Steel" before the Washington Chapter of the American Society for Steel Treating at its monthly meeting Feb. 17.

J. J. FORBES, coal-mining engineer of the Bureau of Mines, is collecting data for the preparation of a bulletin on sampling and analysis of Alabama coals. This bulletin will give information regarding the coals of the Birmingham district. One hundred and forty-nine face samples of coal have been taken in thirty-four mines in Alabama, representing fourteen different coal beds.

A. P. GEST, JR., formerly assistant superintendent of the Frankford Plant of The Barrett Co. and more recently in the technical service department as expert on the industrial uses of coal-tar solvents, is now associated with Keator & Wilson, Philadelphia, Pa., as Eastern representative of the St. Louis Pump & Equipment Co., St. Louis, Mo., and of Morrison Bros., Dubuque, Iowa.

C. F. GRASS, president and general manager of the American Nitrogen Products Co., Seattle, Wash. was in New York last week.

H. W. HARDINGE, of Hardinge Co., New York, sailed Feb. 15 on the S. S. *Baltic* for Europe, and plans to return about the middle of April.

HAROLD E. MARTIN, who last May left the General Chemical Co., where he was employed as an engineer in the research department, is now with Johns-Manville, Inc., in the New York insulation and power plant specialties department.

Dr. DUNCAN MACRAE, physical chemist for the Westinghouse Lamp Co., delivered a lecture on "Physical Chemistry and Some of Its Applications" before the senior class in chemistry of the Cooper Union night school on Feb. 23.

Dr. C. E. KENNETH MEES, director of research and development, Eastman Kodak Co., gave several lectures in Montreal and Toronto during the last week of February. On Feb. 20 at Montreal he spoke before the Canadian Club on "The Road to Wealth." The same evening he lectured before the Montreal Section of the Society of Chemical Industry on "Chemistry and the Motion Picture." At Toronto he gave the following lectures: Feb. 21, "Photography Through the Microscope," before the Camera Club; Feb. 22, "Chemistry and the Motion Picture," before the Toronto Section of the Society of Chemical Industry; Feb. 23, "The Getting of Wisdom" before the Empire Club, and "A Hundred Years Hence," before the Canada First League.

Dr. CLARK MINTER, of the Hanovia Chemical Co., delivered a lecture on "Osmotic Pressure" before the senior class in chemistry of the Cooper Union night school on Feb. 9.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

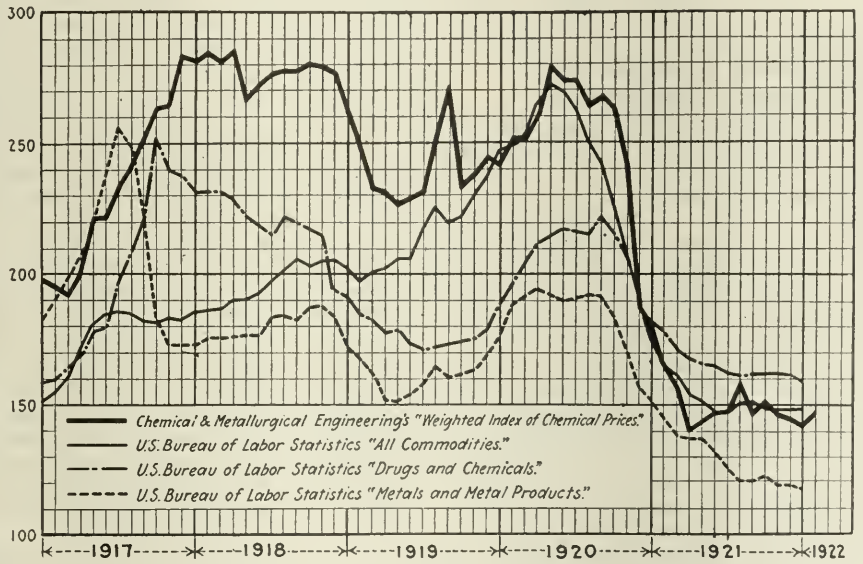
A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Fundamental Progress in Business During February

Underlying conditions improved somewhat during February, but the progress toward better business has been slow and painful. The general upward trend of business has been punctuated with reactions, many of which had depressing effects on industry.

Outstanding among the developments of the month have been the threatened coal strike with its almost inevitable consequences to industry, the serious agitation for the soldier bonus with its menace to business progress, and the continued wage disputes, which have added greatly to the ranks of the unemployed. On the other side of February's ledger are to be noted the striking rise in foreign exchange, the noticeable upturn in certain commodity prices, and finally the announcement of the government's more sympathetic attitude toward industry as evidenced by Secretary Hoover's defense of the trade association and other methods of modern business.

The proposed miners' strike, directly involving soft- and hard-coal miners in more than twenty states, may have a most serious effect on industry if we are to judge from the disastrous results of the late British coal strike. Even today Great Britain's foreign trade is suffering from ailments which economists declare are directly attributable to that long tie-up of industry. As is doubtlessly well known, all wage agreements in American coal mines will terminate April 1 and unless the miners force the acceptance of a new and higher wage scale, production will cease. The effects will be felt most seriously by industry, for supplies are adequate to meet the householders' demands, especially since in most sections, the weather will have moderated considerably by April 1. Those most familiar with the situation are confident that, whatever the temporary consequence, the net result will be a downward turn in the present inflated prices of coal. Still 90 per cent above pre-war levels, lower coal prices are generally regarded as inevitable.



A COMPARISON OF WHOLESALE PRICES, 1917-1922

The sensational financial development of the past month has been the sharp rise in sterling and the sympathetic strengthening of practically all of the other exchanges. After averaging $4.16 for December and $4.22 for January, the British pound opened the past month at $4.28, crossed $4.37 on Feb. 9, and then after a temporary slump, jumped to 4.41\frac{5}{16}$ on Feb. 23. This is the highest level reached since 1919. The exchange on Paris has risen from $0.0835 on Feb. 1 to $0.0913 on Feb. 24 and the Italian lire from $0.0466 to $0.0502. The business situation in Great Britain is not generally regarded as sufficient in itself to have so strengthened the exchange. The most likely explanation is that it is the cumulative effect of smaller imports, the apparent arrangements to provide £25,000,000 to cover 6 months interest on the English debt to the United States, and finally the larger exports of gold. Announcement was made on Feb. 20, that in the one week ended Jan. 18 Great Britain had exported £1,276,816 in gold to the U. S.

On Feb. 3 wages in the textile mills of the three states of Massachusetts, New Hampshire and Maine were greatly reduced. Other states immediately followed suit. This cut of 20 per cent, following a general reduction of 22½ per cent which was put into effect early in January, 1921, has resulted in a strike of very generous proportions. The chemical industry is not so organized as to be affected by such blanket wage decreases, but during the past month more than one prominent dyestuff and chemical manufacturer has made drastic reductions both in salaries and personnel. Reducing wages is the most obvious path to lower costs, but it is also the most difficult.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	151.21
Last week	149.05
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

Wholesale Prices

Although the general level of prices has probably remained almost stationary, a number of important commodities have shown an upward tendency during February. Particularly is this true in the chemical market. CHEMICAL & METALLURGICAL ENGINEERING'S Weighted Index of Chemical Prices stood at 144.60 on Feb. 1, increased to 147.33 on Feb. 8, to 149.05 on Feb. 22 and on March 1 had risen to 151.21. This is highest level of chemical prices

since October, 1921. These higher prices are not necessarily to be regarded, however, as progress toward business recovery in the chemical industry. They may mean speculation and artificial activity, but as has often been pointed out in these columns, the essential requirement is the proper adjustment between the great groups of commodity prices and between such economic factors as costs, wages and transportation.

Wholesale Prices in January

The U. S. Bureau of Labor Statistics index numbers indicate that wholesale prices in general averaged somewhat lower in December than in the preceding month. The bureau's "all commodities" index number, comprising 327 price series, stood at 148 for January, compared with 177 for January, 1921.

Below are shown the index numbers of wholesale prices in the United States, by groups of commodities, as computed by the Bureau of Labor Statistics for the months named.

INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES. (1913 = 100)

	1921		1922
	January	December	January
Farm products	136	113	116
Food	162	139	134
Cloths and clothing	208	185	183
Fuel and lighting	228	187	183
Metals and metal products	152	119	117
Building materials	239	203	202
Chemicals and drugs	182	161	159
Housefurnishing goods	283	218	214
Miscellaneous	190	148	146
All commodities	177	149	148

Working Hours and Wages in the German Chemical Industry

A report on the labor supply of the German chemical industry, comparing the working hours in 1913 and 1921, has recently been made by Dr. C. Duisberg. Labor conditions have apparently varied considerably in the individual factories of the Rhineland district. Before the war, the working day at the Bayer Farbwerke was 9 hours (from 7.30 a.m. to 6 p.m. with a midday break from 12 to 1.30), but as a rule most factories worked 10 hours. Heavy manual laborers, such as stokers and workers in the heavy chemical industries, worked an 8-hour day.

This report, which has been summarized in a late issue of the *Journal of the Society of Chemical Industry*, states that at Hoechst, in 1913, the 10-hour day was the rule. At the works of the Aktiengesellschaft für Anilinfabrikation, Berlin, the length of the working day varied with the nature of the work performed. The 12-hour day was worked at Berlin-Treptow, the 10-hour day in the Filmfabrik Wolfen (6 a.m. to 6 p.m. with 2-hour rest) and either 11 or 13 hours in the Rummelsburg works. A special working day of 8½ hours for women was provided in one of the plants.

At the Badische Anilin- und Soda-Fabrik at Ludwigshaven, labor conditions were said to resemble those at the Leverkusen plant of the Bayer company. The 9-hour day (7.30 a.m. to 12 m. and 1.30 p.m. to 6 p.m.) was the usual basis, although the pay was for 10 hours. In some instances where there was need for continuous service the men worked in 12-hour shifts from 6 to 6 and were paid for 13 hours.

Directly after the revolution in November, 1918, the 8-hour day was introduced into the chemical industry. Among the rules set down by the German *Reichsanzeiger* were the following:

"The working time, including rest periods, shall be 8 hours.

"By agreement, the working hours on Saturday may be shortened, the time lost being spread over other days.

"Female workers over 16 years may be employed, where two or more shifts are worked, up till 10 p.m., provided they are then allowed a rest period of at least 16 hours."

These rules are said to have been universally accepted in the chemical industries. The 8-hour day, with a half hour break from 12 to 12.30 p.m. is most common. Where shifts are worked they commence at 5.55 a.m., 1.55 p.m. and 9.55 p.m. and end at 2.05 p.m , 10.05 p. m. and 6.05 a.m. respectively.

The New York Market During February

NEW YORK, Feb. 27, 1922.

The chemical market during the past month showed very little signs of recovery. On the surface, the total amount of business for February seems to have increased over the preceding month. However, the persistent conservatism on the part of buyers to limit their purchases to immediate requirements, together with the policy of large manufacturers to hold production at a minimum, has had a disastrous effect on the general trend of trading and has retarded any forward movement. The steady arrivals of imported materials at extremely low figures has also been a severe handicap and has caused serious consideration among many of the largest domestic producers.

During a recent address before the Rochester Section of the American Chemical Society, Dr. W. J. Hale of the Dow Chemical Co. stated that his company is selling at 12c. per lb. bromide which is actually costing 23½c. per lb. to produce and is doing this in order to prevent the Germans from dumping on the American market vast quantities of the product now held in Eastern warehouses.

One of the encouraging developments of the month was the advance in foreign exchange, and this has been reflected in the export market in the form of expansion in trading and has also served as a limited bar on imported materials. Foreign buying during the past few weeks has been practically the only hopeful sign in the industry and an appreciable increase has been reported in many quarters. Frequent sales of large tonnages were noted to Japan, Mexico, Italy and South America.

The prussiate market continued its steady advance, with the demand heavy and supplies exceedingly scarce. Yellow prussiate of soda reached a new high level when sales were recorded at 18½c. per lb. Red prussiate of potash became a nominal proposition during the month as prices soared from 33c. to 60c. per lb. Spot supplies have been wiped out of the market and futures have been reported in only a very limited way. Another item that has been of some market interest is linseed oil. Opening the month at 74c. per gal. for the raw product in carload quantities, prices advanced to a high level of 86c. per gal. for February shipments. Leading interests predict a much higher market with the season closely ahead. The alkali market has shown a decided decline since the opening of February owing to increased competition and large spot supplies of imported material. Caustic soda opened the month at $3.60 per 100 lb. and reached a low mark of $3.25 toward the close. Soda ash sold during the early part of the month at $1.80 per 100 lb. and factors at the close were selling carload lots at $1.65. Imported ash has been a serious factor to the domestic producers.

DEVELOPMENTS OF THE WEEK

Trading, in general, has uncovered no striking developments during the past week. Small lots still continue to rule the market, although a few inquiries were noted for round quantities at a fraction under quoted figures. There were rumors in the trade that imported nitrite of soda was slated for a sharp advance and holders began to tighten offerings with the memory of the March, 1920, movement that resulted in increasing the price to 60c. per lb. Domestic producers have already advanced prices a full cent per lb., making the market 8½c. per lb. at the works. Oxalic acid was reduced by leading interests to 12c. per lb. This is the lowest first-hand price since last November. Competition was responsible for a reduction in formaldehyde at the works. Caustic soda has merited added attention for export and considerable small-lot business has been placed at slightly higher figures. Prussiate of soda touched a new high mark of 8½c. per lb. This is the highest price paid since November, 1920.

THE COMMODITY MARKETS

Alums—Ammonia alum held by domestic producers was quoted on a basis of 3½@3¾c. per lb. for the lump. Imported potash alum is quoted freely at 3¼@3½c. per lb.

Barium Chloride—Sales were recorded during the week at slightly lower figures—around $55 per ton on spot.

The market was very firm at the figure toward the end of the week, with some interests asking up to $57 per ton.

Bicarbonate of Soda—Producers' quotations remain unaltered at 2c. per lb. for barrels f.o.b. works. Spot material, however, is on the market as low as $2.10 per 100 lb. Some small lot sales were made at $2.15.

Caustic Potash—There was an appreciable improvement noted in the consuming inquiry for the imported. The 88-92 per cent is quoted at $5.65@$5.75 per 100 lb., with shipment goods held at $5.60@$5.85 c.i.f. Domestic producers are still asking 8c. per lb, f.o.b. works.

Caustic Soda—Leading factors stated that February shipments have been heavily sold and the market looks much firmer. March shipments are quoted at $3.35@$3.40 per 100 lb. f.a.s. and April at $3.30, although the latter can possibly be purchased on a firm bid of $3.25. Export inquiries are holding up fairly well.

Citric Acid—The consuming inquiry has not shown any appreciable increase, but the tone of the market is much stronger, owing to the advice from abroad indicating a restricted output. Some of the largest producers in Italy were reported to be closed down. Spot goods are quoted at 45c. per lb.

Formaldehyde—The domestic as well as the export demand continues quiet and the market has shown the effect of the competition for new business. Producers quote from 9@10c. per lb., f.o.b. works, in barrels.

Nitrite of Soda — A distinctly firmer market has been brought about with the exhaustion of spot foreign supplies and some domestic factors have advanced their prices to 8½c. per lb. at works. There are only a few scattered lots available on the open market at this figure.

Oxalic Acid—Leading producers reduced prices sharply at the works. Goods were offered at 12c. per lb. and upward, depending on the quantity and seller.

Prussiate of Soda—Very firm conditions continue to prevail for spot material. Limited offerings and a good consuming inquiry have been sufficient to create this condition. Dealers report sales at 18½c. per lb. and it is doubtful if better prices could be obtained in any direction.

Shellac—The market has been very active during the past week and prices moved upward from 5@7c. per lb. on practically all grades. Arrivals at New York were reported larger, but as a market factor this was completely overshadowed by the receipt of news that a large cargo of shellac from Calcutta has been wholly or partly destroyed by fire. The demand was active for nearby material. T. N. was quoted at 73c. per lb., superfine at 77c.

The Chicago Market

CHICAGO, ILL., Feb. 23, 1922.

A slight improvement of the general conditions in the industrial chemical market was noted during the past week. Sales have increased and the inquiry is more active. Buying continues to be for small or moderate quantities but the volume of this business is reported as very satisfactory. Prices as a rule are unchanged and the tendency with a few exceptions is upward. This upward trend is to be noticed particularly on chemicals of foreign origin as cable quotations from abroad were sharply higher.

GENERAL CHEMICALS

Contract business for alkalis is reported as brisk and small sales from warehouse stocks as dull. Prices are slightly weaker in some directions, which is probably due to the necessity of moving present stocks. Small lots of solid *caustic soda*, 76 per cent, were quoted at $3.75 per 100 lb. delivered to the consumer. *Soda ash* on spot was rather quiet with $2.30 per 100 lb. for 58 per cent material in cooperage the prevailing offer. *Caustic potash* was firm at 6½c. per lb. for 88-92 per cent material.

Ammonium chloride is unchanged as to price and is reported to be moving fairly well at 7¾c. per lb. for the white granular in casks. *Ammonium carbonate* is rather quiet and small lots on spot are offered at 9@10c. per lb. *Bleaching powder* is firm at 3c. per lb. delivered and is said to be moving in a fair way. *Copper sulphate*, like the metal, is very firm and 6c. was the prevailing quotation, although it was still possible to do $5.90 per 100 lb. in one direction. While *formaldehyde* was reported to be moving well, prices were a little weak and 10c. per lb. could very likely have been shaded for a fair-sized lot. *Glycerine* was in fair demand and unchanged at 16½c. per lb. for c.p. material in drums. *Epsom salts* are in but small demand with plentiful supplies of U.S.P. material available at 2¾c. per lb.

Bichromates are enjoying a fair demand and supplies are reported to be not very heavy. *Potash bichromate* is quoted in single-cask lots at 11¾c. per lb. and the soda at 9@9½c. *Yellow prussiate of potash* is in brisk demand and with supplies light, prices are firm at 27@28c. per lb. The market is entirely clear of the *red prussiate* and even a firm offer for future delivery could not be had. Cables abroad also failed to locate any material for prompt shipment. Several large sales of *sodium bicarbonate* were reported, but aside from these only a few small lots changed hands. Spot material in cooperage is available at $2.35 per 100 lb. *Hypo* is very quiet, with only small parcels moving. Prices remain the same, $3.95 per 100 lb. for pea crystals in barrels. *Silicate of soda* appears to be moving in a fair way and single drums of the 40 deg. material is quoted at $1.40 per 100 lb., drum extra.

Linseed Oil — The movement of linseed oil continues slow, buyers showing a pronounced reluctance to take on even small supplies at the present high level. Boiled oil in single drum lots was offered today at 88c. per gal., drum extra, and similar lots of the raw at 86c.

Naval Stores—Turpentine is slightly lower in price but the movement continues slow. Single drums were quoted today at 95c. per gal., drum extra, delivered to the buyer's store. Rosin is moving in a fair way and $8.50 per 280 lb. was today's prices of the WW grade in less than carlots.

Furfural—Technical furfural was available for the first time in commercial quantities, the offer being 50c. per lb., drums extra, for quantities larger than 100 lb.

The Iron and Steel Market

PITTSBURGH, Feb. 24, 1922.

Steel mill operations have increased a trifle more in the past week, reflecting still heavier buying, since practically all production is against orders placed for prompt shipment. The rate of steel ingot production in the past fortnight has probably averaged 27,000,000 or 28,000,000 tons per annum, against a rate under 18,000,000 tons at the end of December and a rate of 23,000,000 tons in October and November, denoting the volume of last autumn's demand. Thus with spring not yet arrived the demand rises well above that of last autumn. When eventually the curve of production can be plotted, this spring's demand is likely to represent 25 or 30 per cent more demand than that of last autumn, while a reasonable expectation is that next autumn will show a higher tide still.

Up to date there is no indication that buyers will depart from their practice of buying steel practically from hand to mouth. The old practice of distributers and manufacturing consumers carrying large stocks of steel, and of various interests carrying large stocks of manufactured wares, seems to be abandoned for quite a period. A necessary consequence would be that of demand upon the steel mills exhibiting much greater seasonal variations than has ever been the case before. Part of the ups and downs in steel demand has been due to buyers accumulating stocks at one time and liquidating at another time, these movements having no particular connection with the calendar.

There is lacking any comprehensive method of determining what the consumptive requirements or capacity of the country really are. When it is known, for instance, that steel ingots are being produced at the rate of, say, 28,000,000 tons per annum, there is no standard with which to compare this number of tons except the productive capacity, and that obviously is not a standard equally applicable to consumption. The happy state of productive capability and consumptive capability being balanced is unlikely to obtain in any commodity. That is one reason why the practice much in vogue in the past of indicating the rate of steel production by expressing it in terms of percentage of productive capacity is avoided in these reports. Such statements are both misleading and depressing. The

capacity has been estimated for some time past at about half way between 50,000,000 and 55,000,000 tons, in steel ingots.

A Broad Demand

The breadth of steel demand is the most conspicuous feature of the market. The agricultural implement trade is conspicuous for its almost complete absence, while practically every other steel-consuming industry is buying in a fair way. The electrical industry is buying much more freely than 2 or 3 weeks ago. Material required in dwelling house construction is doing very well, illustrated by there being a demand not far from normal for standard steel pipe, while the sheet mills are receiving larger orders from makers of eave trough and conductor pipe, metal lathing and ceiling, etc. Although out of season, the petroleum industry is buying in a very moderate way. The automobile trade is taking fair tonnages and is buying steadily instead of for extended deliveries. Railroad buying is somewhat more in evidence.

All appearance that buyers of steel are waiting for something to turn up is a thing of the past. Business is being conducted, and buyers are ordering freely. They do not buy for extended delivery and perhaps will not do so for a long time to come. A distinct possibility, however, is that of mills falling somewhat behind in deliveries whereby buyers would be forced to stock up in a moderate way instead of depending on mills for almost instant shipment against mixed specifications. This would create an extra tonnage demand for a time, the more important feature from the mill standpoint being that it would permit of better and more economical scheduling of rollings.

Steel Prices

With the gradual sagging in prices of bars, shapes and plates already reported, whereby 1.40c. became the more common market price, there is a tendency for this price to be adhered to with considerable strictness. It is possible that the market may be what is called "stabilized" at this figure, with the possibility of some contracting at this price, to be followed by a slight advance to "protect the contracts" in accordance with a principle the mills frequently invoked before the war. Certainly there is no room, with wages and freight rates as they stand, for the general market to go an appreciable amount lower.

In sheets the prices ruling for about 3 months past, 2.25c. on blue annealed, 3c. on black and 4c. on galvanized, are well maintained. Separate testimony to that fact is afforded in the American Sheet & Tin Plate Co. opening its order books, Feb. 20, for second quarter business at these figures. On the heavy gages, say 12 gage and under, there is plate mill competition.

Wire nails, which have been $2.40@$2.50 for several weeks, depending on size of order, show the $2.40 price more and more frequently. In standard steel pipe the extra concession of 2½ per cent, commonly given by independents, has lately been more often 5 per cent, and at present a total of 7½ per cent is sometimes found.

Pig Iron

Basic pig iron presents rather a complicated market. The furnaces insist that they are firm at $18 valley as minimum, with an asking price of $18.25, but a recent purchase reported to have been at $18 valley is believed in some quarters to have been of resale iron, from a middle interest, at $17.65. Foundry iron has been bought from a valley furnace in one case at $18.75, though some sales have also occurred at the old minimum of $19. Bessemer is down 50c., being quotable at $20.96 delivered Pittsburgh or $19 valley, the occasion being a sale of a few hundred tons by the Cambria Steel Co., which recently decided to devote part of its furnace capacity to the production of merchant iron. Freight to Pittsburgh is the same from Johnstown as from the valleys, $1.96.

Connellsville coke maintains the advance reported a week ago, but has not advanced farther, spot and prompt being quotable at $3.25@$3.50 for furnace and at $4@$4.25 for foundry per net ton at ovens.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... -	$0.40 - $0.42
Acetone	lb.	$0.12½ - $0.12½	.13 - .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 - 2.60	2.65 - 3.00
Acetic, 56 per cent	100 lbs.	5.00 - 5.25	5.30 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 - 9.50	9.75 - 10.00
Boric, crystals	lb.	.11½ - .11¾	.12 - .13
Boric, powder	lb.	.11¾ - .12	.12½ - .13
Citric	lb.	..... -	.45 - .45½
Hydrochloric	100 lb.	1.15 - 1.25	1.30 - 1.75
Hydrofluoric, 52 per cent	lb.	.11 - .11½	.11½ - .12
Lactic, 44 per cent tech	lb.	.09½ - .10	.10½ - .12
Lactic, 22 per cent tech	lb.	.04 - .04¼	.04½ - .05
Molybdic, c.p.	lb.	3.00 - 3.25	3.30 - 3.75
Muriatic, 20 deg. (see hydrochloric)	....	..... -	..... - .....
Nitric, 40 deg	lb.	.06½ - .06½	.06½ - .07
Nitric, 42 deg	lb.	.06½ - .07	.07½ - .07½
Oxalic, crystals	lb.	.12 - .12½	.13 - .14
Phosphoric, 50 per cent solution	lb.	.08 - .08½	.08½ - .09½
Picric	lb.	.20 - .25	.27 - .35
Pyrogallic, resublimed	lb.	..... -	1.65 - 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 - 11.00	..... - .....
Sulphuric, 60 deg., drums	ton	12.00 - 14.00	..... - .....
Sulphuric, 66 deg., tank cars	ton	16.00 - 16.50	..... - .....
Sulphuric, 66 deg., drums	ton	20.00 - 20.50	21.00 - 22.00
Sulphuric, 66 deg., carboys	ton	..... -	..... - .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 - 20.00	..... - .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 - 22.50	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.	lb.	..... -	.60 - .75
Tannic (tech.)	lb.	.40 - .45	.46 - .50
Tartaric, imported crystals	lb.	..... -	.25 - .26
Tartaric acid, imported, powdered	lb.	..... -	.26 - .29
Tartaric acid, domestic	lb.	..... -	..... - .30
Tungstic, per lb. of WO	lb.	..... -	1.00 - 1.10
Alcohol, ethyl	gal.	..... -	4.75 - 5.50
Alcohol, methyl (see methanol)	....	..... -	..... - .....
Alcohol, denatured, 188 proof No. 1	gal.	..... -	.36 - .37
Alcohol, denatured, 188 proof No. 5	gal.	..... -	.36 - .37
Alum, ammonia, lump	lb.	.03½ - .03¾	.04 - .04½
Alum, potash, lump	lb.	.03½ - .03½	.03¾ - .05
Alum, chrome lump	lb.	.07½ - .08	.08¼ - .08½
Aluminum sulphate, commercial	100 lb.	1.65 - 1.85	1.90 - 2.40
Aluminum sulphate, iron free	lb.	.02½ - .02¾	.03 - .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ - .07¾	.08 - .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 - .30½	.31 - .33
Ammonium carbonate, powder	lb.	.07 - .07½	.08 - .09
Ammonium nitrate	lb.	.06½ - .07	.07½ - .07¾
Amylacetate tech	gal.	..... -	2.00 - 2.40
Arsenic, white, powdered	lb.	.07 - .07½	.07½ - .08
Arsenic, red, powdered	lb.	.12 - .12½	.12½ - .13
Barium chloride	ton	55.00 - 57.00	58.00 - 70.00
Barium dioxide (peroxide)	lb.	.21 - .21½	.22 - .23
Barium nitrate	lb.	.06½ - .07	.07½ - .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ - .04	.04¼ - .04½
Blanc fixe, dry	lb.	.04 - .04½	..... - .....
Blanc fixe, pulp	ton	45.00 - 55.00	..... - .....
Bleaching powder	100 lb.	2.00 - 2.25	2.30 - 3.25
Blue vitriol (see copper sulphate)	.....	..... -	..... - .....
Borax	lb.	.05¼ - .05¾	.06 - .06¾
Brimstone (see sulphur, roll)	.....	..... -	..... - .....
Bromine	lb.	.20 - .21	.21½ - .26
Calcium acetate	100 lbs.	1.75 - 2.00	..... - .....
Calcium carbide	lb.	.04½ - .04¾	.05 - .05½
Calcium chloride, fused, lump	ton	24.00 - 24.50	24.75 - 27.00
Calcium chloride, granulated	lb.	.01½ - .02	.02½ - .02½
Calcium peroxide	lb.	..... -	1.40 - 1.50
Calcium phosphate, tribasic	lb.	..... -	.15 - .16
Camphor	lb.	..... -	.90 - .92
Carbon bisulphide	lb.	.06 - .06½	.06½ - .07½
Carbon tetrachloride, drums	lb.	.10½ - .10¾	.11 - .12
Carbonyl chloride, (phosgene)	lb.	..... -	.60 - .75
Caustic potash (see potassium hydroxide)	.....	..... -	..... - .....
Caustic soda (see sodium hydroxide)	.....	..... -	..... - .....
Chalk, precip.—domestic, light	lb.	.04½ - .04½	..... - .....
Chalk, precip.—domestic, heavy	lb.	.03½ - .03¾	..... - .....
Chalk, precip.—imported, light	lb.	.04½ - .05	..... - .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 - .06½	.06½ - .07
Chloroform	lb.	..... -	.37 - .40
Cobalt oxide	lb.	..... -	2.00 - 2.10
Copperas	ton	15.00 - 16.00	16.50 - 30.00
Copper carbonate, green precipitate	lb.	.19 - .20	.20½ - .21
Copper cyanide	lb.	..... -	.58 - .60
Copper sulphate, crystals	100 lb.	5.55 - 5.65	5.70 - 6.25
Cream of tartar	lb.	..... -	.23 - .24½
Epsom salt (see magnesium sulphate)	.....	..... -	..... - .....
Ethyl acetate com. 85%	gal.	..... -	.60 - .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... -	.93 - 1.00
Formaldehyde, 40 per cent	lb.	.09 - .09½	.09¾ - .10½
Fullers earth, f.o.b. mines	net ton	16.00 - 17.00	..... - .....
Fullers earth—imported powdered—net	ton	30.00 - 32.00	..... - .....
Fusel oil, ref.	gal.	..... -	2.50 - 3.00
Fusel oil, crude	gal.	..... -	1.40 - 1.75
Glauber's salt (see sodium sulphate)	.....	..... -	..... - .....
Glycerine, c. p. drums extra	lb.	..... -	.16½ - .17
Iodine, resublimed	lb.	..... -	4.05 - 4.15
Iron oxide, red	lb.	..... -	.12 - .18
Lead acetate	lb.	..... -	.10 - .12
Lead arsenate, powd.	lb.	.15 - .15½	.15¾ - .16½
Lead nitrate	lb.	..... -	.15 - 20
Litharge	lb.	.07½ - .07¾	.08 - .08½
Magnesium carbonate, technical	lb.	.06 - .06½	.06¾ - .08
Magnesium sulphate, U. S. P.	100 lb.	2.65 - 2.70	2.75 - 3.00
Magnesium sulphate, technical	100 lb.	..... -	1.00 - 1.80
Methanol, 95%	gal.	..... -	.57 - .58
Methanol, 97%	gal.	..... -	.59 - .60
Nickel salt, double	lb.	..... -	.11 - .11½
Nickel salt, single	lb.	..... -	.11 - .11½
Phosgene (see carbonyl chloride)	.....	..... -	..... - .....
Phosphorus, red	lb.	.45 - .46	.47 - .50
Phosphorus, yellow	lb.	..... -	.30 - .35

		Carlots	Less Carlots
Potassium bichromate	lb.	.10 – .10⅛	10½ – .10½
Potassium bromide, granular	lb.	.... –	.13 – .17
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80-85%	lb.	.04 – .04½	.04½ – .05½
Potassium chlorate, crystals	lb.	.05½ – .06	.06½ – .08
Potassium cyanide	lb.	.... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.65 – 5.75	5.80 – 6.50
Potassium iodide	lb.	.... –	3.10 – 3.15
Potassium nitrate	lb.	.07½ – .07¾	.08 – .09
Potassium permanganate	lb.	.13 – .14	.14½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.25½ – .26	.26¼ – .26⅓
Rochelle salts (see sodium potas. tartrate)	....	....	.... – ....
Salammoniac, white, granular	lb.	.06¾ – .07	.07¼ – .07½
Salammoniac, gray, granular	lb.	.06½ – .06¾	.07 – .07⅛
Salsoda	100 lb.	1.60 – 1.70	1 75 – 2.00
Salt cake (bulk)	ton	17.00 –20.00	.... – ....
Soda ash, light	100 lb.	1.65 – 1.80	1.85 – 2.40
Soda ash, dense	100 lb.	1.75 – 1.85	1.90 – 2.40
Sodium acetate	lb.	.04 – .04¼	.04½ – 05
Sodium bicarbonate	100 lb.	2.10 – 2.15	2.20 – 2.50
Sodium bichromate	lb.	.07¾ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06¼ – .06¾	.07 – .07½
Sodium chloride	long ton	12.00 –13.00	.... – ....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10¼ – .11
Sodium hydroxide (caustic soda)	100 lb.	3.35 – 3.40	3.45 – 4.00
Sodium hyposulphite	lb.	.03¼ – .03½	.03⅞ – .04
Sodium nitrite	lb.	.08 – .08¼	.08½ – .08¾
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	.... –	.18 – .21
Sodium prussiate, yellow	lb.	.18½ – .18¾	.19 – .19¼
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.15 – 1.25	1.30 – 1.90
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04 – .04½	.04½ – .04¾
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, red	lb.	.05 – .05½	.05½ – .06
Sulphur, crude	ton	18.00 –20.00	.... – ....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	.... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	.... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	.... – ....
Talc—domestic powdered	ton	18 00 –25.00	.... – ....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	.... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran	lb.	.08 – .08½	.08¾ – .09
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.28 — .30
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% n drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.30 — 1.35
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.15 — .16
Ortho-cresol, in drums (100 lb.)	lb.	.18 — .20
Cresylic acid, 97-99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.05 — 1.10
Dimethylaniline	lb.	.39 — .41
Dinitrobenzene	lb.	.21 — .25
Dinitroclorbenzene	lb.	.25 — .27
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.23 — .25
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.60 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	1.00 — 1.05
Monochlorbenzene	lb.	.10 — .12
Monoethylaniline	lb.	1.15 — 1.20
Naphthalene crushed, in bbls.	lb.	.06½ — .07
Naphthalene, flake	lb.	.06¾ — .07½
Naphthalene, balls	lb.	.07½ — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.17 — .18
Paranitroaniline	lb.	.77 — .80
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38
Phenol, U. S. P., drums	lb.	.11½ — 15
Pyridine	gal.	1.75 — 2 75
Resorcinol, technical	lb.	1.25 — 1.30
Resorcinol, pure	lb.	1.85 — 2 00
Salicylic acid, tech., in bbls.	lb.	.18 — .20
Salicylic acid, U. S. P.	lb.	.22 — .23
Salol	lb.	.80 — .82
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 — .14
Sulphanilic acid, crude	lb.	.25 — .27
Tolidine	lb.	1 20 — 1.30
Toluidine, mixed	lb.	.32 — .38
Toluene, in tank cars	gal.	.25 — 28
Toluene, in drums	gal.	.30 — 35
Xylidines, drums, 100 gal.	lb.	.40 — 45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0 20 — $0.21
Beeswax, refined, dark	lb.	.25 — .26
Beeswax, refined, light	lb.	.30 — .32
Beeswax, white pure	lb.	.35 — .38
Candellila wax	lb.	.24 — .25
Carnauba, No. 1	lb.	.45 — .46
Carnauba, No. 2, North Country	lb.	.24 — .24½
Carnauba, No. 3, North Country	lb.	.14½ — .15
Japan	lb.	.19 — .20
Montan, crude	lb.	.05 — .05½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ — 04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ — .05½
Stearic acid, single pressed	lb.	.08¾ — .09
Stearic acid, double pressed	lb.	.09¼ — .09½
Stearic acid, triple pressed	lb.	.10¼ — .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.30 —	5.35
Rosin E-I	280 lb.	5.40 —	5.45
Rosin K-N	280 lb.	6.05 —	6.80
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.89½ —	....
Wood turpentine, steam dist	gal.	.87 —	....
Wood turpentine, dest. dist.	gal.	.86 —	....
Pine tar pitch, bbl.	200 lb.	.... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	10.00
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, bulk	100 lb.	$2.60 —	2.70
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.45 —	2.50
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	37.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0.17½ —	.18
Upriver coarse	lb.	.12½ —	.13
Upriver caucho ball	lb.	.12 —	.12½
Plantation—First latex crepe	lb.	.15 —	.15½
Ribbed smoked sheets	lb.	.15¼ —	.15½
Brown crepe, thin, clean	lb.	.13 —	....
Amber crepe No. 1	lb.	.15 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.14 —	.14½
Coconut oil, Ceylon grade, in bbls.	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09¾ —	.10
Corn oil, crude, in bbls.	lb.	.08½ —	.08¾
Cottonseed oil, crude (f. o. b. mill)	lb.	.09½ —	.09⅝

Cottonseed oil, summer yellow	lb.	.10½ —	.11
Cottonseed oil, winter yellow	lb.	.11½ —	.11¾
Linseed oil, raw, car lots (domestic)	gal.	.86 —	.87
Linseed oil, raw, tank cars (domestic)	gal.	.83 —	.84
Linseed oil, in 5-bbl lots (domestic)	gal.	.90 —	.91
Olive oil, denatured	gal.	1 10 —	1.12
Palm, Lagos	lb.	.08½ —	.08¾
Palm, Niger	lb.	.06½ —	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09 —	.09¼
Peanut oil, refined, in bbls	lb.	.11¼ —	.11½
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls, N. Y.	lb.	.09½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.08 —	....

FISH

Light pressed menhaden	gal.	$0.48 —	....
Yellow bleached menhaden	gal.	.51 —	....
White bleached menhaden	gal.	.50 —	....
Blown menhaden	gal.	.57 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$1,000.00	$1,200.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	80.00	—125.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	12.50	— 17.50
Barytes, ground, white, f.o.b. mills	net ton	23.00—	209
Barytes, ground, off color f.o.b. mills	net ton	17.00	— 21.50
Barytes, floated, f.o.b. St. Louis	net ton	23.00	— 24 00
Barytes, crude f.o.b. mines	net ton	6.00	— 7.00
Casein	lb.	.15	— .16
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	— 8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	— 10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	— 20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00	— 20.00
China clay (kaolin), imported, lump	net ton	14.00	— 20.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, No. 1 p ttery grade	long ton	6.50	— 6.75
Feldspar, No. 2 pottery grade	long ton	5.75	— 5.90
Feldspar, No. 1 soap grade	long ton	7.25	— 7.50
Feldspar, No. 1 Canadian, for mill	long ton	22.00	— 22.50
Graphite, Ceylon lump, first quality	lb.	.04½	— .06½
Graphite, Ceylon chip	b.	.03½	— .05
Graphite, high grade amorphous crude	lb.	.00½	— .02¼
Kieselguhr, f.o.b. mines, Cal	per ton	40.00	— ....
Kieselguhr, f.o.b. N. Y	per ton	55.00	— 60.00
Magnesite, calcined (crude)	per ton	12.00	— 15.00
Pumice stone, imported	lb.	.03	— .40
Pumice stone, domestic, lump	lb.	.05	— .05½
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	.75	— .76
Shellac, orange superfine	lb.	.77	— .78
Shellac, A. C. garnet	lb.	.64	— .65
Shellac, T. N	lb.	.73	— .74
Silica, glass sand, f.o.b. Indiana	per ton	1.25	— 1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	— 4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	14 00	— 14.50
Silica, building sand, f.o b. Pa	per ton	2.25	— 3.00
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	8.25	— 13.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	— 20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o b. works)	net ton	53–55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	27–30

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½—	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 78-82% Mn, English and German c. i f. Atlantic seaport	gross ton	58.00 —	62.50
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon 75%	gross ton	115.00 —	120.40
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.37 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	4.00 —	4.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00 —	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	20 00 —	21.00
Coke, foundry, f.o.b. ovens	net ton	3.75 —	4.25
Coke, furnace, f.o.b. ovens	net ton	2.85 —	3.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.23 —	.25
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.48 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½—	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.40
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29 25
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.40
Zinc, spot, New York	4.925–4.95
Zinc, spot, E. St. Louis	4.475–4.50

OTHER METALS

Silver (commercial)	oz.	$0.65¼
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	85.00@ 90 00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	49.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.25
Copper bottoms	28.25
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	20.75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Cleveland	Chicago
Structural shapes	$2.63	$2.63	$2.63
Soft steel bars	2.53	2.53	2.53
Soft steel bar shapes	2.53	2.53	2.53
Soft steel bands	3.13	3.13	3.13
Plates, ¼ to 1 in. thick	2.63	2.63	2.63

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

ASHDOWN—The White Cliff Products Co., recently organized to operate in the White Cliffs section, will commence immediately the construction of a crushing and pulverizing plant for the manufacture of whiting, fertilizer and kindred products. It will have a capacity of about 15 tons an hour, and is estimated to cost close to $100,000. Work is under way on a power plant at the property. The company is headed by A. B. Banks, Little Rock, Ark. The Ashdown Chamber of Commerce is interested in the project.

California

NEWPORT BEACH—The Council has called a special election for April 10, to vote bonds for extensions to the municipal artificial gas plant, for reserve supply, to cost about $75,000. Paul E. Kressly, H. W. Hellman Bldg., Los Angeles, is city engineer.

Georgia

PERRY—The Council will install a new filtration plant in connection with an improved waterworks system, plans for which have been prepared by O. H. Sheffield, 505 Peachtree St., Atlanta, Ga., engineer. S. P. Crowell is city clerk.

MACON—The Buckeye Cotton Oil Co., is planning for the erection of a new oil mill on local site. Plans will be prepared at an early date.

SAVANNAH—The Savannah Gas Co. is planning for extensions and improvements in its plant on East Broad St., to cost about $50,000. John W. Golden is vice-president and general manager.

Illinois

EAST ST. LOUIS—The Obear-Nestor Glass Co., 25 North 2nd St., St. Louis, Mo., has excavations under way for the erection of its proposed 1-story plant addition at Broadway and Belt St., to cost about $75,000. It will be equipped for the manufacture of glass bottles.

CHICAGO—The Dryden Rubber Co., 1014 South Kildare Ave., has filed plans for the erection of a 1-story extension, 20 x 77 ft.

Maryland

BALTIMORE—The Holtite Mfg. Co., Warner and Ostend Sts., manufacturer of rubber products, is planning for the erection of a 1-story addition to double the present capacity. Morris Eisen is president and general manager.

Massachusetts

PEABODY—The Hunt Rankin Co., manufacturer of suede leathers, etc., is completing the erection of a 4-story addition, and will place the factory in operation at an early date.

SOUTHBORO—The Dennison Mfg. Co., Framingham, Mass., manufacturer of paper specialties, is having plans prepared for the erection of a 4-story plant, 70 x 300 ft., at Southboro. Monks & Johnson, 99 Chauncey St., Boston, are architects.

WORCESTER—The United States Peat Products Co., recently organized with a capital of $99,000, is considering tentative plans for the establishment of a color pigment manufacturing plant in connection with the development of peat properties. Edmund P. Cummins, Worcester, is treasurer.

BOSTON—The B. O. & G. C. Wilson Co., 196 Cambridge St. manufacturer of chemicals, drugs, etc., is taking bids for the erection of a 5-story plant, 60 x 200 ft., on Farwell St., Waltham, Mass. The H. M. Hope Engineering Co., 185 Devonshire St., Boston, is engineer.

Michigan

CADILLAC — The Cadillac Lumber & Chemical Co. has plans under way for the erection of a new plant at Sault Ste. Marie, Mich. The present works will be removed to this location.

MT. PLEASANT—The National Portland Cement Co. is completing plans for its proposed new 2-story cement manufacturing plant at Coldwater Lake, Mich., and will commence erection in April. It is estimated to cost about $500,000, including machinery. H. C. Shields is general manager.

ALPENA—The Kelley Island Stone & Lime Co. has acquired the plant of the Great Lakes Stone & Lime Co., at Rockport, and plans for extensive operations at the property. The present plant consists of two crushers, with total capacity of about 12,000 tons per day of 10 hours. The site comprises approximately 1,500 acres of property.

DETROIT—Plans are being completed by the Board of Water Commissioners for the construction of a filtration plant for the city waterworks at Waterworks Park, estimated to cost in excess of $2,000,000. Theodore A. Leisen is engineer. H. S. Starkey, 176 East Jefferson Ave., is secretary.

KALAMAZOO — The Kalamazoo Paper Box Co. has commenced the construction of a new plant to cost in excess of $150,000, including machinery. Robert E. Staebler is secretary, treasurer and general manager.

Missouri

KANSAS CITY—The Fleischmann Yeast Co. has acquired the plant of the Liberty Yeast Co., at North Kansas City, now in course of erection. It will be completed at once, with estimated cost of about $350,000. The factory will have a daily capacity of about 15,000 lb. of yeast.

ST. LOUIS—A large filtration plant will be installed at the city waterworks in connection with a number of extensions and improvements, estimated to cost in excess of $5,000,000. An election to vote bonds will be held during the summer. Edward E. Wall is city water commissioner.

New Jersey

TRENTON—Fire, Feb. 17, destroyed the plant of the Vulcan Recovery Co., May and Beakes Sts., manufacturer of reclaimed rubber products, with loss estimated at about $100,000, including equipment.

New York

SYRACUSE—The Syracuse Pottery Co., 711 East Division St., has tentative plans under consideration for the erection of a new plant at Amboy, near Syracuse.

BROOKLYN—J. M. Huber, 602 62nd St., manufacturer of colors, is taking bids for the erection of a 2-story plant addition, 36 x 52 ft., at 62nd St. and 6th Ave.

North Carolina

HENDERSONVILLE—A filtration plant will be installed at the new city waterworks, estimated to cost about $400,000, complete. Bonds have been issued. The Gilbert C. White Co., Durham, N. C., is engineer. C. E. Brooks is chairman of the Water Committee.

SALISBURY—The Arey Brick & Lumber Co., recently organized, will install a new drier system and make other improvements at its local brick-manufacturing plant. The company will operate with a capital of $100,000. F. M. Tyack is secretary and treasurer.

CHARLOTTE—The Council is planning for extensions and improvements in the municipal water gas plant, to cost about $40,000, to include a new tar extractor and equipment to increase the output from 15,000 to 25,000 cu.ft. per hour.

Pennsylvania

PHILADELPHIA—The Moore White Co., 15th St. and Lehigh Ave., manufacturer of iron and steel castings, etc., has commenced the erection of a 2-story foundry addition, 60 x 165 ft., estimated to cost close to $35,000.

YORK—The Ford Roofing Products Co., manufacturer of asbestos roofing, is completing plans for enlargements in its plant to double the present output. Work will be commenced at an early date.

PHILADELPHIA—The Wittman Moriarty Co., 4th and Vine Sts., manufacturer of leather products, has awarded a contract to William F. Newberry, 112 South 16th St., for the erection of a 1- and 2-story addition to its tannery at Ontario and C Sts., 75 x 105 ft. Furness, Evans & Co., 315 South 15th St., are architects.

LANCASTER—The Armstrong Cork Co. has construction under way on a 1-story addition to its local plant at Mary and Liberty Sts., 30 x 50 ft.

Tennessee

MEMPHIS—The Kot-N-Wood Products Co. has work under way on a new plant on local site for the manufacture of fiber paving brick, wallboard and kindred composition products, utilizing treated waste cotton stalks as basic material. The initial brick plant will have a capacity of 3,600 bricks per hour, with building 60 x 240 ft. George B. Stryker is president. William D. Edwards is engineer in charge.

LAFOLLETTE—The LaFollette Coal & Iron Co. has preliminary plans in preparation for the erection of its proposed new fuel-carbonizing plant. Parker & Wilder, Cincinnati, O., are architects. S. S. Pratt is assistant general manager.

Texas

DALLAS—The Trinity Paper Mills Co., Commerce, Tex., operating a local pulp mill, has acquired property at 3010 Williams St., Dallas, as a site for the erection of a new 1-story plant for the manufacture of waxed paper specialties. A subsidiary company will be organized to operate the factory, with J. Y. Webb and J. M. Irwin, officials of the Trinity company, as president and vice-president, respectively.

ROCKDALE—The Douglass Drilling Co. will commence the immediate erection of a new oil refinery to handle crude oil from its Rockdale-Tracy leases. It will be built on the unit plan, with first unit to have a capacity of 15 bbl. per day. A lubricating oil and grease plant will also be established.

Virginia

WINCHESTER—The American Gas Improvement Co., 2 Rector St., New York, N. Y., is planning for extensions and improvements in its local gas plant to cost about $150,000. A new electrochemical gas-manufacturing process will be installed.

RICHMOND—A new purification and filtration plant will be installed in connection with extensions and improvements to be made to the city waterworks, estimated to cost about $1,500,000. The Water Department is in charge.

West Virginia

BELLE—The Belle Alkali Co. is perfecting plans for the erection of its proposed plant addition, to be used for the manufacture of caustic soda, chlorine and kindred products. D. W. Stubberfield is manager.

FAIRMONT—The Board of Water Commissioners is planning for the installation of a filtration plant at the city waterworks, with capacity of about 4,000,000 gal. per day. S. B. Miller is city engineer.

Wisconsin

MILWAUKEE—The Red Star Yeast & Products Co., has taken bids for the erection of a new experimental plant, 25 x 40 ft. E. R. Liebert, Milwaukee, is architect.

OCONTO FALLS—The Falls Mfg. Co. has preliminary plans under consideration for the erection of a 1-story paper mill, 60 x 200 ft., estimated to cost about $150,000, including machinery. Frank Cota is secretary.

Capital Increases, etc.

THE LOUISVILLE CEMENT CO., Louisville, Ky., has filed notice of increase in capital from $850,000 to $2,100,000.

THE DUNN OIL CO., Kansas City, Mo., has filed notice of increase in capital from $400,000 to $1,000,000.

THE MACDOUGALL PROCESS CO., Niagara Falls, N. Y., has filed notice of change of name to the Rowe Paint & Varnish Co.

THE MITCHELL-RAND MFG. CO., 18 Vesey St., New York, N. Y., manufacturer of insulation products, has filed notice of reduction in capital from $200,000 to $155,000.

THE PETOSKEY PORTLAND CEMENT CO., Petoskey, Mich., has filed notice of increase in capital from $1,500,000 to $2,500,000.

Percival Wilds has been appointed receiver for the HERCULES PAPER CORP., 135

Broadway, New York, N. Y., manufacturer of paper products, in bond of $25,000. The liabilities are stated to be $1,790,509, and book value of assets, $3,315,487. The same receiver has also been appointed for the company's subsidiaries, the FRANK GILBERT PAPER CO. and the UNION WAXED & PARCHMENT PAPER CO.

THE DURST MFG. CO., 119 Chambers St., New York, N. Y., manufacturer of rubber products, has filed notice of increase in capital from $100,000 to $400,000.

THE CALIFORNIA & HAWAIIAN SUGAR REFINING CORP., Crockett, Cal., operating a local refinery, has arranged for a bond issue of $7,000,000, for general operations. Andrew Welch is president.

THE GREEN BAY PAPER & FIBER CO. and the JOHN HOBERG CO., both of Green Bay, Wis., manufacturers of paper and fiber products, have filed notice of merger. Operations will be continued as heretofore at the two mills.

New Companies

THE SUPERIOR CRYSTAL CO., Newark, N. J., has been incorporated with a capital of $25,000, to manufacture soaps and kindred products. The incorporators are A. Leiberman, Benjamin Burden and Solomon Halperin, 109 South 20th St., Newark.

THE BAXTER PAPER CORP., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture paper products. The incorporators are H. L. Bunker, I. Baxter and H. J. Wellebil. The company is represented by Graves, Miles & Yawger, 111 Broadway, New York.

THE CRAINE-SCHRAGE STEEL CO., Detroit, Mich., has been incorporated with a capital of $150,000, to manufacture steel castings and other steel products. The incorporators are C. P. Craine, Arthur A. and W. C. Schrage, 965 Devonshire Ave., Detroit.

THE MULBER OIL CO., Pawhuska, Okla., has been incorporated with a capital of $200,000, to manufacture petroleum products. The incorporators are William W. Cruber, Pawhuske; H. C. Durnell, Bartlesville, Okla.; and R. V. McMullen, Eureka, Kan.

THE AROMO MFG. CO., 740 West North Ave., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals, chemical compounds, drugs, etc. The incorporators are Arthur W. Smith, Norris Bernstein and Albert Paltieloff.

THE RAY D'OR CHEMICAL CO., Scranton, Pa., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. J. Harold Clarke, Scranton, is treasurer.

THE FAIRFIELD SHEET GLASS CO., Wilmington, Del., has been incorporated under state laws with capital of $800,000, to manufacture glass. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE BERGEN LABORATORY PRODUCTS CO., 142 Market St., Newark, N. J., has filed notice of organization to manufacture chemicals and chemical compounds. The company is headed by Joseph F. Papscoe, 800 South 19th St., Newark.

T. A. DESMOND & CO., INC., New York, N. Y., has been incorporated with a capital of $600,000, to manufacture rubber products, gutta percha goods, etc. The incorporators are T. A. Desmond, H. S. Delanie and F. M. Tienken. The company is represented by Murray, Prentice & Aldrich, 37 Wall St.

THE INTERNATIONAL REFINING & MFG. CO., Greenleaf and Hartrey Sts., Evanston, Ill., has been incorporated with a capital of $500,000, to manufacture refined petroleum products. The incorporators are E. R. and William O. Jeffery, Sr. and Jr.

THE WHITE CO., 206 Water St., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals, varnishes, paints, etc. The incorporators are I. and Earl A. Constam, and G. M. Stengle. The company has plans under way for the erection of a new plant.

THE VIRGINIA SOUTHERN OIL CORP., Wilmington, Del., has been incorporated under state laws with a capital of $750,000, to manufacture petroleum products. The company is represented by the Corporation Service Co., Wilmington.

THE MELITE CORP., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture carbon black, compounds, etc. The incorporators are J. M. Stower and J. C. Woodruff. The company is represented by H. G. Baker, attorney, Plattsburg, N. Y.

THE ARCHER PHOSPHATE DEVELOPMENT CO., Archer, Fla., has been incorporated with a capital of $75,000, to operate phosphate properties, manufacture fertilizers, etc. W. F. Walker is president, and S. G. Moyes, vice-president, both of Archer.

THE S. & S. MFG. CO., Columbia, Pa., has been incorporated with a capital of $10,000, to manufacture iron, steel and other metal castings. Samuel A. Stape, Columbia, is treasurer.

THE SYRACUSE CONSUMERS' OIL CO., Syracuse, N. Y., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are H. F. Schoonmaker, W. A. Wright and L. C. Helms. The company is represented by J. B. Neily, Gurney Bldg., Syracuse.

THE LUMINITE CORP., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are Carl T. Fregens, M. Burgesser and John A. Bernard, 753 Broad St., Newark.

THE CELLULOSE PRODUCTS CO., INC., 1119 Fidelity Bldg., Baltimore, Md., has been incorporated with a capital of 100,000 shares of stock, no par value, to manufacture pyroxylin products, composition specialties, etc. The incorporators are Edward M. and E. H. Hammond, and R. Bennett Darnall.

THE BRAZOS VALLEY OIL CO., New York, N. Y., has been incorporated under Delaware laws with capital of $6,000,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE POMPEIAN ROMANZA CORP., Fayette and 11th Sts., Highlandtown, Baltimore, Md., has been incorporated with a capital of $1,760,000, to manufacture edible oils, compounds, etc. The incorporators are W. W. Cook, W. H. Hamilton and W. H. Cook.

THE PRESTO LEATHER PRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture leather goods. The incorporators are J. Pressman, M. L. and F. Weissman. The company is represented by Leo Rosenberg, 200 Broadway, New York.

THE D. P. O'BRIEN CO., INC., Camden, N. J., has been incorporated with a capital of $20,000, to manufacture chemical compounds, drugs, etc. The company is represented by the Corporation Guarantee & Trust Co., 419 Market St., Camden.

THE DRAKE OIL CO., 30 North Michigan Ave., Chicago, Ill., has been incorporated under state laws to manufacture petroleum products. The incorporators are Frank H. Pitkin, William Mannhardt and Charles O'Hare.

THE ALABAMA MICA CO., Heflin, Ala., has been incorporated with a capital of $75,000, to operate mica properties and manufacture mica products. The incorporators are W. B. Merrill and L. L. Tapley, Heflin.

THE TRINITY OIL CORP., Jersey City, N. J., has been incorporated under Delaware laws with capital of $3,000,000, to manufacture petroleum products. The company is represented by the Registrar & Transfer Co., 900 Market St., Wilmington, Del.

THE HAMPTON ROADS EXTRACT CO., Norfolk, Va., has been incorporated with a capital of $25,000, to manufacture chemical extracts, compounds, etc. Nicholas Pavlou is president, and W. W. Ritter, secretary, both of Norfolk.

THE CARNAHAN OIL & REFINING CO., Augusta, Me., has been incorporated under state laws to manufacture refined oil products. D. A. Leland is president; and W. T. Gardiner, treasurer. The company is represented by C. L. Andrews, Augusta.

THE EASTERN CHEMICAL CO., Wilmington, Del., has been incorporated under state laws with a capital of $250,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE H. B. VITT CO., Richmond, Staten Island, N. Y., has been incorporated with a capital of $10,000, to manufacture paints, oils, etc. The incorporators are H. and C. Vitt, and W. Stumpf. The company is represented by F. W. Clifford, Stapleton, S. I.

THE ARKANSAS PLATINUM DEVELOPMENT CO., Little Rock, Ark., has been incorporated with a capital of $350,000, to operate platinum properties and manufacture platinum. The incorporators are J. E. McLean, T. W. Mattingly and C. C. Williams, Little Rock.

THE FORDS PORCELAIN WORKS, INC., Perth Amboy, N. J., has been incorporated with a capital of $1,000,000, to manufacture sanitary ware. The company will succeed the organization of the same name, now operating two plants at Perth Amboy, and one at Fords. Abel Hansen is president.

THE SURE CHEMICAL CO., Pittsburgh, Pa., has been incorporated with a capital of $100,000, to manufacture chemicals, chemical byproducts, etc. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

New Publications

THE ANNUAL REPORT of the Director of the Bureau of Foreign and Domestic Commerce to the Secretary of Commerce for the fiscal year ended June 30, 1921, has been issued.

THE UNIVERSITY OF IDAHO has issued Bull. 13, on "The Availability of Western Wood Oils for Flotation Concentration." Part I, on the Production of the Oils, is by I. W. Cook, and Part II, on the Flotation Properties of the Oils, is by Louis A. Grant.

THE BUREAU OF MINES AND GEOLOGY of the State of Idaho has published four pamphlets. No. 1 is on Interfacial Tension Measurements and Some Applications to Flotation, by Robert B. Elder; No. 2 is on Size of Mineral Particle in Relation to Flotation Concentration, by A. W. Fahrenwald; No. 3 is on Testing Ores for Flotation, by A. W. Fahrenwald, and No. 4 on Differential Flotation, by A. W. Fahrenwald.

INDUSTRIAL OPPORTUNITIES IN NEW JERSEY is the title of a new publication issued by the Land Registry, Department of Conservation and Development, State House, Trenton, N. J.

THE CITIZENS' NATIONAL BANK of Decatur, Ill., has prepared a series of illustrated folders entitled "Our National Resources." A brief description of the occurrence, mining and uses of the more important metals, salt and non-metallic elements is given in a popular manner. The illustrations are interesting and instructive. The series presents an interesting example of the application of technical information to business advertising.

THE ROYAL SOCIETY OF ARTS, London, England, has issued a pamphlet on Major G. W. C. Keye's address delivered before the Royal Society of Arts on "X-Rays and Their Industrial Applications."

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting, Friday, March 3, at the Hotel McAlpin, New York City. A sectional meeting will also be held at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

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Volume 26 — New York, March 8, 1922 — Number 10

Proving An Obsession

SENATOR KING, attacking the American dye industry, apparently bases his major charge upon the assumption that there is a monopoly in the American business. He cites as evidence the two great producers of organic chemicals in the United States, the du Pont and the Allied Chemical & Dye organizations. It is absurd on the face of it to charge monopoly when there are two or more great competing groups of industrial interests. These two the Senator admits; and if he were better advised regarding the business, he would know of other well-established active competitors of these two corporations. It is little but an obsession on the part of a vigorous opponent of the industry which brings forth such a charge.

This position of Senator KING is perhaps the most favorable one which he could have taken. In any event it gives a splendid opportunity for developing the real economic and industrial side of the case, as well as the technical problems involved.

In striking contrast to this attitude of the Senator is the very frank response which the principal representatives of the chemical industries are making before the investigating committee. Mr. GARVAN has promised on behalf of the Chemical Foundation and others that every document or needed person will be at the service of the committee without subpœna. The industry and its representatives know well that a thorough public presentation of the facts, not only of dye manufacture but also of dye import, cannot be harmful to the American industry. It is fortunate, indeed, that a frank spirit is thus made evident at the very start of the investigation.

Helium and The Roma Disaster

DOUBTLESS many lessons are to be drawn from the disaster that overtook the Roma and brought death to thirty-four persons engaged in the development and operation of lighter-than-air craft. The lack of helium has been blamed for much of the trouble, probably too much, although it should have been used in this ship. And the United States can no longer be held guiltless if it continues to permit training in the lighter-than-air service in hydrogen-filled bags. We have the helium—2,300,000 cu.ft. of it—or more than twice enough to have filled the Roma. It has been alleged that helium was not used because the Roma was an old ship with leaky fabric, from which the precious helium would have escaped. By what curious distortion of values does the government place helium above the lives of those who are "merely in training"?

Of course we realize that helium would not mitigate all the dangers of lighter-than-air travel and that mechanical failures have been primarily responsible for the terrible disasters that overtook the ZR-2 and the Roma. But in both cases death and destruction due to fire would not have occurred had there been a non-flammable gas in the bags. A sane program for our lighter-than-air service will abandon training in second-hand ships filled with hydrogen. It will provide for the use of helium even in training. And finally it will grant the Bureau of Mines sufficient money and talent to make the necessary fundamental scientific studies on helium and for the ultimate erection of plants for the recovery of the gas.

The recent disasters point to the necessity of recovering helium not only for the conservation of a natural resource but as a measure of humanity in safeguarding those who are devoting their lives to the conquest of the air. Let's have no more disasters in which a flammable gas adds horror to a mechanical failure. We may not be able to foresee the break of a rudder or the buckling of a frame member, but we do know that hydrogen will burn and that it is likely to take fire in almost any disaster that can overtake a lighter-than-air ship.

A German Chemist's View Of Conditions in America

THERE has lately been sent to us a reprint of an address made by an eminent German chemist who spent a considerable number of years in the United States but who returned to Germany before the war and settled down there as managing director of an important chemical enterprise. Last year he visited this country for the first time in 13 years, and he gave his impressions in November at a meeting of the "Verein zur Wahrung der Interessen der chemischen Industrie Deutschlands." He is a typical German of the cultivated class in industry; competent, able and faithful to his obligations as he sees them. He speaks English fluently.

He confirms his earlier impressions of the United States as the land of great contrasts, or, more correctly said, of great antitheses. He is impressed with the vast number of automobiles, with the high wages that are still paid, with the number of men out of work and the threats of collision between labor and capital. He draws an interesting comparison between the efficiency with which HENRY HOWARD, a chemist, trained officers for the mercantile marine, and the débâcle of American shipping that has followed the Armistice. Prohibition comes in for extended discussion, and from this he proceeds to an observation made by a chauffeur on a trip from Niagara Falls to Buffalo. At the time a plebiscite was about to be taken as to whether or not Niagara Falls should adopt the commission form of government, and billboards were plastered with arguments pro and con. He asked his chauffeur if he favored the commission form. "No," said he, "I'm against it. They all steal from the city; formerly there were thirteen who got the pickings, and now they propose to reduce the

number to five. I'm in favor of letting as many as possible get something out of it." That was abundant evidence for the German mind. "I could offer nothing against this argument," said the speaker. "I held my peace and thought of the former conditions bei uns in Deutschland, of the blessings that democracy has brought us already, and of what it has yet to vouchsafe us." From a former dyed-in-the-wool Prussian Royalist, that observation about the blessings of democracy seems a little strained, but maybe it was not.

Of greater interest are his comments on the friendly disposition of Americans toward Germany and Germans. He takes pleasure in announcing that *this grows in favor as their relations with England and France grow worse.* He cautioned his hearers, however, to avoid any awkwardness in *aiding such convalescence* (Gesundungsprocess) but rather to await its natural development. There speaks your true German! The willingness, the desire, to profit by ill-will and hatred among others remain, but wisdom counsels caution as to the methods.

It is worth while to pause right at this point lest we fall into hypocrisy. The Gospel of Hate was indeed the very shibboleth of the old German Foreign Office. To foment strife among others is the easiest way to conquer them. It is also very practical. There is no question that it has been for many years the German method. It is terribly destructive and harmful, but at the same time very profitable. Until, however, we can feel ourselves wholly free from the practice it is best not to get angry over it. Our business is to resist the lure and to make the best we can of things as they are. To do this is no angelic virtue; it is merely being decent in bad times.

A curious chapter has to do with the persistent German obsession about British control of American newspapers. Lord NORTHCLIFFE'S "influence" over twenty-seven daily publications is demonstrated by his cable news connections, and the speaker learned from "authority" that while the New York *Times* paid only 3½ cents a pound for Canadian paper "the well-known owner of the New York *American*, HEARST, the paper for the by him controlled 19 Zeitungen only at 13 cents the pound could buy. His refusal, himself into the service of the Entente to place, must have cost him $11,000,000 during the war, whereas the *Times* saved every year $360,000 on the cost of paper." The quotation, which for prudential reasons we have made as literal as possible, carries the suggestion that NORTHCLIFFE controls the Canadian paper manufacturers who refuse to sell to HEARST.

The speaker waxed very warm in his denunciation of the confiscation of German chemical patents and was persuaded that this "theft" would in time be made good, either to the former owners of the patents or by the United States Government to that of Germany.

The automobile works of HENRY FORD made a deep impression and the fundamental principle that "The laborer never waits for work, but the work always waits for the workman" is one which he commends to German manufacturers. He noted also in the power plant that with each electric generator there is coupled a two-cylinder gas engine that works at full load together with a tandem compound steam engine that meets the peaks and valleys.

He was not hopeful of a favorable revision of the tariff for German goods, especially German-made chemicals. Despite the disadvantages of high wages and prices, he thought that in this respect, as indeed often occurs, absurdity (Unvernunft) would remain the victor.

Patience, Patience, And Then More Patience

A REPORT of 1919, lately published in the *Journal of Commerce and Commercial Bulletin* of New York, estimated the loss to labor through strikes during the year at $750,000,000, and the loss to industries as $1,250,000,000, all right here in the United States.

The majority of strikes are called by men in occupations that can scarcely be designated as trades. A job that may be learned in a week or in a day or so or in a forenoon is not a trade. That is manual labor that does not require thinking to perform. It is the kind of work into which those men and women drift who are feeble of mind or will. They weigh a great deal when they go out on strike because they are parts of an organized whole, but they could all be replaced without much interruption by other willing workers. Indeed in most cases the output would be increased by *willing* workers. They are entirely different from skilled mechanics, who also strike, but who usually do so for a definite purpose. Skilled mechanics plan their walk-out carefully, and they know what they want. Usually they keep their agreements. The unskilled, however, so far as a vast number of their members are concerned, follow out like sheep. They don't think, because they can't. They can't co-ordinate. Like the student K of whom we told lately, they have a mental age of 10 or 12 years. What they call thinking is being led. "I made up my mind to walk out," says one, when he did not make up his mind at all. He means that his tropisms were responsive to the stimulus. He couldn't help going on strike.

These mental children are scarcely to be blamed for breaking their agreements. We do not hold a child of 10 or 12 to a signed contract. Why should we make an infantile striker's muscles and his long pants responsible for what he has not got in his head?

Somehow, some way, some new approach must be discovered. There's no use in fooling ourselves with the belief that the mentally undeveloped are the same as other men. They do not constitute the whole of unskilled labor, and even among those that appear hopelessly stupid there are those who may have undeveloped resources, that if aroused, would place them, in one or more single respects, far beyond the rest of us. CLAUDE LORRAINE was held to be a half-wit until one day he took a canvas and some of his master's brushes and paints along with him and came back with a picture. After that Cardinals and Princes pressed for admission to his studio. We do not know what the fraction is of the undeveloped or moron class. We know they are there, however, and that they do not and cannot understand the nature of an obligation. If they commit perjury, they are like a child who thinks itself immune because it has its fingers crossed.

They are entitled to life, liberty and the pursuit of happiness. But they should be known and placed in yard gangs or at work of a sort that will not land them into positions of trust and responsibility by virtue of seniority. If they organize into unions, they should not be permitted to strike save under the approval of some senior body or committee or organization that requires mental responsibility and character for its membership. Maybe the psychologists will help out some day. As it is, the situation is as though we were to ask a child to leave its maypole dance and come over to steer a ship.

A Plea for Chemical Economics

IN HIS ADDRESS at the International Meeting of Chemical Societies in the Great Hall of City College last September, Sir WILLIAM POPE urged chemists to bear in mind that there is great wealth yet to be obtained from the soil. Nature has a way of working silently, without coal consumption—that is, without requiring coal from the mines—and without charging for time by the hour. She synthesizes according to local conditions. Not only do plants grow and secrete exactly what we want, but micro-organisms are available to do far more than to produce alcohol and carbon dioxide. These also work 24 hours a day and they know just what they need to complete their cycle of existence, whereby we may profit. Professor HIBBERT of Yale has long been urging the slogan, "Let the Microbes Do Your Work for You!" Lately Dr. E. J. RUSSELL of Rothamsted has written of "Soil Conditions and Plant Growth" in a Rothamsted monograph published by Longmans, Green & Co., of London. His observations on conditions affecting plant growth are reported to be of wide general interest.

Our readers may recall an incident that occurred several years ago. A Mr. ECKERT, who was manager of a sugar plantation in Hawaii, was troubled by weeds. The rainfall is especially heavy there. The cost of labor in weeding ate up the profits. He bethought himself that the young sprouts of sugar cane were sharp and stiff, whereas the weeds were not. He softened roofing felt with caustic soda, laid it over the young sprouts, which pierced through or buckled under, making a visible hump which could be easily cut through later on. The weeds curled up and died. He saved 75 per cent of his labor costs and got 25 per cent better crop by it. Then he came on to Dr. LITTLE and got him to work out a soft, easily piercable bagasse felt, which served in the place of the building felt. Then he put up a paper mill for his company in Hawaii—and the outfit works very successfully. Mr. ECKERT patented his invention.

Sir WILLIAM wondered whether, if the same measure of scholarly and intelligent study had been addressed to the production of indigo from natural sources as was given to the synthesis of the product from coal tar, the artificial product would have replaced that produced on plantations properly administered. The beet-sugar industry worries along under tariff protection which it always needs, but has the last word been said in regard to sugar beets? Has the maximum been reached in growing sugar cane? Have we exhausted the product of sumac? What is the cheapest source, besides molasses, for the production of ethyl alcohol? Will it come from the intensive production of corn, and if so, what kind of corn? Where is the incidence of diminishing returns in the intensive growing of corn? What are the possibilities of cassava? How about a strain of potatoes more abundant in starch, irrespective of its eating qualities?

Industry is constantly providing new solvents. What are we doing with them in relation to natural products?

These are questions in chemical economics and the answers are not available, because we neglect chemical economics. The reason is, we do not fit ourselves to take a comprehensive view. What is needed is more co-ordination among chemical engineers and biochemists and botanists, all working together, understanding one another, and using the same scientific language in discourse. It is time for chemists to quit playing on a fiddle with one string, whether that string be organic or colloidal or metallurgical or biochemical or what not. We recommend to the American Chemical Society a committee on co-ordination which shall have for its purpose the bringing of specialized chemists out of their ruts. The great merit of the Society is the multiplicity of its divisions and sections. Why not mix 'em up? It would be a good thing all around.

What Does the Steel Recovery Mean?

AFTER extensive liquidation of stocks of steel in the hands of steel buyers, and of manufactures of steel in the hands of makers and distributors, a liquidation that was claimed to have been practically completed by the beginning of last October, the rate of steel ingot production rose to a rate of 23,000,000 tons in October and November, declining to a rate of 16,000,000 or 17,000,000 tons in the last week of December.

Now we have a remarkable fact, that the rate of steel ingot production has risen, in approximately 2 months, to about 29,000,000 tons a year. That is a fact. What does it mean?

To account for this rise in steel production in such a short space of time one might refer to the fact that production of steel ingots in July, 1921, was at the rate of only about 11,000,000 tons a year, while in the first 9 months of 1920 the rate had fluctuated but little from an average of 42,000,000 tons a year. The one rate was scarcely more than one-fourth of the previous rate. The extremity of the decline was explained on the ground that consumers were using up stocks. However, if that suggests an explanation to the recent rise, there is an admission that buyers of steel have been replenishing stocks lately, which is denied by both parties.

Is the steel industry overbuilt or not? Most observers claim it is. The capacity in ingots is between 50,000,000 and 55,000,000 tons a year, this being indicated by taking the actual production in 1916 and allowing for increases since, the estimate being supported by the fact that when greatly handicapped by various physical disabilities the industry produced during the first 9 months of 1920 at the rate of 42,000,000 tons a year. The capacity is fully double that of 1910, when a production of 25,000,000 tons kept domestic consumers quite busy working up the steel and allowed a considerable tonnage to be exported.

Against the contention that the steel industry is overbuilt it is urged in some quarters that an excess capacity over normal requirements is needed to carry the peak load. This sounds nice in theory except for the expense of carrying the extra capital investment and the difficulty in finding labor when men are busy consuming steel, but it presents an awkward situation when one recalls that before the war steel producers used to say it was impossible to advance prices unless the industry was operating at not under 80 or 85 per cent of capacity, while present prices are claimed to be far below cost of production and in some cases to be no more than cost less overhead. An industry is not very well fixed if it can get its prices only up to cost when running at peak load.

If the steel industry is overbuilt and the buying in the past few weeks has represented actual consuming requirements, business in the United States is in very fair condition indeed, even if the steel industry is not. A few weeks' time will tell, in all probability, what the actual condition is in steel with respect to business in general.

Italian Chemical Industries

From Our Special Correspondent

Genoa, Italy, Feb. 7, 1922.

JANUARY was a very difficult month for the Italian chemical industry owing to the following economic factors: (1) Suspension in the payments of a large bank, (2) the continued scarcity of electric power, (3) a considerable fall in the foreign exchange, and (4) a reduction in the demand, as well as lower prices, especially for the commoner products and fertilizers. The coming spring will, however, improve matters because the exhaustion of stocks in many quarters will necessitate the production of goods of all sorts.

Sulphur Industry

In order to avoid the damaging of crops on the isle of Sicily through the continued action of sulphur-dioxide fumes, the Italian Government issued special regulations requiring that the burning of sulphur on this island, or elsewhere, be conducted at least 100 meters from cultivated properties, and that all possible precautions be observed for avoiding atmospheric pollution. The sulphur mines continued their campaign for reducing manufacturing costs of crude sulphur, pointing out that the deficient means of transportation between the mines and the coast resulted in freight rates as high as 100 lire per ton. The necessity of developing the water power and increasing the number and capacity of the hydro-electric plants was urged as a relief for this situation. A further reduction in the prices of the different sulphur products was noted, owing to the scarcity of demand on the part of Italian and foreign clients.

Tartaric Acid and Tartar Materials

Italian tartaric acid and cream of tartar producers brought forward a motion to the Italian Chamber, insisting on the application of a much higher export tax on raw tartar, pointing out that the present price permitted foreign manufacturers to produce the finished tartar products cheaper than is possible in Italy, due to the high cost of Italian labor, transportation and coal.

The largest works producing tartaric acid and tartrates have their headquarters at Agnano, Barletta, Milan and Casale. An export tax of 22.50 lire per ton was placed on raw tartar for assisting the development of the manufacturing industry before the war, being raised recently to 50 lire (10 gold lire). An export tax of 100 lire (20 gold lire) is now proposed in the case of raw materials containing up to 50 per cent of potassium bitartrate, and of 160 lire (32 gold lire) in the case of raw materials containing more than 50 per cent of this compound.

During the first 6 months of 1921 the exports of raw tartar reached 1,268 tons, as compared with 4,467 tons in 1920 and 1,724 tons in 1919 during the corresponding period; the countries of exportation being France, Germany, England, Holland, Switzerland and the United States, this last country being the most important importer of raw tartar (650 tons). The imports reached 29 tons, against 91 tons in 1920 and 2 tons in 1919.

The higher prices demanded by Italian producers of tartaric acid brought a marked reduction in the exportation of this product. During the first 6 months of 1921 only 834 tons was exported, compared with 1,415 tons in 1920 and 633 tons in 1919 during the same months. The exports of cream of tartar were also reduced, reaching 325 tons, against 355 tons in 1920 and 103 tons in 1919. The imports of cream of tartar reached only 3 tons, against 4½ tons in 1920 and 4 tons in 1919.

Copper Sulphate

The production of copper sulphate, which reached 101,000 tons in 1918, has since continued good, and would certainly have been greater if there had not been difficulty in getting raw materials. To alleviate the situation the producers demanded repeatedly from the Italian Government that they be given some of the copper left over from the war, and after some delay they obtained 1,000 tons of this, and 20,000 tons was delivered to the state railways for electrification purposes.

The exportation of copper sulphate increased con- foreign products. During the first half of the past year 2,476 tons, against 4,116 tons in 1920 and 800 tons in 1919 during the same period of time. The importations reached only 598 tons during 1921, 791 tons during 1920 and 35 tons during 1919 in the first 6 months.

Caustic Soda

The production of solid caustic soda was increased during the war from an annual average of 3,200 tons to an average of 14,000 tons, and that of strong caustic soda solutions, or lyes, from 8,000 tons to 28,320 tons. After the war, however, it had to compete against the reductions that followed through the competition of foreign products. During the first half of the past year foreign competition reduced its exportation, which amounted to only 290 tons, against 1,702 tons in 1920 and 45 tons in 1919 during the corresponding period. The importations remained high, being 4,412 tons, against 18,831 tons in 1920 and 3,669 tons in 1919.

Gold in the Ticino River

The Ticino River, a large stream flowing to the River Po in the north of Italy, has sands that contain gold flakes and grains in quantities varying from 0.25 to 6 g. per cubic meter. This metal is always combined with silver (10 per cent), more rarely with palladium, and with it, at a depth of 15 meters, is also found iron, chromium, molybdenum, nickel, thorium and radium. Proper exploitation of this sand has not yet been undertaken, but a campaign has been started to this end.

Suspension of Electric Energy in the North of Italy

Through the precautions taken to avoid waste, greater intensity of the generating plants employing coal, benzine, petroleum, heavy mineral oils and weak fuels, an increase in the water power available and the importation of 150,000 kw.-hr. from Switzerland, the quantity of electric energy available has been increased and some of the railways have resumed the use of electric current. For some time they have been compelled to use steam. However, there is still a scarcity of electric energy for industrial plants.

Developments in Hydro-Electric Plants

With the Piave S. Croce hydro-electric plant Italian engineers expect to get 140,000 electric horsepower during 1922. By 1924 it is expected this will be increased to 200,000 and by 1928 to 300,000 and more. This will be sufficient to operate all the electric plants and railways in the Veneto region. The expense of the hydro-electric plant is estimated at about 1,300,000,000 lire.

Sectional Meeting, American Society for Steel Treating

SEVERAL local chapters of the American Society for Steel Treating, from Boston to Washington, met in New York Friday afternoon and evening, March 3, for a sectional meeting of the society. It is planned to hold three of these gatherings at various centers during the year, in addition to the regular annual convention. At least two aims may be accomplished. First, to give members who have not the opportunity to go to some far distant general convention the privilege of meeting men from other localities and discussing everyday problems with them. Second, directors' meetings will be held during the sectional meetings, thus permitting the general executives of the society to appraise local sentiment without an excessive amount of travel.

If the New York meeting may be taken as a criterion, the plan is excellent. About 100 out-of-town members registered, which, with an equal or greater number of men from the metropolitan district, gave an interested attendance at meetings which would have done credit to many an older society. Thanks to the indefatigable work of Captain Walter C. Graham of the program committee, all but one of the papers had been obtained in time for publication in the February *Transactions*. Members were therefore appraised of what was to be said, and the discussion was correspondingly animated.

A pleasant feature of the evening program was the notification of Dr. John A. Mathews, of the Crucible Steel Co., of his election to honorary membership.

Manufacture of Stainless Cutlery

The one paper not readily available in the published *Transactions* was read by R. G. Hall, of R. Wallace & Sons Manufacturing Co., on "The Manufacture of Stainless Steel Cutlery." He recognized that authorities differ on many essential points, but nevertheless desired to record his personal experiences. For cutlery, carbon should range between 0.3 to 0.45, and chromium from 13 to 15 per cent; silicon 0.30 and manganese 0.50. Although the tendency is for higher carbon and chromium steels, higher carbons produce a steel which punishes cutting dies excessively and is therefore costly to use; as carbon goes up, chromium must also increase in order to resist corrosion. Cutting efficiency —determined by cutting wooden chips on a lathe and noting the time before it is necessary to hone the edge —also increases with high alloying, as may be shown by the last steel in the attached table (a steel, by the way, which cannot be manufactured into cutlery by the methods to be given below). Staining liquid used was concentrated acetic, tartaric and hydrochloric acids.

TABLE I—COMPARATIVE TESTS ON STAINLESS CUTLERY

Analysis		Time to Stain	Cutting
Carbon	Chromium	Minutes	Test
0.30	11.93	28	Good
0.26	17.21	35	Fair
0.40	13.60	13	Good
0.31	15.90	75	Good
1.10	23.32	43	Extremely good

One general precaution is to pay great attention to the tools—a die which is the least bit dull will tear the stock ever so slightly; the resulting damage will not be apparent until the blade is nearly finished. Seamy blades are usually ascribed to poor steel, but in most cases are caused by metal torn during fabrication. Second, even with sharp tools it is also necessary to keep the metal well softened, "annealed" as it is called in the shop, although "tempered" would probably fit the operation better, since it involves a slow cooling from a soaking heat at 1,400 deg. F. (below the critical). Thirdly, all heating should be done in reducing atmosphere, and every precaution made to keep the metal free of scale at all times.

Manufacturing operations are somewhat as follows: The "annealed" stock, which is usually bought in round rods, is cut to proper length, drop forged, trimmed, and the blade rolled. Careful temperature regulation between 1,650 and 1,750 deg. F. is essential for the latter, on account of the abrupt change of section at the shank. Scale must not be rolled into the blade, nor should it be permitted to cool rapidly, as on a damp floor. Premature hardening causes internal strains and cracked articles. Next the forged and rolled piece is softened at 1,380 to 1,400 deg. F. in a muffle, slowly cooled, and the blades are blanked out, using *sharp* tools.

Now follows the hardening, which is the most difficult part of the operation, affecting not only the cutting qualities of the knife, but also its resistance to strain. For several "practical" reasons Mr. Hall prefers to quench in oil from 1,650 to 1,950 deg. F., depending upon the composition, although he recognizes that the British practice is to water-quench, and no difference in microstructure is discernible. The hardened blade is then tempered so that when loaded centrally it will bend 1 in. in 5 without a set, and have a Brinell hardness of 525 to 550. Time and temperature are adjusted to the steel for this result. Commonly 15 minutes at 650 deg. F. is correct. Since temper colors appear in heated stainless steel at about twice the heat of carbon steels, and are also unreliable, a bath should be used.

Grinding should be done without haste. Heavy grinding induces staining—the first evidence is "grinders' scorch," which polishes off easily enough but leaves an area which stains again very easily. It is also necessary to grind to the bottom of all pits and surface imperfections, since a minute amount of adhering mill scale will cause delayed staining and many complaints after blades have been in satisfactory service for months. Cutlery is then glazed on a fine wheel to remove grinding marks, inspected, mounted in the required handle (soldered to hollow handles, welded to solid ones), again glazed and tested for stainless qualities by immersion for 2 minutes in concentrated copper sulphate solution. Finally the accepted knife is etched, wrapped and stocked.

Magnetic Testing of Chain

A brief paper on this subject read by A. V. de Forest, research engineer, American Chain Co., proved exceptionally interesting, since the author had brought with him the electrical equipment and sample chains necessary for making the required tests.

Anti-skid chains are exposed to extremely severe service, and it has been found on road test that a certain depth of hardened case gives longest life; shallow cases are too soft, while deep ones are too brittle. Magnetic testing has proved of extreme value in promoting uniformity of product; if road tests indicate that a certain stock, carbonized and heat-treated in a certain way, will give superior wearing qualities, then the magnetic test may be relied upon to hold the mill production as close to this given ideal as desired. Or, if all manufacturing conditions but one are held constant, the magnetic test will very sensitively indicate values of that variable.

Electrical Porcelain Manufacture

Description of the Plant and Operations of R. Thomas & Sons at East Liverpool, Ohio — Production of Ware for High- and Low-Voltage Uses—Raw Glazes Employed—Body Similar to Chemical Stoneware—Ceramic Control

BY CHESTER H. JONES

THE 12-kiln plant of R. Thomas & Sons, manufacturers of electrical porcelains, is well located in East Liverpool, Ohio, for while the ultimate product and markets are different from tableware, the operations in the plant are essentially those belonging to the white ware pottery. The labor market is also best at this point. The plant produces a general line of insulators for low- and high-voltage electrical construction, while the 10-kiln plant at Lisbon, Ohio, is devoted to the manufacture of the patented Hewlitt insulator. The Lisbon plant was originally built to manufacture tableware.

R. Thomas, together with his son, the late George W. Thomas, organized the present company in 1873, building the first plant in East Liverpool. It was the first firm in the United States established for making high-voltage porcelains. Low-voltage porcelains are made by the dry process, where the dried cake from the filter press is ground to powder and compressed in heavy molding machines. High-voltage porcelains follow the method of molding the plastic clay employed in chinaware plants.

Storage and Blunger House

The raw materials used are kaolin or English china clay, English ball clay, flint or ground silica, feldspar, barium carbonate, magnesium carbonate and calcium carbonate. Raw white glazes are made up of these materials, no frits being used. Colored glazes are made from Albany slip, feldspar and flint. The top of the raw storage piles and blunger house is on a level with the incoming railroad tracks. The materials are delivered from cars to storage by an endless belt and tripper to four of the seven concrete bins and direct by shovel to the remaining three.

Fig. 1 is a view in the aisle of the blunger house. On the left are the blungers with feed openings nearly on a level with the Fairbanks transfer table scales appearing in the center. This weighing outfit is so arranged that the scale car can be wheeled into each concrete raw material bin for loading. The doors of two of these bins are seen on the right. A blunger charge for the wet process slip weighs 5,400 lb. and for the dry process 6,500 lb. There are four blungers, consisting of steel tanks lined with vitrified brick and equipped with double agitators. The line shaft driving the blungers through bevel gears is in turn driven by a 20-hp., 220-v., two-phase motor.

FIG. 1—TRANSFER SCALES

FIG. 2—SLIP PUMP AND BLUNGERS

Three blungers operate on the wet-process slip, the remaining one on the dry-process. The charge is blunged 1 hour to give the necessary creamy slip. Three agitated storage cisterns below the floor receive the slip from the blungers. The three blungers deliver into two of these, while the third receives the dry-process slip from one blunger.

Fig. 2 is a view on the delivery side of the blungers, with the wet-process double-acting slip pump in the foreground. This pump delivers wet-process slip from the two cisterns to the lawn room in the main buildings located up hill from the railroad. A similar pump likewise handles the dry-process slip from the third cistern to a second lawn room. These pumps are also equipped with 20-hp. Westinghouse motors.

Sagger Room

The saggers for holding insulators while burning in the kilns are made as usual in a separate department. Raw materials used for making these saggers are Kentucky ball clay, Pennsylvania sandy clay, wad clay and

grog. The equipment here consists of a small dry pan, grinder, vertical pug mill, small wad mill and a 28-ton steam press having a pressure of 250 lb. per sq.in. for forming the sagger. The wad mill is a small affair extruding a plastic clay string about ¼ in. diameter. This is used between the top edge and the lid of the complete sagger for sealing in the ware, thus preventing the entrance of kiln gases and resultant contamination of the ware.

The formed sagger from the steam press is dried thoroughly by placing over a gas flue. It is not necessary to burn the saggers in separate kilns, as often

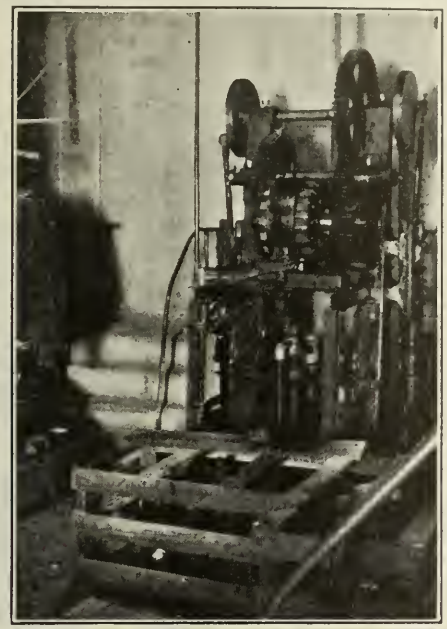

FIG. 3—LAWN ROOM PUMP

practiced. The "green" product from the drying flue may be filled and burned at the same time as the ware it contains.

Lawn Rooms

The slip for dry body or low-voltage porcelain is delivered from the blunger house as mentioned above to a cistern in the low-voltage lawn room. Thence it is pumped onto a 120-mesh lawn shaker screen and returns to a second cistern, where it is agitated until delivered by a second pump at 80 lb. pressure to the filter room.

The larger or high-voltage lawn room is equipped with two units, each consisting of a cistern receiving slip from the blunger house, a 120-mesh shaker lawn,

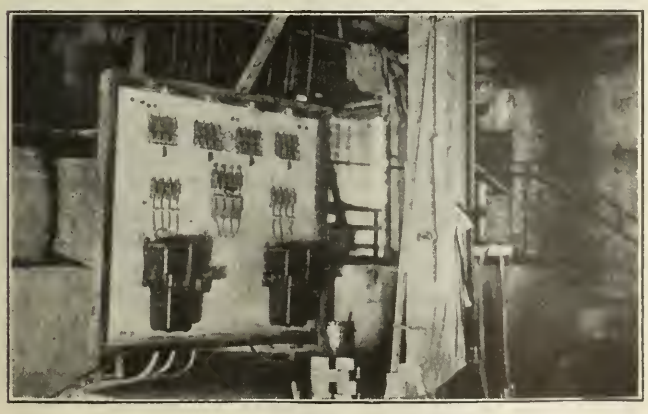

FIG. 4—LAWN ROOM SWITCHBOARD

FIG. 5—SHAKER LAWN

a second cistern and a pump delivering the finished slip to the filters. Fig. 3 shows one of the double-acting pumps in the high-voltage lawn room driven by two-phase electric motor, and Fig. 4 shows the switchboard, carrying oil switches, fuses and knife switches controlling the pump motor circuits and shaker lawn motor. The shaker lawn appears in Fig. 5.

The glazes made from white ingredients or Albany slip without frits are ground in three 1,000-lb. pebble mills adjoining the high-voltage lawn room. Fig. 6 shows a portion of one of these arranged with belt drive.

Filter Room

Production of the plastic cake from the slips as they are pumped in from the lawn rooms is carried on in one location with a battery of seven 80-lb., leaf type, Patterson filter presses. One press is used on low-voltage and six on high-voltage body. For dry-process low-voltage porcelains, the cakes from the filter press

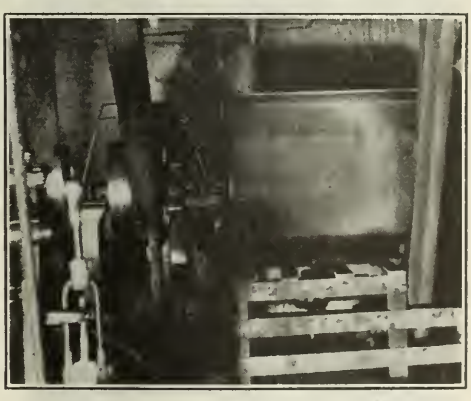

FIG. 6—PEBBLE MILL FOR RAW GLAZES

are elevated to a drying room located over the kilns and after thorough drying are pulverized and tempered for pressing to shape.

For wet-process, high-voltage porcelain the plastic cakes are piled in a heap, beaten with mallets into a solid mass and permitted to age for a period varying from 1 to 3 days. During this time the moisture becomes evenly distributed throughout the mass. Just before it is sent on to the shaping department it passes a vertical type pug mill. This operation consolidates the clay, works out any air bubbles and forms it to suitable slabs for working.

Pugging

The pug mill consists of a vertical hollow cylinder, in the middle of which revolves a shaft carrying

projecting blades. The blades, being set at an angle, gradually force the clay downward, at the same time kneading and mixing it. At the bottom of the cylinder it is forced through an opening in the side, coming out as a continuous bar from 4 to 6 in. in diameter. From this bar slabs are cut of suitable length for subsequent processes. Pugging is an important operation in the manufacture of insulators, for upon it depends the freedom of an insulator from checks and air bubbles and the consequent ratio of dielectric strength.

Shaping High-Voltage Insulators

The jigger room is equipped with about ten jiggers and several hot presses. The jigger as here employed consists of a vertical shaft revolving at a moderate speed and having at the top on a level with the workman's bench a plaster of paris mold to form the outside shape of the piece. A lump of pugged clay is dropped into the mold and formed roughly to shape by hand. The metal template, called a tool or shoe, having the contour of the inside surface of the insulator, is then pressed down by means of an arm attached to the machine and the finished interior outline given. The mold containing the shaped piece is then removed and another mold dropped into place for the next piece.

The pieces are permitted to remain on shelves in molds for 24 hours. The mold is then opened up, the piece removed and set upon boards or cars in readiness to be taken to the drier.

Hot Pressing

The hot press room contains eight hot presses, a machine similar in general characteristics to the jigger. Fig. 7 shows one of these ready for the operation.

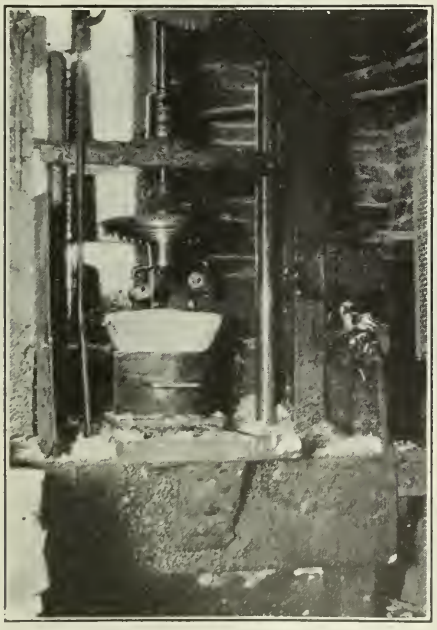

FIG. 7—HOT PRESS

Different from the jigger, the table below does not revolve, but holds the plaster of paris mold solidly in position. A circular billet of clay with one end rounded is thrown with round end down into the mold.

While the machine is in the position shown two gas flames play upon the upper cast-iron half of the mold, keeping it warm between movements. These gas burners are visible between the upper and lower halves of the mold. It will be noted that the upper half is threaded and grooved to form the inside of the insulator. The crosspiece above acts as a guide for the threaded mold shaft.

After the clay is placed in the lower half, the operator throws on power, causing the shaft to revolve, and due to threads on shaft of the same pitch as the threads on the mold the upper half moves downward quickly and enters the clay, forcing it to fill all the space between the upper and lower halves and simultaneously forming a thread on the interior of the piece. At the end of the travel the piece is thus shaped, the power is reversed and the upper half unscrews upward to its original position, to be heated again by the gas flumes.

The heating of this mold causes a film of steam to form when it comes in contact with the wet clay, giving a clean-cut surface and, still more important, permitting an immediate removal of the iron from the clay without danger of sticking. The iron mold is hollow, avoiding suction by permitting air to pass through small holes when it is withdrawn. The operation may be repeated very rapidly, the speed being entirely dependent on how quickly the lower half may be removed from the machine and a new plaster of paris mold inserted.

As in the case of jigger work, the piece is permitted to remain in the mold 24 hours before removing and transporting to the drier.

Other Shapes

The method of shaping the high-voltage pieces depends upon the article to be made. Pieces of a diameter rather large in proportion to the height, such as pin and suspension insulators, are made on the jigger or press as above described. Long corrugated pieces like bushings and post insulators are turned. This turning may be done on a special lathe or jigger. It is essentially the same as wood turning. Wet turning is most advantageous where possible because of increased speed and lack of dust.

Plain tubes are made by extrusion from a machine composed essentially of a cylinder and a piston. In the bottom of the cylinder is placed a die having a hole equal to the outside diameter of the desired tube and a concentric mandrel to form the bore. In the case of small tubes several may be extruded simultaneously. The cylinder is filled with pugged clay, the piston moves slowly down, squeezing the clay from the die in the form of a continuous tube. Suitable lengths are cut off and straightened by rolling. The head is pressed up on small tubes and spun on in the larger sizes.

Drying High-Voltage Body

All of the various pieces having been placed on rack cars after removing from the molds, these are wheeled to the entrance of the large drier as shown in Fig. 8. This drier is 104 ft. long and three tracks wide. It has a capacity of nineteen cars per track. One track handles cars containing larger ware and operates at a rate of one car entering every 3 hours, or giving a drying time on each car of 57 hours. The two other tracks carry cars of smaller ware and operate on a 2-hour schedule, consequently giving a drying time of 38 hours per car.

Proper regulation of drying rate is one of the most important features of insulator manufacture. Extreme care must be taken or cracks and warping will develop, affecting both the mechanical strength and dielectric

FIG. 8—RACK CARS ENTERING DRIER

properties of an insulator. Before the advent of the mechanically operated, automatically controlled drier in the ceramic industries it was necessary to place the ware in a heated room with little humidity control for a period of from 2 to 6 weeks.

The insulation at this plant is a Hurricane drier manufactured and installed by the Philadelphia Drying Machinery Co. The humidity and air supply is automatically controlled by wet and dry bulb Tycos regulators. Fig. 9 is a part view along the drier showing blower drive and control.

There are nine fans alongside the drier, all driven by a 25-hp. two-phase motor. Steam at 100 lb. pressure is supplied to the coils. All steam used in the plant is purchased from an adjoining factory. An air pump furnishes 25 lb. air pressure to operate the diaphragm valve on the controls. There are four sets of control mechanism for automatically handling the supply of steam and air to the drier. Pieces from the drier are conveyed to the glaze dipping room.

Dry-Process, Low-Voltage Room

Low-voltage body in the form of filter cake, having been passed through the drier on cars along with the high-voltage shapes and subsequently stored in a heated room over the kilns, is sent to the low-voltage shaping room. Here it is rough ground to nut size and mixed with just sufficient water to make a damp powder without becoming plastic. It finally passes through a plate type grinder running at 2,200 r.p.m., coming out as a fine damp powder. Two complete grinding units perform this operation.

Arriving in the press room through a chute from above, the powder is shaped in about fifty different hand presses to the forms required. The dies used in these presses are lubricated with a special oil known as Franklin XX. After trimming off the rough edges by hand, an operation known as fettling, the pieces are transported on trays to the dipping room.

Dipping Room

Both high- and low-voltage bodies are dipped by hand in tubs of wet raw glaze. The ingredients of the glaze are ground with water as previously noted. Colors are often introduced in glazes to identify electrical circuits when the insulators are in place. These include chromium, cobalt, Albany slip, a dark brown and the natural white. Before dipping in the glaze the pieces are immersed in water to remove dust which may have accumulated through the process. The dipped pieces are allowed to drain and dry in the air and are then ready for the kiln. In cases where it is desirable to roughen part of the surface of the insulator to give friction where in contact with insulator pin or for other reasons, the part is coated with paraffine, then with a mixture of sodium silicate and gum arabic and dipped in high-voltage sand. The sand adheres to the sticky surface, giving the desired roughness. The portions of all insulators which come in contact with the sagger are paraffined.

Firing

The kiln room is equipped with twelve updraft periodic kilns of 12, 14 and 16 ft. diameters. Materials and saggers are handled in and out of the kilns by Lowden overhead conveyors. When the saggers of ware are stacked in the kilns, the green or unburned saggers are placed near the top above the jack saggers.

Actual firing time varies from 40 hours on the small ware to 70 hours on the larger pieces. During the first stage the temperature is raised and the moisture is driven off. This moisture includes that merely mixed with the clay which has not been driven off in drying and also that which is chemically combined with the clay particles as an essential constituent. The latter action is accomplished at about 1,200 deg. F. and is a true decomposition of the clay substance. In the next stage the temperature is raised to proper value for the vitrification to porcelain and is held there until a heat-saturation point is reached as indicated by cone 11.

FIG. 9—VIEW ALONG DRIER SHOWING BLOWER DRIVE

This is a delicate stage. If the temperature is too low, the porcelain is underfired and porous, and if too high, it becomes brittle, full of bubbles and therefore electrically weak. During the last stage the kiln is allowed to cool gradually so that the ware is well annealed. The entire cycle requires about 5 days.

Fuel

Three of the kilns burn coal, three gas with natural draft burner and the remaining six burn fuel oil or gas. The combination burners on two of the kilns are the Maxon Premix and on four kilns are Spencer burners made by the Leader Furnace Equipment Co., Cleveland, Ohio. Fig. 10 shows the new type gas-oil burner applied through the ash door of a kiln. The oil is sprayed into the space below the firebox at a pressure of 30 to 40 lb. with air pressure at a maximum of 3 oz. The oil nozzle is cut with cross-shaped slot. Fuel oil is purchased from the Oklahoma fields and is a refining residue. The main storage tank holds 200,000 gal., with an auxiliary tank of 6,600-gal. capacity.

Fig. 11 is a view of the natural draft burner adapted through ashdoor.

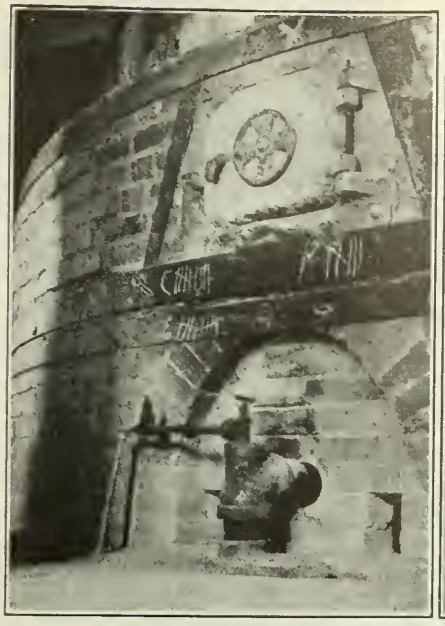

FIG. 10—NEW TYPE GAS-FUEL OIL BURNER

FIG. 11—NATURAL DRAFT GAS BURNER

An average kiln consumes about 2,000 gal. of fuel oil per burn, making a fuel cost of $70. To do the same work 220,000 cu.ft. of gas is required at a cost of $100. Twelve tons of coal at $5 per ton is used per burn, at a cost of $60 plus the cost of cleaning and ash-handling. It is obvious that oil is the most economical fuel for this plant.

Assembling

After the burning operation the insulators are sent to the assembling and testing departments. The parts of pin and suspension insulators are fastened together with portland cement mixed neat and just thin enough to flow readily. The tubes of roof and wall bushings, not being exposed to much mechanical strain, are fastened together with an asphalt compound which incidentally gives increased insulation.

Electrical Testing

Dry-process porcelain, being for low voltage, is not ordinarily subjected to electrical tests. On the contrary, the wet-process, high-voltage product must undergo not only electrical but also mechanical tests. Electrical tests which do not injure the test-piece, to determine size and proportion such as measurements of dry and wet flashover, corona voltage, etc., are usually made on a few samples. Electrical tests are made where the proportions and size are assumed to be correct and it is required to determine the limitations of the porcelain or compare with some standard.

Where the ultimate limit is to be determined, the piece is destroyed, which prevents the application of the test to more than a small fraction of the product. The puncture under oil test and the ultimate mechanical strength test are examples. The particular sample being destroyed, the only value of such tests lies in what may be inferred as to the qualities of the large proportion not tested.

Where the material is merely required to come up to a certain standard, only pieces failing to meet it are destroyed. Common examples are the routine flashover test in the pan applied to all insulators, and with suspension insulators the test load. Good judgment is required in laying out such tests. They should be severe enough to remove really defective material but not injure or weaken average or good material. This is complicated, since there is no sharp distinction between good and bad, and all intermediate grades will exist. For commercial purposes the test must be such that most of the material if of average quality will pass it, and the pieces so selected will stand the working conditions. If these features are not consistent, a design of stronger proportions must be selected.

Dimensions of Porcelain Pieces

The accuracy to dimensions of porcelain is affected by a number of factors. There is first the wear of the molds. This is important with both steel and plaster molds. The greater the variations which can be permitted the longer the life of the mold. Next comes the shrinkage in drying. This depends upon the amount of moisture in the clay, and is difficult to control very closely. Finally there is the shrinkage in firing. Of course exactness in dimensions can be obtained by gaging and rejecting all parts outside the limits, but this is scarcely possible except in the few instances in which the rejected pieces can be used for other purposes where exact dimensions are not so important. In some cases the variation can be reduced by special attention to the moisture content, by trimming after drying, or grinding to size after firing. All such methods cause added expense, and unless really necessary are avoided. Good commercial limits which do not involve any unusual precautions are a total variation from minimum to maximum of $\frac{1}{32}$ in. per inch for dry process porcelain, and $\frac{1}{16}$ in. per inch for wet process.

Shipping Room

The inspected and tested insulators finally arrive at the shipping room, where they are packed with shavings in barrels and crates. The finished package is weighed over an American Kron scale and passed into the cars.

Ceramic Laboratory

In addition to research work the ceramic laboratory controls the various operations in the plant. Moisture factors must be taken on all raw materials. Porosity and screen tests are made on clays. Chemical analysis is made on feldspar and elutriation tests on flint and feldspar. Some test must be made of the lime content of the flint.

Ball clay vitrifies at cone 11 but does not overfire, because of long vitrification range. It also has high mechanical strength. Electrical porcelain is a vitrified ware, where tableware made in this district is only semi-vitreous. Naturally the body used is difficult to dry because of high ball clay content. China clay runs more uniform and causes less trouble.

The body mixed is controlled by regular tests which effect the length of time to age, the moisture in the filter cake and the operation of the drier. The uniformity of mixture secured by aging is most important in the manufacture of porcelain. It resembles chemical stoneware in this respect.

Concentrating Dilute Nitric Acid Solutions

Results of Experimental Studies on the Concentration of Dilute Nitric Acid by Distilling at Atmospheric Pressure While Keeping the Liquid and Gas Phases in Equilibrium

By CLIFFORD D. CARPENTER and JOSEPH BABOR
Department of Chemistry, Columbia University

ZEISBERG has recently translated for this journal two articles on the concentration of nitric acid. In the first[1] Galle has considered the preconcentration of dilute acid by fractionation and its superconcentration in the presence of sulphuric acid. In the second[2] Pascal has studied the binary system nitric acid-water (Part I) and the ternary system water-nitric acid-sulphuric acid (Part II).

As a result of his experiments Galle advises preconcentration to about 65 per cent acid solution. The results given in his Table III show that he fractionated 33.8 per cent nitric acid to a strength of 65 per cent with a negligible loss either as nitric acid or by decomposition. A thermometer sealed in at the top of his fractionating column remained at 98 to 99 deg. C. throughout the experiments. When he made an attempt to concentrate farther the temperature rapidly rose and nitric acid came over in the vapor. During the last 2 years students[3] have concentrated dilute nitric acid solutions by fractionation in an apparatus identical to the one described by Galle except that the fractionating column was not as thoroughly lagged and the heating of the flask was accomplished by a bath of calcium chloride solution. It was found by them that when heated directly by the flame considerable more decomposition of the acid took place. In general it was found that the acid could be brought to about 35 per cent with very little loss of acid, but that the amount of acid in the distillate increased very rapidly as the concentration of the residue increased above this point. It would seem that Galle had an exceptionally efficient fractionating column.

TABLE I—CONCENTRATION OF NITRIC ACID BETWEEN 6.533 AND 59.72 PER CENT

Weight of Residue, g.	Weight of Total Distillate, g.	HNO_3 in Distillate, Per Cent	Total Distillate, Per Cent	HNO_3 in Residue, Per Cent	Temperature of Bath, Deg. C.
618.370	.....	.....	.....	6.533	.....
559.33	59.04	0.07	9.55	7.21	110–112
495.20	123.17	0.17	19.92	8.12	110–112
451.20	167.17	0.25	27.04	8.90	110.112
403.68	214.69	0.35	34.72	9.92	112
339.67	278.70	0.54	45.07	11.74	112
277.41	340.96	0.84	55.14	14.26	113
218.93	399.44	1.33	64.60	17.85	113
161.99	456.38	2.30	73.81	23.52	114
111.48	506.89	4.59	81.97	32.13	114
79.15	539.22	8.46	87.20	40.36	117
51.69	566.68	15.42	91.80	48.33	119
32.29	586.08	22.34	94.78	55.95	120
24.97	593.40	25.49	95.96	59.72	122

Pascal has studied the nature of the vapor phase in equilibrium with the liquid phase at various pressures and temperatures and finds considerable decomposition at the higher temperatures.

In connection with a study of several ternary systems which the authors are making at the present time, the binary system water-nitric acid has been briefly studied. Like Pascal, we have kept the vapor in equilibrium with the liquid phase throughout the distillation, but have considered the results in a slightly different manner. A description of our apparatus,[4] method of procedure and a discussion of our results are given below.

Apparatus

A complete diagram of the apparatus is shown in Fig. 1. The distilling flask and delivery tube is completely immersed in a bath (a solution of calcium chloride) so that the vapor will not condense until it enters the condenser. The condensed liquid then drains down directly into the receiving vessel. A glass stopcock is sealed onto the delivery tube so that there will be no loss of distillate which runs down while the flask which has received the first fraction is being replaced by a second. The detail of the apparatus is fully given in the figure. The flask and all material coming in contact with the vapor or liquids are of Pyrex.

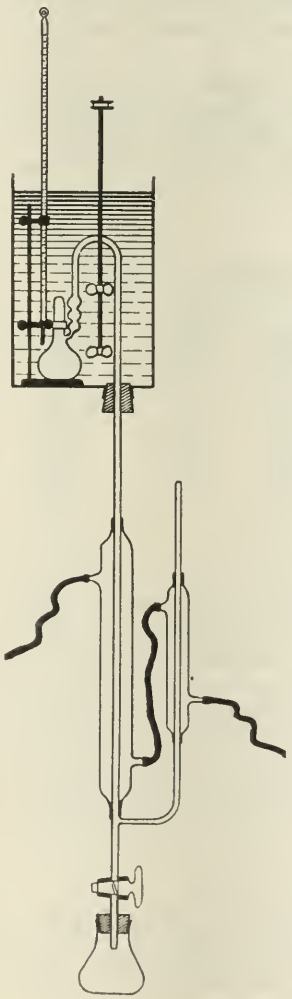

FIG. 1—DISTILLATION APPARATUS

Procedure

A quantity of nitric acid of known concentration is weighed into the flask. The flask is then introduced into the empty pot, the delivery tube led through the stopper in the bottom and then sealed to the inner condenser tube. The bath liquid is then poured into the pot until the flask and delivery tube are well covered. The bath is vigorously stirred and sufficient heat is applied to keep up a slow but continuous distillation. A fraction of 25 or 30 g. is received into a small weighed flask and removed. While a second fraction is being collected the first is weighed and titrated. In this manner a continuous experiment gives a number of values which can be expressed in such a manner that the rate

[1] Elements of the Superconcentration of Nitric Acid, CHEM. & MET. ENG., vol. 25, p. 741, Oct. 19, 1921; translated from *Z. angew. Chem.*, 1921, vol. 34, pp. 168-170, 173-175.

[2] Distillation Studies of Nitric Acid and Sulphuric-Nitric Acid Mixtures—I, CHEM. & MET. ENG., vol. 25, p. 1103, Nov. 14, 1921; II, CHEM. & MET. ENG., vol. 25, p. 1145, Nov. 21, 1921; translated from *Ann. Chim.*, 1921, new series, vol. 15, pp. 253-290.

[3] Chem. 104. Advanced Inorganic Preparations.

[4] Although the apparatus and method is very similar to that of Pascal, it was designed and used 2 years ago, when this work was first started.

of concentration of the acid is known. All experiments were carried on at atmospheric pressure. The results of three experiments are given in Tables I, II and III respectively and these results are graphically expressed in Fig. 2.

In the first experiment 618.37 g. of 6.533 per cent nitric acid was concentrated to 59.72 per cent acid while the temperature of the bath changed from 110 to 122 deg. C.

In the second experiment 705.995 g. of 6.533 per cent nitric acid was concentrated to 53.25 per cent acid while the temperature of the bath changed from 110 to 124 deg. C.

In the third experiment 517.56 g. 38.518 per cent nitric acid was concentrated to 51.915 per cent acid while the temperature of the bath changed from 118 to 122 deg. C.

As has been pointed out by previous experimenters, the results become more or less unsatisfactory as the amount of distillate approaches the amount of residue. In studying the salt effect. McBain[5] used large quantities of dilute solutions and took the composition of only one small fraction as representing the nature of the vapor phase. In Fig. 2, however, we have plotted the results of our experiments on a different basis than previous experimenters and the regularity of the curves indicates the probable value of our results. The third experiment is given in order to give more accurately the upper portion of the curve. As is stated above, an acid of higher concentration was used so that the ratio of the amount of distillate to residue in the higher concentrations should not be large enough to introduce an error.

TABLE II—CONCENTRATION OF NITRIC ACID BETWEEN 6.533 AND 53.25 PER CENT

Weight of Residue, g.	Weight of Total Distillate, g.	HNO_3 in Distillate, Per Cent	Total Distillate, Per Cent	HNO_3 in Residue, Per Cent	Temperature of Bath, Deg. C.
705.995	.....	.....	.....	6.533	.....
638.73	67.27	0.09	9.53	7.21	110–114
570.79	135.21	0.17	19.15	8.05	114
501.16	204.84	0.30	29.01	9.14	115
437.19	268.81	0.47	38.08	10.44	116
366.63	339.36	0.73	48.07	12.38	117
309.18	396.82	1.05	56.21	14.58	118
256.15	449.85	1.49	63.72	17.42	119
211.67	494.33	2.11	70.02	20.79	120
172.93	533.07	3.06	75.50	24.90	120
132.50	573.49	5.03	81.23	31.01	121
109.95	596.05	7.11	84.43	35.48	122
85.43	620.56	10.86	87.90	41.27	123
56.15	649.85	18.79	92.05	48.67	124
34.71	671.28	27.64	95.08	53.25	124

TABLE III—CONCENTRATION OF NITRIC ACID BETWEEN 38.518 AND 51.915 PER CENT

Weight of Residue, g.	Weight of Total Distillate, g.	HNO_3 in Distillate, Per Cent	Total Distillate, Per Cent	HNO_3 in Residue, Per Cent	Temperature of Bath, Deg. C.
517.5621	.....	.....	.....	38.518	.....
493.17	24.39	3.94	4.71	39.63	118
463.04	54.53	9.37	10.54	41.03	118
418.22	99.35	18.76	19.20	43.19	119
366.54	151.02	31.84	29.18	45.70	119
321.10	196.46	45.58	37.96	47.89	119
282.84	234.72	58.90	45.35	49.66	120
245.19	272.37	73.59	52.63	51.30	121
230.65	286.91	79.61	55.44	51.92	122

Discussion of Results

A study of Fig. 2 shows that starting with 10 per cent nitric acid, its concentration increased to 20 per cent when little more than half had distilled over, while from 10 to 40 per cent about three-fourths distilled over. Thus as the concentration becomes higher the rate of concentration becomes less. The data from experiment 3, Table III, lie on almost a straight line between 40 and 50 per cent. When the line is extrapolated it passes through the point of constant boiling acid as the last fraction comes over. It would appear therefore from Fig. 2 that an acid of constant boiling point could not be prepared by simple distillation. This is in accordance with what might be expected, as the concentration of the acid in the vapor is continuously below, although continuously approaching, that of the acid in the residue; the point at which this change becomes zero, of course, is at the point at which all the solution distills over.

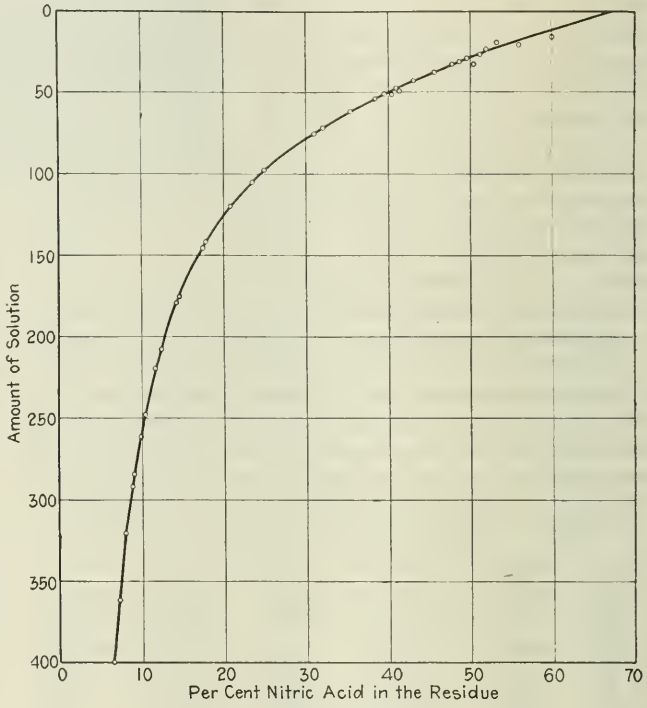

FIG. 2—CHANGE IN COMPOSITION OF NITRIC ACID RESIDUE DURING DISTILLATION

A study of Fig. 2 shows that in a distillation of 1,000 g. of a 10 per cent solution, the concentration would change as in Table IV.

TABLE IV—INTERPRETATION OF FIG. 2

Total Solution, g.	Water, g.	Acid, g.	Concentration of Residue, Per Cent HNO_3	Loss of Acid, Per Cent of Total
1000	900	100	10	0
484	387	97	20	3
302.3	212	90.7	30	9.3
197.7	118.6	79.1	40	20.9
108.6	54.3	54.3	50	45.7

Summary

1. Experimental data are given to show how nitric acid concentrates when it is distilled at atmospheric pressure, with the vapor phase in equilibrium with the liquid phase.

2. It is evident that concentration of dilute nitric acid could not be profitably carried on above 20 to 30 per cent by such a distillation, as 3 per cent is lost as the concentration changes from 10 to 20 per cent and 9.3 per cent as the concentration changes from 10 to 30 per cent.

New York City.

[5] *J. Chem. Soc.*, vol. 115, pp. 1332-46 (1919).

Relation of Shale-Oil Residue to Other Bitumens*

A Preliminary Study of the Resemblance of Some of the Physical and Chemical Properties of Heavy Shale-Oil Materials to Those of Gilsonite, Asphalt and Rosin

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SOME of the properties of the heavy residues from representative Colorado and Utah shale oils were given in a former article.[1] These properties suggest resemblance to better known and widely used bitumens and it is therefore desirable to study the relation of this "shale-oil residue" to other bituminous materials. In the study presented in this paper special attention has been given to the products of thermal decomposition at atmospheric pressure and to the effects of the decomposition on saturation and nitrogen content. Wherever data on the different bitumens could be found in the literature they have been freely used. However, little information could be obtained on the saturation of the oils produced by destructive distillation of the other bituminous materials, and it was necessary to make a distillation of each substance studied. These distillations have been made for gilsonite, asphalt and rosin, but experimental work planned for grahamite and petroleum residues has been postponed because of difficulty in obtaining authentic samples.

The destructive distillations were made in the same way as the distillation of the "shale-oil residue."[2] The oils obtained were tested for gravity and saturation,[3] then fractionated and the boiling point, gravity and saturation of each fraction determined. The distillation of the bitumen and of the resulting oil was in each case made from Pyrex distilling flasks at atmospheric pressure without steam. The gilsonite and gilsonite oil were also analyzed for nitrogen and sulphur. The data for gilsonite and the gilsonite oil are given in Table I, for asphalt and the asphalt oil in Table II, and for rosin and the rosin oil in Table III. Fig. 1 shows the saturation curves for the oils from the "shale-oil residue," gilsonite, asphalt and rosin and for the once-run Nevada oil[4] and the once-run Utah oil No. 2.[5] Fig. 2 gives specific gravity-boiling point curves for these oils, for the once-run Utah No. 1 and for pure paraffines, and indicates the position relative to the curves of the boiling point and specific gravity of a number of olefines and cyclic hydrocarbons. Table IV is a tabulation of some of the properties of the "shale-oil residue" and the corresponding properties of gilsonite, grahamite, asphalts and petroleum residues. The values for the asphalts and petroleum residues are based largely on data given by Richardson in his "Modern Asphalt Pavement, 1910," and the values for gilsonite and grahamite on the work of William C. Day, Mabery and Richardson. Credit in most instances is given in the footnotes to the table. The data (Table IV) on the "shale-oil residue" and on the products and effects of destructive distillation are taken from a former paper.[1]

The data of Tables I, II and III show a number of interesting phenomena relative to each substance that are not directly pertinent to the objects of this investigation and will not be further mentioned. A study of the data tabulated in Table IV and of the curves in Figs. 1 and 2 will serve to indicate the chief relations of the "shale-oil residue" to the other bituminous materials.

Resemblance of Shale-Oil Residue to Gilsonite

The "shale-oil residue" more nearly resembles gilsonite than any other bitumen. These materials are very much the same in gravity, high content of unsaturates and malthenes and low content of carbenes; in percentages of nitrogen, sulphur and fixed carbon; in yields of coke, gas and "additional saturates" on destructive distillation, and in the properties of the oils obtained by decomposition. The oil from the "shale-oil residue" has a saturation of 54 per cent and the oil from the gilsonite a saturation of 55 per cent. Fig. 1 shows a similarity in the saturation of the fractions of these oils, and Fig. 2 indicates almost identical specific gravity-boiling point curves. The main points of difference are a higher content of malthenes and a higher percentage of high melting point paraffines in the "shale-oil residue." This difference in heavy paraffines is indicated by the amount

TABLE I—DATA ON DESTRUCTIVE DISTILLATION OF GILSONITE

500 g. distilled from a 1,000-c.c. Pyrex distilling flask

Water, per cent by weight	1.0
Oil, per cent by weight	54.5
Coke, per cent by weight	27.8
Gas, by difference	16.7

Changes Produced by Distillation of Gilsonite

	Gravity	Saturation Per Cent	Nitrogen Per Cent
Before distillation	1.038	6.6	2.32
After distillation	0.8679	55.0	1.02

Additional saturates, per cent*	29.0
Loss as gas and coke, per cent	44.5
Loss of nitrogen, per cent	76.3

Results of Fractionation of Oil From Gilsonite
250 c.c. distilled from 500-c.c. Pyrex distilling flask

Percentage-off	Vapor Temperature, Deg. F.	Gravity (Of 10 Per Cent Fractions)	Saturation Per Cent
10	290	0.719	70.0
20	375	0.783	69.0
30	445	0.816	68.2
40	492.5	0.842	66.0
50	532	0.861	63.0
60	580	0.882	60.0
70	624	0.899	56.5
80	667	0.910	53.2
90	695	0.924	48.8
	705		
96.4	650	0.953	43.0
Composite of above		0.855	60.4

Products of Distillation of Gilsonite Oil

Oil, per cent by weight	95.0
Coke, per cent by weight	3.2
Gas, by difference	1.8

*For explanation of "additional saturates" see CHEM. & MET. ENG., vol. 26, No. 9, pp. 399, March 1, 1922.

*Contribution from the Research Laboratories of the Colorado School of Mines.

[1]CHEM. & MET. ENG., vol. 26, No. 9, p. 398, March 1, 1922.

[2]CHEM. & MET. ENG., vol. 26, No. 9, p. 400, March 1, 1922.

[3]For method see CHEM. & MET. ENG., vol. 24, p. 876, May 18, 1921.

[4]Distillation data, CHEM. & MET. ENG., vol. 24, p. 879.

[5]Distillation data will be given in a subsequent paper.

of wax which crystallized from the heavy fractions of the oil from the "shale-oil residue" and from the position of the specific gravity-boiling point curves for the heavy fractions of these oils. Mabery has shown[6] that a considerable portion of the saturates from gilsonite oil belongs to cyclic series (C_nH_{2n} and C_nH_{2n-2}) and that some of the unsaturates are olefines. The saturation and specific gravity-boiling point curves for the oils from the "shale-oil residue" and the gilsonite indicate that these oils may be composed of similar series of saturated and unsaturated compounds, the proportions of which vary in about the same way throughout the ten fractions. This close resemblance in the properties of the oils obtained by destructive distillation is additional evidence of similarity in the composition of the parent substances. From a chemical standpoint the gilsonite is such bitumen as might have been removed from some oil shales by pressure and a temperature sufficiently high to cause primary decomposition.[7]

Destructive Distillation of Asphalt

The bitumen of the asphalt examined contained 18.1 per cent of saturates and the asphalt oil contained 5.8 per cent of "additional saturates" not present in this bitumen.[8] The asphalt oil decomposes very little on distillation and the content of saturates is not increased. The percentage of saturates in the asphalt oil is lower than in the once-run shale oils, but the distribution is similar. In the light fractions the curves (Figs. 1 and 2) show a rather high content of saturates and considerable likeness in gravity, boiling point and saturation to shale oils, but in the heavy fractions as the gravity increases a difference becomes more and more evident. The gravity and boiling point of the heavier fractions do not indicate the presence of paraffines. The asphalts (Table IV) resemble the "shale-oil residue" in percentage of malthenes, but the malthenes of the asphalts are higher in saturates and sulphur and as a rule lower in nitrogen.

TABLE II—DATA ON DESTRUCTIVE DISTILLATION OF ASPHALT

400 g. distilled from a 1,000-c.c. Pyrex distilling flask

Oil, per cent by weight of bitumen distilled	53.3
Fixed carbon	33.3
Gas, by difference	13.4

Changes Produced by Distillation of Asphalt

	Gravity	Saturation Per Cent
Before distillation	1.154	18.8
After distillation	0.9121	45.0

	Per Cent
Loss as gas and coke	46.7
Additional saturates	5.8

Results of Fractionation of Oil From Asphalt

100 c.c. distilled from 200-c.c. Pyrex distilling flask

Percentage-off	Vapor Temperature, Deg. F.	Gravity (Of 20 Per Cent Fractions)	Saturation Per Cent
10	317		
20	410	0.778	59.0
30	485		
40	537	0.881	53.8
50	575		
60	627	0.926	42.0
70	670		
80	697	0.950	37.4
90	730		
99.3	815	0.976	28.2
Composite of above		0.902	44.2

Products of Distillation of Asphalt Oil

Oil, per cent by weight	97.2
Coke, per cent by weight	1.84
Gas, by difference	0.96

TABLE III—DATA ON DESTRUCTIVE DISTILLATION OF ROSIN

500 g. distilled from a 1,000-c.c. Pyrex distilling flask

Water, per cent by weight	5.0
Oil, per cent by weight	86.8
Coke, per cent by weight	3.7
Gas, by difference	4.5

Changes Produced by Distillation of Rosin

	Gravity	Saturation
Before distillation	1.068	0.2
After distillation	0.9815	20.0
Loss as gas, coke and water		13.2
Additional saturates		17.5

Results of Fractionation of Oil From Rosin

300 c.c. distilled from a 500-c.c. Pyrex distilling flask

Percentage-off	Vapor Temperature, Deg. F.	Gravity (Of 10 Per Cent Fractions)	Saturation Per Cent
10	380	0.875	21.8
20	575	0.957	22.1
30	605	0.967	31.7
40	614	0.975	33.5
50	620	0.978	35.2
60	624	0.979	39.8
70	630	0.980	42.0
80	648	0.986	49.0
90	695	1.000	46.6
99.1	690	1.012	23.0
Composite of above		0.976	22.6

Products of Distillation of Rosin Oil

Oil, per cent by weight	98.6
Coke, per cent by weight	0.8
Gas, by difference	0.6

Peckham[9] has suggested that some of the heavy materials of California petroleum high in nitrogen consist of basic oils combined with feebly acid tars. William C. Day[10] has pointed out resemblance between these petroleums and gilsonite and has made a product called artificial gilsonite by combining, in the vapor phase, the distillation products of fish (basic oil) and pine chips (acidic plant materials). The high nitrogen content of the "shale-oil residue" and the gilsonite suggests that they may be composed of basic nitrogen constituents in unstable combination with acidic resinous materials, and that such compounds may be the source of the saturates formed on decomposition. A destructive distillation of rosin was made to determine whether this material decomposes with the formation of saturated compounds. The rosin contained (data Table III) only 0.2 per cent of saturates soluble in petroleum ether, but the rosin oil, although it was highly unsaturated (20 per cent saturates), contained 17.5 per cent of "additional saturates" not present in the rosin. The oil on distillation showed little evidence of decomposition other than the formation of water. The first eight of the 10 per cent fractions of this oil have an opposite distribution of saturates to that in the shale oils. The rosin oil exhibits the paradoxical behavior of averaging 34.5 per cent for the saturates in the ten fractions, while the composited oil of these fractions tested only 22.6 per cent of saturates. After standing for 3 months, 7.7 per cent of water had separated from the composite of these fractions. The oil then tested 31.2 per cent of saturates. On redistillation the boiling points, except for the first fraction, were practically identical with the former ones and the distribution of the saturates through the fractions was also similar, but each fraction was about 4 per cent higher in saturation than in the first distillation. The composite of the fractions from the second distillation contained 31.4 per cent of saturates when tested in the usual way, while an average of the percentages found in the individual fractions was 38.5 per cent. Strange variations of this kind have been noticed for some shale oils, but the difference between the average and that of

[6] *J. Am. Chem. Soc.*, vol. 39, pp. 2022 and 2023.

[7] Prof. R. D. George has noted minute specks closely resembling gilsonite in Colorado shales. Colorado Geological Survey, Bull. 25, p. 22.

[8] These percentages are based on the weight of the pure bitumen in the crude asphalt.

[9] *Am. J. Sci.*, III, vol. 48, p. 250.

[10] J. Frank. Inst., vol. 145, p. 476.

the analysis of the composite has not usually exceeded 1 per cent and was attributed to experimental error. Error cannot be the cause of this discrepancy in the rosin oil, but the apparent inconsistency may be connected with the water, which was a decomposition product in both distillations. Mills[11] gives bromine numbers for twenty-three fractions of rosin oil obtained by steam distillation. His results indicate a similar distribution of saturates to that of Table III, and the average bromine number for the fractions is about 26 per cent less than for the crude rosin. These data obtained by bromine absorption methods tend to substantiate the data of Table III obtained by absorption in sulphuric acid.

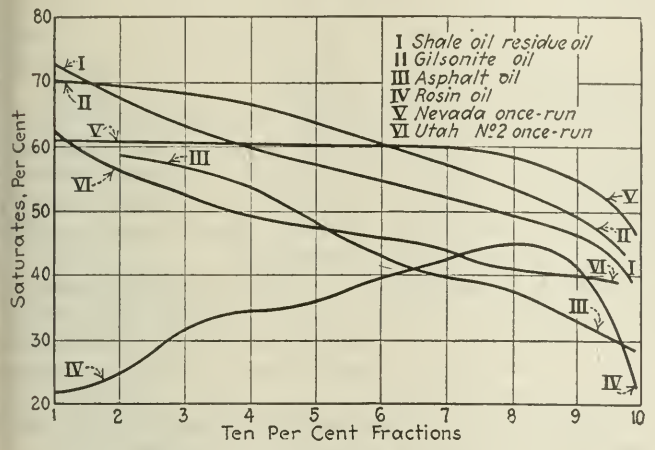

FIG. 1—SATURATION CURVES

Except in the formation of "additional saturates," the rosin bears little resemblance to the "shale-oil residue." The rosin on distillation formed small percentages of gas and coke, but a very high percentage of water. Water was also formed in both distillations of the rosin oil, but did not readily separate from the oil, and measurement was not possible except by redistillation or after standing for months in a warm place.

Petroleum residues are similar to the "shale-oil residue" in content of malthenes, but the petroleum malthenes are higher in saturates and as a rule petroleum yields less fixed carbon on distillation. Further discussion relative to these materials is at present inopportune, since no data have been obtained in regard to the amounts of gas, coke and "additional saturates" formed and nitrogen lost in destructive distillations of petroleum residues at atmospheric pressure. It has not been possible to include these distillations in the experimental work of this paper, but a study of this kind is desirable, since the results might give information regarding the truth of the hypothesis suggested by the author in a former paper[12] that "the 'additional saturates' are formed by decomposition of unstable nitrogen constituents" and might also give light on the correctness of Richardson's hypothesis[13] as to the origin of gilsonite and grahamite from petroleum. It is probable that gilsonite and the many varieties of bitumen found in and near the State of Utah may prove to be more closely related in composition to shale materials than to petroleum.

Both Richardson[14] and Mabery[15] have pointed out the differences between gilsonite and grahamite. These differences apply also to the "shale-oil residue" and grahamite. The grahamite has a higher gravity, lower content of malthenes, a much higher content of carbenes, and yields on distillation less oil[16] but more fixed carbon and residual coke than the "shale-oil residue." The large proportion of saturates noted by Mabery[16] in oil from grahamite and the small amount of saturates found by Richardson[17] in this bitumen suggest that grahamite on distillation may yield an oil of much higher saturation than gilsonite and the "shale-oil residue."

[11]"Destructive Distillation," p. 13.
[12]CHEM. & MET. ENG., vol. 26, No. 9, p. 399, March 1, 1922.
[13]*J. Ind. Eng. Chem.*, vol. 8, p. 494.
[14]"Modern Asphalt Pavement," 1910, p. 549, *J. Ind. Eng. Chem.*, vol. 3, p. 494.
[15]*J. Am. Chem. Soc.*, vol. 39, p. 2024.

Probable Origin of Distillation Products

Mabery's statement that "while there is considerable decomposition in the initial distillation, it seems probable that heavier saturated hydrocarbons and solid paraffines form a considerable part of the natural bitumen (gilsonite) . . ."[18] is not in harmony with the very low percentages of saturates found by Richardson[19] in gilsonite and verified by the writer in the gilsonite studied in this paper. This gilsonite contained 6.6 per cent or less of saturates and the gilsonite oil contained 29 per cent of "additional saturates." There can be no doubt that large quantities of saturates are formed in the distillation of the gilsonite and the "shale-oil residue." It is probable that diminished pressure would decrease the decomposition of these bitumens on distillation and possible that grahamite may undergo a large amount of decomposition on distillation, even though the pressure is greatly reduced. Such behavior would account for the large amount of unsaturates found by Mabery in the gilsonite oil and for the rather high percentage of saturates noted by him in the grahamite oil. It is not reasonable that coal, grahamite and oil shale,

[16]Mabery, *loc. cit.*
[17]*Loc. cit.*
[18]*Loc. cit.*, p. 2022.
[19]*Loc. cit.*, p. 494.

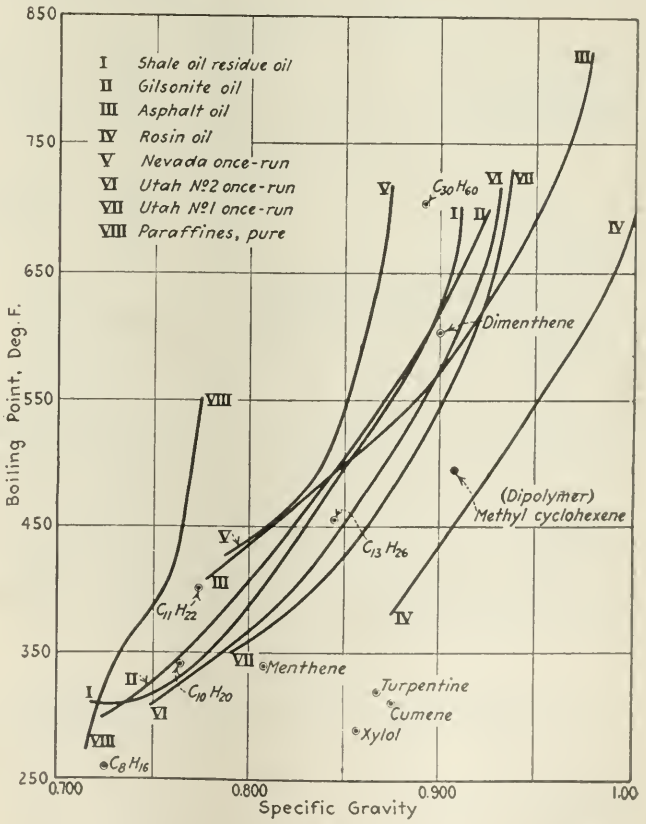

FIG. 2—SPECIFIC GRAVITY-BOILING POINT CURVES

which contain but very small amounts of materials soluble in petroleum ether, can contain paraffines in considerable quantity. The saturated and unsaturated oils produced by destructive distillation of these materials and of the gilsonite and the "shale-oil residue" must be formed by decomposition of heavy unstable materials, other than saturates, in the parent substances. It is evident from the decomposition of the crude shale oils already studied[20] that the percentage of saturated oil increases as the decomposition of the unstable material proceeds and is a maximum only when the decomposition of the unstable shale bitumen is complete.

Both the "shale-oil residue" and the gilsonite contain over 2 per cent of nitrogen. On distillation these materials lose 72.8 per cent and 76.3 per cent respectively of the original nitrogen, and the losses are attended by the formation of 23.3 per cent and 29 per cent respectively of "additional saturates." This is further evidence to that already given[21] that the unstable heavy materials, which are readily removed from the crude oils by sulphuric acid and which form "additional saturates" on decomposition, are composed largely of nitrogen compounds. On decomposition the nitrogen forms ammonia and soluble organic bases and a portion remains as a constituent of some of the lighter stable oils. Small quantities of water are noticeable in the decomposition

TABLE IV—SUMMARY OF DATA ON "SHALE-OIL RESIDUE" AND RELATED BITUMENS

	Asphalt	Petroleum Residues	Shale-Oil Residue	Gilsonite	Grahamite
Gravity	1.06–1.42	0.926–1.14	1.015	1.011–1.057[2]	1.157–1.184[2]
Saturates, %	8.0–29.0	41–79	10.7	5.5[2]–6.6	0.3[2]
Soluble in CS_2	40–98	99.6–99.9	99.8	99.0–99.9	94.–98
Malthenes, %	43–72	60–98	83.6	24.5–55.5[2]	0.4–38.8[2]
Carbenes, %	17.5	.....	0.26	0–0.4	55–80[1]
Residual coke	33.3[6]	.....	36.2	10.0–16.7[2]	40–51.4[2]
Fixed carbon, %	10.8–17.9	1.8–10.8	10.6	3.3–26.0[1]	35–53[1]
Sulphur, %	4.0–8.3	0.6–4.5[5]	0.37	0.26–1.3[4] 0.02[3]	2.07[3] 0.9–2.0[1]
Nitrogen, %	0.5–1.0	.....	2.05	0.3–2.5[9] 1.05[3]	0.2[5]

Products of Destructive Distillation

	Shale-Oil Residue	Gilsonite	Asphalt
Water, per cent by weight	0.2	1.0	0.0
Oil, per cent by weight	53.2	54.5	53.3
Residual coke, per cent by weight	36.2	27.8	33.3
Gas, by difference	10.4	16.7	13.4

Effects of Destructive Distillation

	Shale-Oil Residue Per Cent	Gilsonite Per Cent	Asphalt Per Cent
Additional saturates	23.3	29.0	5.8
Loss of nitrogen	72.8	76.3	
Loss of bitumen	46.8	45.5	46.7

[1] Richardson, "Modern Asphalt Pavement," 1910.
[2] Richardson, *J. Ind. Eng. Chem.*, vol. 8, p 494.
[3] Mabery, *J. Am. Chem. Soc.*, vol. 39, p. 2,024.
[4] William C. Day, *J. Frank. Inst.*, vol. 140, p 221, vol. 145, p. 476.
[5] Cross, "Handbook of Petroleum, Asphalt, etc.," No. 15, 1919.
[6] Table II.

products of the heavy materials of shale oils. The amount of water thus formed is very small compared with that from the rosin and it does not seem probable that the heavy shale materials can contain any very considerable proportion of oxygen. Whether in the crude shale oils the organic nitrogen bases are combined with acidic constituents such as are found in resins is a question whose solution is beyond the limits possible for the experimental work of this paper.

Summary

A preliminary study has been made of the relation of the "shale-oil residue" to other bitumens. A sample of gilsonite proved to be almost identical in properties to the "shale-oil residue" and the products obtained from these substances by destructive distillation were also similar in quantity and properties. A destructive distillation of asphalt yielded less oil and a much lower percentage of "additional saturates" than the "shale-oil residue," but the distribution of the saturates in the fractions of the oils is similar. On distillation rosin formed "additional saturates" equal in quantity to the yield from crude shale oils, but the decomposition was accompanied by the formation of a much larger quantity of water and the distribution of the saturates in the fractions of the oil was the reverse (last fraction excepted) of that in the oil from the "shale-oil residue." The shale-oil bitumen is more closely related in composition and properties to gilsonite than it is to asphalt, grahamite or petroleum residues.

The high content of nitrogen in the "shale-oil residue" and in the gilsonite, together with the large nitrogen losses which occurred when these substances were distilled, indicates that the decomposition and attending increase in saturates is probably caused by the breaking down of heavy nitrogen compounds.

The saturates in the oils from rosin, gilsonite and the "shale-oil residue" are not present as such in the parent substances, but are produced by decomposition when these substances are destructively distilled at atmospheric pressure.

The author expresses his indebtedness to R. W. Boyd for the distillation of the rosin and the rosin oil.

Golden, Col.

[20] CHEM. & MET. ENG., vol. 24, p. 876. CHEM. & MET. ENG., vol. 26, No. 9, p. 398, March 1, 1922.

[21] CHEM. & MET. ENG., vol. 26, No. 9, p. 399, March 1, 1922, Table I.

"Oxide Pox" Among Zinc Oxide Workers

The effects of zinc oxide dust in causing a troublesome dermatitis were observed recently in a zinc oxide manufacturing plant in the course of an investigation of the effects of inhaling zinc oxide dust. In the plant investigated the workers called the disease "oxide pox," because of its similarity to the eruption of smallpox.

Of the seventeen men examined who are exposed to the oxide dust in the bag-room and packing departments all but three gave a history of having had attacks of "oxide pox" and eight were suffering from the affection at the time of the investigation. The men had been employed for varying periods so that the length of employment did not seem to play any part in the occurrence of the disease. "Oxide pox" is caused by a clogging of the sebaceous glands with zinc oxide and subsequent bacterial infection. The disease is most prevalent in summer, although six of the men claimed they were affected regardless of the season but that it was more troublesome in the summer months. The eruption is accompanied by intense itching and usually persists for a week or 10 days, gradually subsiding and drying up, and is then followed by a slow but marked peeling of the skin. The cases studied showed no signs of systemic disturbances and no time was lost from work, although the disease caused considerable discomfort.

Zinc oxide is recognized as a non-toxic substance in which adulterating substance is so small as to be harmless, but is capable of acting as a mechanical conveyor of bacteria. It was found to be the general opinion among the workmen that the occurrence of the disease depends entirely on personal cleanliness and if daily baths are taken no trouble is experienced. Special work clothes of a close weave of cloth, made to fit snugly at neckband, wristband and ankles, should be worn to prevent the dust from coming in contact with the body.

Grain Growth and Recrystallization in Metals—III—Underlying Causes

Growth-Force of a Crystal Depends Principally Upon Small Average Grain Size and Large Contrast in Sizes—Recrystallization Is Grain Growth of Fragmented Crystals, No New Nuclei Appearing Until a New Crystalline Phase Arrives*

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MATERIAL presented in previous portions of this article has consisted entirely in the presentation of the facts of grain growth and of such generalizations as may be drawn from them. It is possible that some of these statements will require correction or amendment in the light of more accurate or more complete observations, but in the main they are well established and are of immediate practical use in controlling grain growth in metals. For ready reference, the "Laws of Grain Growth" coded in the last article are here repeated.

Laws of Grain Growth

1. The grain size of cast metals is usually smaller the more rapid the rate of solidification.
2. The grain size in cast metals which undergo no phase change in the solid state cannot be changed appreciably by heating below the melting point.
3. Grain growth in the solid state may occur in (*a*) worked metals, (*b*) compressed powders, (*c*) electrodeposited metals, (*d*) in iron when it changes allotropic form and (*e*) in alloys in which a new phase is formed in the solid state.
4. The recrystallization temperature is lower (*a*) the greater the amount of deformation, (*b*) the smaller the grains prior to deformation, (*c*) the purer the metal, (*d*) the lower the temperature at which the deformation is effected and (*e*) the longer the time of heating.
5. In any given metal the grain size after complete recrystallization is normally smaller the lower the recrystallization temperature.
6. Above the recrystallization temperature the grain size is normally greater the higher the temperature and the longer the exposure.
7. The higher the temperature the more rapid the grain growth. At a temperature near the melting point a few seconds is often sufficient to produce grains which may not change further on extended exposure.
8. Certain conditions of non-uniformity sometimes give rise to the formation of abnormally large grains. This is called germination.
9. The non-uniformities giving rise to germination are: grain size contrast, strain gradients, temperature gradients, concentration gradients, and obstruction gradients.
10. The presence of foreign matter or a second phase introduces mechanical obstruction to grain growth. The resistance to growth increases as the quantity of foreign matter or other phase increases and as the particle size decreases.
11. The presence of a certain amount of obstruction matter promotes germination.
12. The higher the germination temperature the larger will be the grains and the quicker will they form.
13. The more rapid the heating through the germinative temperature range, at least within limits, the finer will be the grain size.

It is also desirable to have a conception of the fundamental causes underlying these phenomena, as by this means the various facts can be more easily correlated and new facts more rapidly discovered. Many contributions have been made to the literature on grain growth and no small part has been devoted to the theoretical aspects. Naturally many of the ideas have been discarded and certain ones have gained a sufficient following to warrant their general acceptance by metallographists. In the remainder of this article the authors will put forth a conception of the fundamental causes of grain growth consistent with the observed facts and with modern developments in molecular physics. While some of the ideas will be recognized as new, the conception as a whole is quite in accord with generally accepted theory on grain growth.

Possible Causes of Grain Growth

Grain growth obviously results from the tendency of matter to assume the form of greatest physical stability, which is the form of least energy. The crystallization of metals from the liquid state is always accompanied by an evolution of heat, representing the loss in the kinetic energy of the atoms incident to their fixation in the rigid crystal lattice. The atoms at the surface of a liquid or solid body are less subject to the attraction of their neighbors than are the atoms in the interior. They are therefore more free to move and consequently possess more energy of motion. A "free" surface of any body is thus a locus of extra energy, known as surface energy or sometimes surface tension. There is, therefore, a tendency for small particles, such as drops of a liquid or crystals of a solid, to unite to form larger particles, since in so doing they diminish their surface area and hence their total energy. It follows that the most stable form for any piece of metal would be a single crystalline grain.

To have the smallest possible surface area this grain should be spherical in shape. This would not, however, necessarily give the minimum surface energy, because of the geometrical properties of the crystal. The most stable shape for a crystalline substance is often an idiomorphic form built up of the natural crystal faces. On the other hand, it is well known that small particles of certain crystalline constituents in a metallic aggregate tend on long heating to assume a spherical form. The question is not of great importance here, and may be dismissed by saying that the most stable form of a metallic crystal is that of least surface energy, which will probably be either idiomorphic or spherical.

There has been considerable confusion in the literature on grain growth arising from a lack of distinction between true or stable equilibrium and metastable equilibrium. Some have considered that the ultimate stable condition of a piece of metal is not a single crystal, simply because such specimens are very rarely encountered and then only as a result of rather special manipulation. Such a conclusion is just as absurd as a conclusion that the gravitationally stable form of the earth's surface consists of mountains and valleys, and for the same reason. Grain growth is a process involving inertia which must be overcome just as the friction of the material composing a mountain must be overcome before the force of gravity can level it with the plain. Similarly the fact that even after prolonged annealing above the recrystallization temperature grains may be found having jagged or irregular outlines does not in any

*Part I, on Definitions, was published in Chem. & Met. Eng., vol. 26, No. 8, p. 343, Feb. 22, 1922; Part II, on Experimental Data and General Laws, vol. 26, No. 9, p. 402, March 1, 1922.

way disprove that smooth outlines would represent a condition of greater thermodynamic stability.

Obviously any roughness on the surface of a crystal is a source of increased surface energy and hence diminished stability.

If a crystal is subjected to an external load below its elastic limit, it becomes temporarily deformed or distorted. On release of the load the crystal returns to its original form. The deformation of the crystal by the external load requires an expenditure of energy which is stored in the crystal itself and manifested by its ability to return to its original shape, doing work as it returns. An elastically deformed crystal thus contains more energy than a similar crystal free from stress and distortion, and is therefore less stable thermodynamically.

We have now considered briefly all of the factors which, according to our present knowledge, may influence the stability of a crystal—namely, size, form, surface and distortion. The most stable form for a solid metal is a single crystal, spherical or idomorphic in shape, of smooth surface, and free from any distortion of its space-lattice. All solid metals must tend to assume this condition.

Conditions for Grain Growth

Any piece of metal which consists of more than one grain must possess a tendency for grain growth which is greater in proportion to the departure from the condition of maximum stability. We may for convenience designate this tendency "growth-force." Grain growth will take place whenever the growth-force is sufficient to overcome the opposition to growth. Grain growth takes place by a process of boundary migration which involves the gradual transfer of atoms from the lattice of one grain to that of the adjacent grain. Whether or not this transfer takes place through a layer of amorphous grain boundary metal, it requires a certain degree of atomic mobility of *temperature* for its accomplishment. There is usually present in metals some form of obstruction which mechanically interferes with grain growth, such as thoria in tungsten and pearlite in steel. This obstruction may be so great that it prevents grain growth altogether. In any case with a given growth-force the presence of obstructing materials raises the temperature required for grain growth.

It has been suggested that in order for one grain to absorb another it is necessary that the orientations of the two grains be very similar. Some observers have reported, however, that the relative orientation of the grains has no apparent effect on growth. It may well be imagined that although similarity of orientation might facilitate the process of growth, this very condition would also decrease the force tending to cause growth. In any event, there is not sufficient evidence to justify serious consideration of relative orientation as a factor in grain growth.

We may take as a sound foundation for the development of a theory of grain growth the proposition that the impetus of growth-force is due to a condition of thermodynamic instability and that when such a condition exists growth will take place whenever the temperature and obstruction factors permit. The factors affecting the stability of the grains of a metal and hence the growth-force have been indicated (size, shape, surface and distortion). The relative importance of these factors will now be considered more fully.

Shape and Surface of Grains

There are frequently found even in unstrained metals grains of such elongated or extended shape that the ratio of surface area to volume is abnormally high for grains of that size. Presumably such grains are less stable than grains of the same size but of more nearly equiaxed shape, which therefore tend to grow at the expense of the former. Actual observation indicates, however, that such differences in shape constitute a relatively minor factor in grain growth.

Rosenhain has observed that in deformed lead in which grain growth was occurring the outlines of the grains were ragged, while in cast lead, in which grain growth could not be produced by heating, the outlines of the grains were much more smooth. He considered that the ragged boundaries represented a condition of greater surface energy, hence less thermodynamic stability, and consequently a greater tendency for grain growth. This may account in part for the fact that grain growth occurs in worked metals but not in cast metals. General observations on the effect of grain outline or surface on grain growth phenomena are lacking, however, so that this factor cannot be incorporated as basic in a theory of grain growth.

Grain Size the Important Factor

The tendency of metals to reduce their store of energy by increasing their grain size is the factor which has probably been considered the principal cause of grain growth. There are, nevertheless, many who do not regard this as furnishing an adequate explanation of all the phenomena involved. The authors believe that grain size, considered both absolutely and relatively, is the chief factor determining the growth-force or tendency for grain growth to occur, and that it furnishes the basis for a completely satisfactory theory of grain growth.

A crystalline grain is to be regarded as an organized structure having a definite power to hold its atoms in their positions in its space-lattice, and to attract neighboring atoms into its lattice. This power is due to the cumulative effect of the directional force fields of the atoms composing the grains. The exact nature of these force fields is not known, consequently the manner of their linkage is unknown. It is held by some students of atomic and molecular physics that the attractive force of an atom does not extend to a distance of more than two or three atom diameters, in which case the orienting power of a crystal would be very little affected by its size when such a crystal contained more than about six atoms across its smallest diameter. The authors believe that the influence of the atoms within a crystal upon its orienting power extends to a much greater distance. In any event, it is certain that large crystals or crystalline grains do possess that property which has here been called "orienting power" to a greater extent than do similar crystals of smaller size.

Many examples of this general fact are known. It is known that the solubility of many salts in water is greater the finer the particles of the salt. Some figures for the solubility of calcium sulphate in water are as follows:

	Diameter of Grains	
	2 μ	0.3 μ
Solubility per liter.....	2.08 g.	2.56 g.

That is, the concentration of a saturated solution in equilibrium with an excess of the solid salt is greater the smaller the particles of the solid. This can mean only that the small particles are less capable of attracting atoms or molecules from solution than are the larger particles. The actual observed effect upon the solubility

is small, and is smaller the larger the size of the particles of excess solid. It is sufficient, however, to cause the size of the particles or crystals to increase by a process of solution and redeposition. Chemically speaking, the solution is unsaturated with respect to the smaller crystals but supersaturated with respect to the larger crystals. The former therefore dissolve and the material thus removed precipitates upon the larger crystals.

Entirely similar phenomena are observed in metals. The most familiar example is that of cementite (iron carbide) in iron. If a steel containing, say, 0.90 per cent carbon is hardened by quenching in water from about 760 deg. C. and then tempered by reheating to about 400 deg. C., it is obtained in a structural condition which is metallographically termed "troostite." Although the structure of troostite is irresolvable under the microscope, it is quite certain that it consists of submicroscopic crystalline particles of cementite imbedded in ferrite (iron). Now, if the steel is heated for several hours at a temperature of about 700 deg. C., the cementite particles become visible, and on continued heating can be observed to grow. They are not directly connected with each other in any way, so the transfer of material from one particle to another must take place through the ferrite. The smaller particles dissolve in the ferrite until a solid solution is formed which is supersaturated with respect to the larger particles. Precipitation then occurs on these larger particles, with the net result that they grow at the expense of the smaller particles. Physically this means that the larger particles have stronger attractions for their constituent atoms than do the smaller particles.

The general principle here illustrated is that in an aggregate of grains of various sizes, the larger grains tend to grow at the expense of the smaller. If we assume a condition in which all of the grains are of exactly the same size and similar in other respects, there is a balanced condition with no opportunity for grain growth, even though the tendency for growth is present, due to the fact that the thermal stability of the aggregate would be increased by an increase in grain size. The grains all possess equal powers of orientation, however, so that there is no resultant growth-force. Grain growth thus depends on a *difference* in grain size, or on what may be called grain size contrast.

While the orienting power of a crystal probably increases with its size almost indefinitely, there is ample evidence that the rate of increase is most rapid when the size is very small, and may become practically negligible for larger crystals. Thus the effect of crystal size on the solubility of salts is appreciable only for relatively small crystals. Similarly the growth of cementite particles in steel becomes very slow after they have reached a diameter of about 0.00004 in. The actual extent to which such growth proceeds is determined largely by the temperature, since a higher temperature is necessary to facilitate growth when the growth-force is small.

Meissner[1] has recently determined the effect of particle size upon the melting point of myristic acid and found that this temperature is lowered about 0.5 deg. C. by decreasing the particle size from 10 μ to 0.8 μ This phenomenon is another illustration of the fact that very small particles of solid have less attraction for their atoms or molecules than do larger particles.

The growth of certain grains in a metallic aggregate at the expense of others may be regarded as a competitive process. At the boundary between two adjacent grains there is a competition for the surface atoms, or the atoms of the essentially amorphous cement which probably surrounds the grains. The grain which has the greater orienting power attracts atoms from the other grain, and thereby grows. Drawing an analogy with vital processes, we may say that the grains have definite powers of attack and defense, and that the stronger grains feed upon the weaker. Power of attack and of defense is of course synonymous with that we have called orienting power. Orienting power depends upon grain size. The tendency for growth or the growth-force depends upon a difference in orienting power. This difference increases with the disparity in grain size and with the smallness of the smaller grain.

To sum up the above discussion, the causes favoring grain growth are:

1. Small grain size.
2. Grain size contrast.

The importance of grain size contrast as a cause of growth has been questioned by some students of the subject and has recently been emphatically denied by Carpenter and Elam[2] as a result of observations purporting to show the absorption of large grains by small ones. These observations are open to two serious objections:

1. They were made on plane sections, and grains which appear small on such a section may actually be very much larger. Given any two adjacent grains of which one is only moderately larger than the other, it will usually be possible to pass through them a plane on which the sections of the grains are reversed in size. It is therefore a mathematical probability that when the differences in grain size are not great there will be on any section including a large number of grains some cases where the larger grains appear to be the smaller. In the discussion of Carpenter and Elam's paper this objection was raised and has not been satisfactorily answered.
2. The alloy of tin and antimony used in their experiments is very soft and susceptible to strain in the polishing operation. It is therefore quite possible that an observed large grain apparently intact had actually been broken up into very much smaller fragments. There is no reason why a small unstrained grain should not absorb a large strained grain; this is in fact more probable than the reverse phenomenon.

The present authors do not know of any well-established case of the absorption of a large unstrained grain by a smaller grain. Even if some such cases should be established, however, they would merely show that some of the other factors which have been mentioned may occasionally overbalance the grain size contrast factor, and would furnish no basis whatever for the dogmatic statement that grain size contrast is not important as a cause of growth. On the other hand there is abundant positive evidence of the strongest kind that the grain size contrast principle is important and usually dominant.

Temperature and Obstruction Limiting Conditions

The presence of a growth-force due to the causes just described will not result in grain growth if the temperature is too low or if the mechanical obstruction to growth is too great. The factors are mutually interdependent. With given conditions as to mechanical obstruction, grain growth will occur at a lower temperature the greater the growth-force; or conversely, the less the growth-force the higher the temperature required to bring about grain growth. With a given growth-force the temperature required to bring about growth increases with the amount of mechanical obstruction. Thus grain growth is controlled by three factors: (1) *grain size;* relative and absolute, which determines

[1] "The Influence of State of Division on the Melting Point," Meissner, *Z. anorg. Chem.*, vol. 110, pp. 169-186, March 12, 1920.

[2] "Crystal Growth and Recrystallization in Metals," Carpenter and Elam, *J. Inst. Metals*, 1920, No. 2.

the growth-force or tendency for growth to occur; (2) *temperature,* which is equivalent to atomic mobility and determines whether the growth-force can overcome the rigidity of the metal; and (3) *obstruction,* which mechanically hinders and sometimes entirely prevents grain growth.

Metastable Equilibrium

Grain growth may fail to occur or having started may come to a halt as a result of unfavorable conditions in respect to any one of these three factors. The growth-force may be so small that even in the purest metal grain growth will not occur at any temperature short of the melting point. This is the condition that ordinarily obtains in metals solidified from the molten state and not subjected to any form of deformation. It is quite natural that this should be the case, in view of the rapidity of grain growth at temperatures near the melting point. The short time which elapses during even the most rapid solidification is sufficient for the growth-force to be reduced by the process of grain growth to such a point that no further growth will take place at lower temperatures even when maintained for long periods of time.

It is quite common to find fairly marked grain size contrast in cast metals in which it is not possible to bring about grain growth. A common example is found in ingots at the junction of the columnar grains which grew out from the mold walls with the equiaxed grains in the central portion of the ingot. Such observations have been considered by some to be inconsistent or even incompatible with the grain size contrast principle. While granting that the failure to obtain grain growth under these conditions may be influenced by the shapes of the grains or their contours, the present authors consider that the grain size principle alone is sufficient to account for the facts. While the grain size contrast may in some of these cases be considerable, the actual grain size is never very fine, in comparison to the grain size of worked metals. It is this general coarseness of grain in cast metals to which may be attributed their failure to exhibit grain growth on heating at temperatures below the melting point.

There is reason to believe that grain growth, in the solid state, does occur in cast metals during the process of solidification. An example was described earlier in this article[3] of a tungsten rod, the axial portion of which had been melted by an electric current and then allowed to resolidify. It was pointed out that whereas we might expect to find the grains formed during resolidification starting from the unmelted grains as nuclei, what we do find in fact is that the new central grains are vastly larger than the old grains in the outer rim, extending from this rim to the center of the rod. It is quite certain that in the initial stages of the resolidification the new grains actually did form upon practically all of the old grains in the rim and began to grow inward. The final result indicates very strongly that some of the larger grains absorbed their smaller and already solidified neighbors.

Upon annealing worked metals under certain conditions it has been shown that the final grain size depends very largely upon the annealing temperature. For the lower annealing temperatures the grain size depends to a large extent upon the degree of prior strain hardening, the rate of heating, time of holding at heat, etc., but at higher temperatures the effect of such variables is greatly reduced, especially if the metal is fairly free from growth obstruction, so that the annealing temperature is the principal factor determining the grain size. In other words, there is an apparent equilibrium grain size for each temperature. As the temperature of the metal is raised, grain growth takes place until the growth-force is reduced to a point where it can no longer cause growth under the existing conditions of temperature and obstruction. The metal is then in a state of metastable equilibrium as regards grain growth. In this condition the grains are usually fairly equal in size. Consequently, the normal grain growth which takes place on heating a worked metal consists merely in a change of structure toward the condition of metastable equilibrium for the temperature of the anneal.

Recrystallization Is Grain Growth

The replacement of a single strained grain by a number of unstrained grains of various orientations suggests that new crystalline nuclei are formed during the process of recrystallization. We know, however, that the strained grain has within it an abundance of nuclei in the form of fragments produced by deformation. It is more logical to suppose that recrystallization consists in the growth of some of these grain fragments to visible size than that entirely new nuclei are formed. A strained grain may be regarded as an aggregate of a large number of crystalline fragments each equivalent to a very small grain. This aggregate is not the same as an equal number of unstrained grains of similar size in annealed metal, since the boundary conditions are undoubtedly different. It is probable, too, that the change in orientation from fragment to fragment is very slight as compared with that from grain to grain in an annealed metal. In spite of such differences, the strained grain is actually an aggregate of smaller grains which, because of their small size and the size contrast unavoidably present, are especially susceptible to growth on heating.

When an annealed metal is plastically deformed, the action is most severe near the grain boundaries. The grain fragments formed are therefore smallest in these regions. Small grain size is conducive to growth at low temperatures, and it is therefore quite natural to find, on heating a strain-hardened metal under conditions of time and temperature which produce only partial recrystallization, that the new grains are first observed at the old grain boundaries. Long heating at low temperature might cause these first grains, by reason of their advantage in size, to absorb all of the grain fragments in the central portion of the old grain. In such a case the new grains could not possibly be smaller in diameter than one-half the least diameter of the strained grain. If the metal is heated quickly to a temperature well above that of incipient recrystallization, fragment growth will take place substantially at the same time in all parts of the old grain. This is probably what happens in ordinary industrial annealing.

An objection to this view that recrystallization is merely submicroscopic grain growth[4] is found in the belief held by some that during plastic deformation the grain fragments retain substantially their original orientation. It is a fact that the new grains which form from a strained grain upon proper heating have practically random orientations, all of which may differ from that of the original grain. If these new grains are held to have grown from the fragments of the old grain, then it must be considered that the fragments which acted as nuclei also possessed random orientations.

In view of the fundamental importance of the question, some experiments were made by means of X-ray analysis to determine whether or not new orientations are produced by

[3] Chem. & Met. Eng., vol. 26, No. 9, p. 403, March 1, 1922.

[4] "Recrystallization of Cold-Worked Alpha Brass on An Mathewson and Phillips, *Trans.*, A.I.M.E., vol. 54, p. 608

deformation. The methods and results have been presented fully in a recent issue of this journal[5] and will not be repeated here. The evidence was conclusive that new orientations *are* produced by the simplest types of deformation, such as rolling or pressing. A stricking illustration of change of orientation produced within a grain by twisting is shown in Fig. 1, reproduced from the same article. The definite proof that the grain fragments produced by the deformation of a single grain actually have mixed orientations removes the only valid objection to the view that recrystallizations is merely grain growth.

The actual amount of grain growth involved in the process of recrystallization is remarkably great considering the small change in temperature necessary for its accomplishment. The average grain diameter in a pure metal or solid solution alloy which has just been completely recrystallized is generally not less than about 0.0005 in. We have as yet no means of accurately measuring the fragment size in a strain-hardened metal, but we know that it is very small, since it requires only a slight deformation to produce slip bands upon a polished metal surface so close together that they cannot be resolved under the microscope. The much more severe deformations commonly effected in cold-working operations must produce fragments with diameters on the order of 0.000001 in. The increase in grain diameter during recrystallization is then about 500 to 1. In terms of grain volumes the increase is 125,000,000 to 1. The same ratio represents the decrease in the number of grains in a given volume of metal. Expressed in a slightly different way, 125,000,000 grain fragments unite during recrystallization to form one unstrained grain. The temperature change required to bring this about for ordinary periods of heating is usually not over 150 deg. C.

If a similar ratio of grain growth would be effected in the recrystallized aggregate whose grains average 0.0005 in. in diameter, the new grains would be ¼ in. in diameter. This is an enormous grain size for any normal worked metal. Such grain sizes are frequently obtained under germinative conditions as described in the second part of this article, but seldom as a result of normal grain growth, even on raising the annealing temperature from that of recrystallization to just under the melting point. This suggests that the commonly observed recrystallization normally takes place under what might be called germinative conditions.

We have seen that the recrystallization temperature is higher the less the previous strain-hardening. As a cause of grain growth, strain is merely a mechanical process of grain refinement. The greater the degree of strain the smaller are the grain fragments produced and consequently the lower the temperature at which grain growth, or recrystallization, will take place.

It is very important here and subsequently to keep clear in mind the fact that small grains or fragments facilitate growth because they are easily absorbed. In an aggregate of grains which are strained to various extents, the grains which are *least* strained are in a position to grow by feeding upon their more severely strained—i.e., fragmented—neighbors. It has been a common mistake to consider that, since strain leads to grain growth, the grains which are most strained are the ones which grow.[2] This fallacy seems to be based upon a false conception of the energetics of the case. It is held that energy is required to impart the power to grow, and that this energy must be stored in some way in the grain. The strained grain is therefore regarded as the one endowed with the power of growth. Actually the conditions are the exact reverse. The unit which does the growing is the grain of greatest thermodynamic stability and hence *least* energy content. The logic of this is apparent on considering the conditions on the solidification of a metal from the molten state. The solid, unstrained grains feed upon the molten phase, which has the higher energy content.

Grain Growth in Electrodeposits

According to the conditions of deposition, electrolytic metal may be obtained in a soft, coarse-grained variety or in a hard form whose structure is so confused that Beilby was led to the conclusion that it is amorphous. Any gradation between these two extremes may also be obtained. If the harder varieties are annealed, they are found to have "recrystallized" very much after the manner of strain-hardened metal. Beilby attributed this to the formation of crystalline nuclei in the amorphous metal. Later researches have shown that the hard electrodeposited metal is predominantly crystalline. There is little doubt that the hardness and recrystallizing properties are due to a very small grain size, just as they are in strain-hardened metal. It is sometimes said that the metal is deposited in a "state of strain," which is correct if taken to mean a condition similar to that produced by plastic deformation. The essential feature in this state of strain is the great fineness of grain.

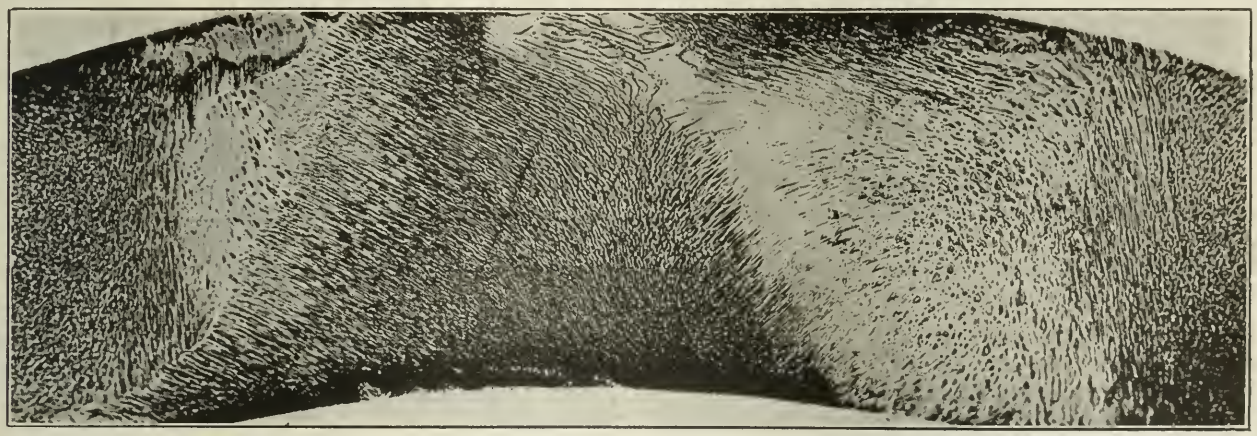

FIG. 1—SINGLE GRAIN IN TUNGSTEN WIRE, TWISTED COLD, POLISHED AND ETCHED. × 300. (TARASOV)

Metal Powders

Growth phenomena in metals formed from powders are exactly the same as in metals which have been melted and cast, although some writers would place them in a separate class. It has been erroneously stated that metal powders will not sinter to form a coherent mass when heated unless the pressure is sufficient to cause fusion at the temperature used. As a matter of fact, tungsten powder can be sintered below the melting point with no pressure except that due to its own weight. In fact it is very difficult to see how pressing a metal powder briquet could have any effect on the melting point except to raise it.

The particles of powder used in making tungsten briquets

[5] "Mixed Orientation Developed in Crystals of Ductile Metals on Plastic Deformation," Bain and Jeffries, CHEM. & MET. ENG., vol. 25, No. 17, Oct. 26, 1921, pp. 775-777.

are crystalline grains formed by reduction from tungstic oxide. It is possible that when strongly compressed some of these grains are plastically deformed. Any such strain-hardening should be removed before sintering takes place, as the sintering temperature is far above that of recrystallization. Sintering therefore consists in the union of unstrained grains accompanied by such boundary migration as is necessary, and usually by distinct grain growth. The grain size of a sintered ingot is never less than the size of the particles from which it was formed. Grain growth here is due to the usual causes—namely, grain size contrast and initial fineness of grain.

Germination

Consider the conditions of grain growth in the hypothetical case represented in Fig. 2. The small grains are supposed to be nearly alike in size, but sufficiently different to give rise to a growth-force capable of causing grain growth when the metal is heated to a suitable temperature, which we will designate *T*2. The small grains in contact with the few large grains are similar to those in the interior of the fine-grained regions. The growth-force is therefore much greater at the boundaries of the large grains than in the interior of the fine-grained regions and the large grains will grow at a lower temperature, *T*1. Now suppose the metal is heated to a temperature above *T*1 but below *T*2. The few large grains will grow at the expense of the small grains until the latter are entirely absorbed and the large grains finally meet one another. Grain growth will then cease on account of the great resistance of the large grains to absorption, and the resulting condition is represented in Fig. 3.

Suppose that instead of being heated to between *T*1 and *T*2 the metal is quickly heated to a temperature above *T*2. The large grains will then begin to absorb the small grains as before, and at an even greater rate. At the same time, however, grain growth will take place among the small grains so that presently the large grains will no longer encounter the very small, easily absorbed grains, but will meet grains of more nearly their own size, which have developed in the fine-grained regions. Grain growth may then cease, leaving the metal as shown in Fig. 4.

Conditions commonly found in metals differ only in degree from the extreme case just described. There are always some differences in growth-force from point to point in the metal, and corresponding differences in the temperature at which grain growth will begin. If the metal is heated at a temperature sufficiently high to cause grain growth at some points but not high enough to cause general growth all through the metal, conditions are favorable for the development of large grains. However, the points at which early growth begins may be so close together that the grains developed are no larger than those normal to the temperature used. On the other hand, if the centers of growth are far apart, abnormal grain growth results. It is this preferential growth of certain grains to abnormally large size which is termed germination.

All kinds of plastic deformation unavoidably produce local, if not general, strain gradients. The strain or fragmentation varies from one region of the metal to another, from grain to grain, and in different portions of the same grain. The greater the strain the lower is the temperature at which grain growth will take place on heating. Hence in a uniformly cold-worked metal it is the points of greatest strain which act as the centers of germination. The grain size produced will be larger as these centers are farther apart. This condition is favored by *slight* deformation. Severe deformation tends to make the strain or fragmentation more nearly uniform throughout the metal, and brings the points of equal strain closer together. Abnormal grain growth is therefore most commonly obtained after mild deformation.

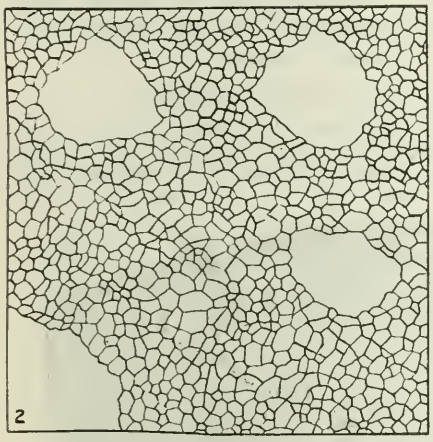

Fig. 2—Metal with moderate grain-size contrast.

Fig. 3—Same metal heated so that large grains grow.

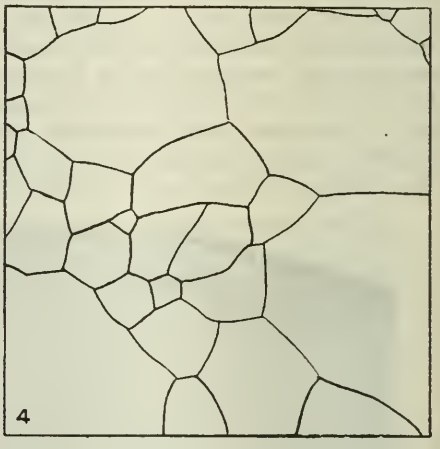

Fig. 4—Metal of Fig. 2 heated so that both sizes grow.

FIGS. 2 TO 4

Sauveur[6] found that a piece of mild steel stressed in tension to 40,000 lb. per sq.in. developed unusually large grains on annealing at 650 deg. C. If stressed to only 38,000 lb. per sq.in., this grain growth did not take place. This simply means that a stress of 40,000 lb. per sq.in. developed at a *few* points strain great enough to cause growth at 650 deg. C. in the time allowed. At 38,000 lb. per sq.in. the greatest strain produced was not sufficient to cause grain growth under these conditions. If a slightly higher temperature or a considerably longer time had been used, germination would have resulted in this case too. On increasing the stress to 42,000 lb. per sq.in. and maintaining the same conditions of annealing, grain growth occurred, but the grain size produced was comparatively fine. The centers of germination were in this case very close together.

When a metal is heated rapidly through the germinative temperature, the preferential growth of a *few* grains is prevented, because at the higher temperatures a very large number of grains are capable of growth. It might be said that they fail to attain abnormally large size because the competition is more keen.

The method of Ruder for producing excessively large grains in silicon steel and of Schaller for producing coarse-grain tungsten wire is based on a very simple type of

[6] "The Metallography and Heat-Treatment of Iron and Steel," A. Sauveur, pp. 265-271.

germination. The grain size of the starting material is sufficiently fine so that marked grain growth of the normal variety will occur at and above a suitable temperature which we will call *T*. The metal is then heated so that one region is above this temperature *T*, but the major portion is below this temperature. In the region heated above *T* grain growth will occur and there will be produced grains considerably larger than those in the colder or "inert" region, where no grain growth is taking place. (It appears that a certain amount of mechanical obstruction helps to prevent the coalescence of the small grains.) At the junction between the large grains of the growth region and the small grains of the inert region, conditions are ideal for the continued growth of the large grains at the expense of the smaller, exactly as in the hypothetical case described above in Fig. 2. The metal is now moved through the heated zone at a rate less than that at which the germinant

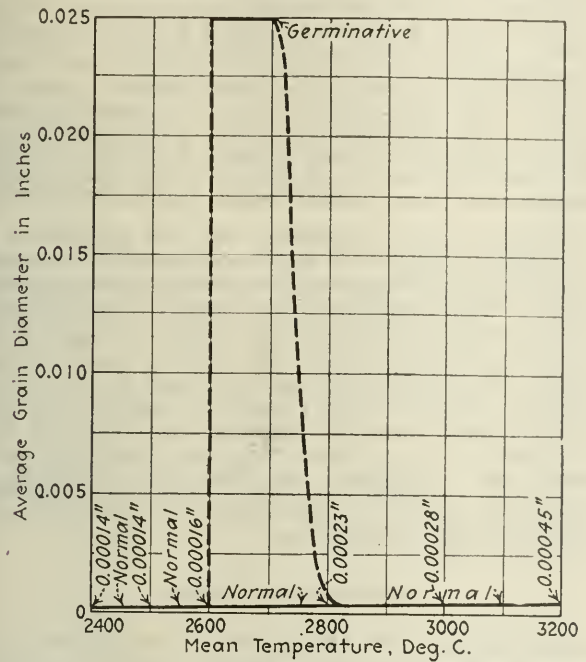

FIG. 5—GRAIN SIZE VS. TEMPERATURE FOR BRIQUETTED TUNGSTEN CONTAINING 0.75 PER CENT THORIA

grains can absorb the inert ones. Advancing the line of the growth temperature *T* at a faster rate would defeat the production of coarse grains just as does rapid heating through the germinative temperature.

The samples from which the "germinative" curve in Fig. 5[7] was obtained illustrates the effect of a temperature gradient nicely. When heated to an average temperature of 2,600 deg. C. by electric current and maintained for about 10 minutes, a few large grains formed about midway between the axis and surface of the rod. The hotter portion, near the axis, was composed of larger grains than the cooler surface portions. This shows that growth had taken place near the axis, but not at the surface. The few large grains were located at the boundary between the axial portion which may be called *growth range* and the surface portion or *inert range*. The inert grains were only inert in so far as concerns absorption by grains of their own size. Before heating, the grain size or particle size was uniform from axis to surface of the briquet. Of course there were local differences, but no general differences. A mean temperature of 2,600 deg. C. was proper to cause growth in the hotter axial portion, but not near the surface. There must then be a boundary between the growth and inert regions. The inert region is inert because of lack of grain-size contrast. Some grains in the growth range at the boundary between growth and inert regions increase sufficiently in size to absorb the inert grains and hence greatly increase in size. These grains are the "germinant" grains. The grains well within the growth range are small compared to the germinant grains, because of lack of grain-size contrast. When the germinant grains reach a size considerably larger than the grains in the growth region the latter are absorbed. The germinant grains then grow toward the surface and toward the axis, eventually producing a very coarse-grained structure as indicated in Fig. 6. The various grain sizes produced by varying the rate of heating through the germinative temperature range in these samples are in exact accord with the hypothetical case cited in Figs. 2 to 4. If the temperature is lowered a little below 2,600 deg. C., the germinant grains form nearer the axis, and with mean temperature a little above 2,600 deg. C. they form nearer the surface.

In the germinative conditions due to obstruction (Fig. 6) it was observed that the germinant grains formed first near the surface of the briquet in the 2.5 per cent thoria sample, about half way between the axis and surface in the 3 per cent thoria sample and near the axis in the 4 per cent thoria sample. The boundary between growth and inert ranges (germinative temperature) was thus at higher temperatures for the greater amounts of obstruction.

It is evident that the presence of a strain gradient in a piece of metal may lead to germination even on uniform heating. When the strain varies continuously as in Chappell's tapered bar,[8] there is some region where the degree of strain is just right to cause germination at the temperature used. After germination has taken place we have a condition similar to that described above —that is, a region of very large grains bordering on the unrecrystallized region of very small grain fragments. Grain growth will then proceed to some extent into this region, but will come to a halt when the strain decreases to a certain value. It should be especially noted that when there is a strain gradient germination may be obtained at any temperature within a rather wide range. When the strain is substantially uniform, there is only one temperature, or a narrow range of temperature, at which coarsening will take place. For this reason the chances of obtaining coarse-grained structures in industrial annealing or under high temperature service conditions is much greater when the strain is not uniform.

The important effect of the obstruction factor on germination has been pointed out. We have seen how germination in steel is most marked for a certain range of carbon content (0.04 to 0.12 per cent). In tungsten

[7]Reproduced from Fig. 26, Section II of this article, CHEM. & MET. ENG., vol. 26, No. 9, p. 408, March 1, 1922.

[8]Fig. 25 of Section II of this article, CHEM. & MET. ENG., vol. 26, No. 9, p. 407, March 1, 1922.

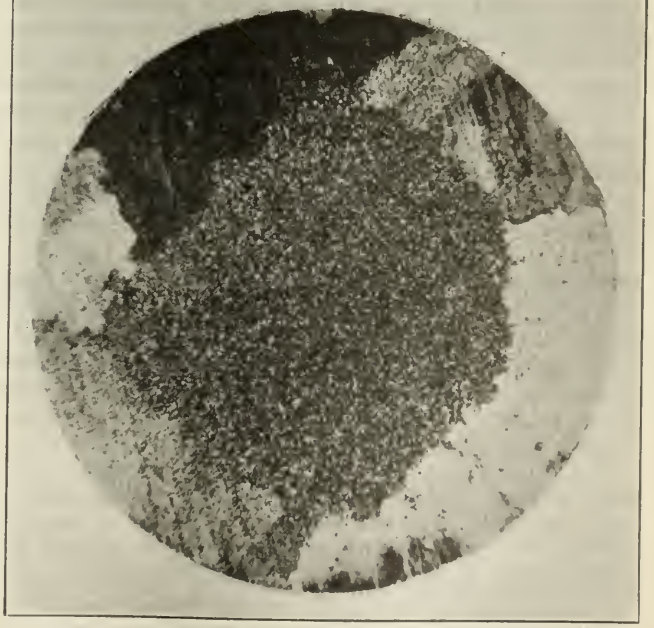

FIG. 6—GERMINANT GRAINS IN POSITION TO ABSORB SMALL GRAINS TUNGSTEN. × 25

heated under certain conditions the addition of a small amount of thoria refines the grain. More thoria causes germination, with the production of relatively enormous grains. Still more thoria inhibits growth to such an extent that no abnormally large grains are produced below the melting point. The same cycle has been shown to obtain on the solidification of a certain aluminum alloy under constant cooling conditions. The first addition of obstructing material refined the grain. A further addition caused marked coarsening, and a still further amount again refined the grain. It is not to be inferred from these examples that the progressive addition of obstruction always results in germination. Germination is in fact the exception rather than the rule. When germinative conditions *are* produced, however, the rule is that the progressive addition of obstructing material causes, first, refinement, then coarsening, then refinement. Often the first stage is not marked—that is, the first addition of obstruction may not produce a grain size noticeably smaller than in the pure metal. The germinative stage is most marked, and the return to normal grain size on the addition of more obstruction is of course equally apparent.

On analyzing the conditions under which these cases of germination occurred, we find that in Sauveur's uniformly stressed bars the coarsening resulted from local strain gradients, while in the tungsten briquets temperature gradients are responsible. In the solidifying aluminum alloy temperature and concentration gradients exist and there is unavoidably at any one time a difference in the size of the newly formed solid grains which corresponds to a strain gradient. These three cases therefore involve the principal factors which at various times cause germination. The fact that the effect of progressive additions of obstructing matter follows the same law in all cases indicates a similarity of mechanism.

Differential Growth Variety

Any case of germination in the solid state depends upon the existence at some stage of a marked grain size contrast as pictured in Fig. 2 or as described in connection with the Schaller process. This condition is always present when there are strain gradients, either general or local, since strain is equivalent to grain fragmentation. At other times, however, the grain-size contrast is not present in the original material, but is developed during the heating as the first stage of the germinative process. This is true of the Schaller process and in general of cases where germination is brought about by temperature gradients. Once this condition of grain-size contrast obtains, it is necessary, in order for germination to proceed, that the metal be held at a temperature where the rate of growth of the larger grains is very great as compared with that of the smaller grains among themselves. We may state the condition for germination as follows: *The existence of marked grain-size contrast in a metal at a temperature which permits absorption of the small grains by the larger, but not growth among the smaller grains.*

Germination thus depends upon a sharp difference in the rate of grain growth from point to point in a metal. It seems probable that the important effect of mechanical obstruction on germination is brought about through the establishment of such differences in growth velocity. We may well suppose that a given obstructing material, present in given quantity and mode of distribution, exerts its maximum obstructing effect on grain growth with respect to grains of a certain size. If such is the case, then the presence of obstruction may accentuate the differences in growth velocity already present because of varying grain size, and thereby increase the probability of germination.

Suppose an obstructing material to be present in a metal to an extent of 1 per cent by volume, and to be uniformly distributed in the form of spheres having an average diameter of 0.0001 in. Assuming for the purpose of calculation a simple cubic distribution, the shortest distance between particles is about 0.0004 in., or about four times the diameter of the particles. Now suppose the grains of the metal to be smaller in diameter than the particles. It is obvious that the particles can have no important effect on the growth of such small grains, since so few of the grain boundaries come in contact with them. If the grains are about the same size or slightly larger than the obstructing particles, the interference with grain growth will also be small in the present case, because of the distance apart of the particles. When the average grain diameter is of the same order of magnitude as the distance between obstructing particles, we may expect a rather marked hindrance to growth. Grains of very much larger size should suffer less interference because the relative distortion of their boundaries by the obstructing particles during growth by boundary migration would be less. It is therefore reasonable to assume that the obstruction to grain growth due to discrete particles scattered through a metal is greatest for a certain range of average grain diameter which is approximately equal to the average distance between particles.

According to this hypothesis, the first addition of an obstructing material to a metal would restrict the growth chiefly of the *larger* grains. Since these grains are already endowed with superior power of growth, the presence of such an amount of obstruction would *decrease* the difference in growth velocity between the larger and the smaller grains. The growth of grains of all sizes is opposed to some extent so that the general effect may well be one of grain refinement. Upon further addition of obstruction, a point will be reached where the maximum retarding effect is on those smaller grains upon which the larger germinant grains feed. Conditions are then most favorable for germination. Still further additions of obstructing material may so increase the general resistance to growth that all grains are kept relatively small.

Formation of Nuclei

It has been stated above that in the opinion of the present authors no new crystalline nuclei are formed during recrystallization. There is no evidence that such nuclei are formed except on the appearance of a new crystalline phase, which occurs in the following cases: 1. Solidification from the molten state. 2. Allotropic transformation. 3. Separation from solid solution. 4. Electrodeposition. The first two of these are most important in connection with grain growth.

Growth of the nuclei proceeds by two distinct processes. First, they feed upon the unstable disappearing phase—that is, the molten metal or the unstable allotrope (as the case may be). Secondly, if the temperature and other conditions are suitable, the larger of the new crystalline units grow at the expense of the smaller by the processes of ordinary grain growth. The resulting grain size therefore depends both upon the conditions affecting nuclei formation and upon the conditions affecting grain growth in the new phase.

Both of these factors are illustrated in the allotropic transformation of iron at A_3 (about 900 deg. C.). Suppose a piece of iron at a temperature above A_3 to be cooled very slowly from one end, so that there is a continuous temperature gradient toward the hotter end. As the cooler end passes A_3, grains of the new crystalline phase appear and grow at the expense of the adjacent disappearing high-temperature allotrope. If a sufficiently sharp temperature gradient can be maintained and advanced at a rate slower than the velocity of grain growth, the grains first formed might sweep the entire piece of metal, as in the Schaller process. Slow cooling through A_3 accompanied by temperature

gradients is therefore conducive to the formation of coarse-grained ferrite.

Slow cooling alone produces distinctly larger grains than rapid cooling. This is attributable to grain growth in the ferrite just after cooling through the A_3 temperature. The rigidity of the metal at this temperature is so great that it is possible to form completely the new phase with a grain size much smaller than the equilibrium grain size. Any exposure to temperatures immediately below A_3 therefore results in normal grain growth.

Other conditions being the same, the grain size of the new allotrope formed on heating or cooling through A_3 is roughly proportional to the grain size of the modification from which it was formed. This principle, which has been called "grain-size inheritance," is believed to depend on the fact that the nuclei of the new phase form most readily in the old grain boundaries.[9]

The fact that grain growth is seldom if ever observed on reheating single-phase cast metals is perhaps responsible for a rather general belief that there is no growth at the expense of *solid* grains during the solidification of metals. This belief leads to the conclusion that all of the crystalline nuclei formed persist, so that the number of grains in the solid metal is equal to the total number of nuclei formed during solidification. The grain size of a cast metal is then held to be a direct consequence of the laws of nuclei formation. This theory of the solidification of metals has been particularly developed by Tammann.[10]

The present authors have indicated above their opinion that normal grain growth involving the absorption of solid grains occurs during and perhaps shortly after solidification. On this basis, the number of grains left on cooling is very much less than the number of nuclei formed. There is considerable evidence that actual solidification is preceded by the formation in the liquid of groups of atoms which are essentially crystalline nuclei and yet obviously some of these groups are absorbed by others during solidification.

Germination in a solidifying alloy may be explained in very much the same way as germination in a solid metal. In the case cited, the first addition of obstructing material caused general interference with growth, but with a maximum effect on the larger potentially germinant grains. A further addition produced germinant conditions by exerting a maximum obstructing effect on the smaller grains, thereby preventing them from coalescing into large grains of greater resistance to absorption. Finally, the obstruction became so great that no grains could attain abnormally large size.

The Distortion Theory of Grain Growth

Within recent years there has been developed, largely by Czochralski,[11] an interesting theory that grain growth is caused by varying distortion of the crystal lattice. It is known that when a metal is cold-worked, internal stresses are left which must necessarily involve elastic distortion of the grains or grain fragments. It is also quite certain that the amount of relative distortion varies from grain to grain. The grains which are distorted the least are most stable and are, from the thermodynamic point of view, in a position to grow at the expense of the more severely distorted crystalline material. The distortion theory postulates that when such growth takes place, the atoms added to a grain arrange themselves in a lattice having exactly the same degree of distortion as that of the growing grain. Grain growth then involves a progressive decrease in the elastic energy of the metal due to lattice distortion. At any given temperature a state of metastable equilibrium is reached.

On heating to higher temperatures, the decreased inertia enables more growth to take place, always with a differential distortion as the cause.

This theory accounts very nicely for the absence of growth in unstrained castings, and fits in well with many of the grain growth phenomena. It depends, however, upon an assumption (which appears to the present authors so improbable as to require quite definite proof) that lattice distortion and hence internal stress exists in metals which have been fully annealed. The effect of heat upon internal stresses has been fully investigated in connection with the season cracking of brass, and it has been found that these stresses are reduced to a vanishing point by annealing *below* the temperature of recrystallization. It does not therefore seem likely that at temperatures several hundred degrees higher any appreciable distortion can exist. The surface energy due to small grains is present at all temperatures, and can be reduced only by grain growth. On the other hand, cast metals can be obtained in a condition of internal stress nearly equal to the elastic limit and involving practically the maximum possible lattice distortion in some of the grains, which distortion can be removed on heating without causing any grain growth. Such considerations lead to the conclusion that surface energy is the principal cause of grain growth.

General Propositions

1. Crystalline nuclei are formed only on the appearance of a new crystalline phase.
2. Crystalline nuclei may grow by the absorption not only of the disappearing phase but also of each other, so that the final number of grains may be less than the total number of nuclei formed.
3. Grain growth results from the tendency of metals to assume the form of greatest possible physical stability.
4. The principal conditions conducive to grain growth are small grain size and grain-size contrast.
5. Grain growth is opposed by mechanical obstruction and by inertia due to low temperature.
6. A condition of metastability as regards grain growth must be recognized, in which, while the metal is not in the most stable form, the forces tending to cause grain growth are insufficient to overcome the opposition to growth. As the temperature rises, this condition of apparent equilibrium approaches that of maximum stability.
7. Recrystallization is essentially grain growth on a submicroscopic scale.
8. Germination consists in the preferential growth of certain grains favored by their large size. The necessary condition is the existence of grain-size contrast and suitable temperature such that the larger grains can grow at a considerably more rapid rate than the smaller grains.
9. There is a critical amount of mechanical obstruction which favors the establishment of this necessary difference in growth velocity and hence germination.

Lead and Zinc Tailings May Be Used as Fertilizer

Tailings from the lead and zinc mines of southwestern Wisconsin may be used by farmers in that vicinity for fertilizer. After experiments with this byproduct at the Wisconsin University it is claimed that it may be a satisfactory source of lime for correcting soil acidity. The experiments further indicated that there are no dangers from the possible poisonous effect of the lead and zinc or the development of sulphuric acid through the oxidation of the sulphide. Quantities as large as 4 or 5 tons to the acre have been used without injurious results and with marked benefit to the clover and alfalfa. The better grade tailings, if dried and ground, would be satisfactory for shipment.

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[9] "Grain Size Inheritance in Iron and Carbon Steel," Zay Jeffries, *Trans.*, A.I.M.E., vol. 58, pp. 669-695 (1918).

[10] Text Book of Metallography, in German, 1914.

[11] "International Zeit. für Metallographie," vol. 6, pp. 289-296 (1914). Also Masing, "Zeit. für Metallkunde," vol. 12, p. 457 (1920).

High Temperatures in Industrial Processes

Use of Various Liquids and of Superheated Steam for Transmitting the Heat Required in the Preparation and Processing of Chemicals and Allied Materials—Development of Direct-Fired Tubular Heaters for Use in the Process Industries

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ONE of the difficult problems confronting the combustion engineer is to obtain the high temperatures often required in modern manufacturing processes in which overheating is likely to result in a loss of products. The solution of such a problem necessitates a thorough working knowledge of the many methods which may be employed as well as the ability to select from these the one which is best adapted to the peculiar characteristics of the particular process. As a matter of fact, the difficulty lies as much in the choice of the most efficient method as it does in its design or application. For example, a chemical manufacturer will commit a serious economic error if he selects, out of the several different methods which are available, one with high operating or maintenance charges. Any decision should be based on a thorough study of the relative advantages and limitations of each of the possible methods.

For the purpose of this article, high temperatures will be considered as those which are higher than can be obtained by the use of steam under moderate pressure. The methods to be considered will be limited to applications in which the delicate nature of the product precludes the use of a direct-fired kettle. By using steam at 150 lb. pressure in a closed coil or jacket, a temperature of approximately 350 deg. F. could be obtained in the product. Where temperatures higher than this are necessary in a plant having only ordinary boiler equipment and cast-iron fittings, a different sort of heating medium is required. It will be useful to consider the various methods available for this purpose, discussing in each case the characteristics which might either recommend or preclude the practicability of each for use in a particular case.

Transmission of Heat by a Liquid

The transmission of heat by a liquid consists in circulating a high-boiling liquid as a medium for conveying the heat from a direct-fired heater to the heating tank. The liquid is kept in continuous circulation by a pump between the heater and a coil placed in a tank containing the material to be heated. As the liquid travels through the tubes of the heater its temperature is raised and its total heat content is increased proportionately. Subsequently in passing through the coil or jacket of the heating tank the heat is transferred from the circulating liquid to the material being heated. Thus the liquid in the system is kept in continuous circulation and is always maintained at a higher temperature than the material to be heated.

A mineral-oil distillate of high flash point is the liquid most commonly used. The oil gives satisfactory results, as it is easy to pump, has a specific heat of about 0.5 and need not be kept under any pressure except that required to give the necessary pumping head and to exclude air. If a liquid of a lower boiling point is employed, a considerable pressure has to be carried on the system in order to keep the liquid from vaporizing. It is possible to obtain temperatures as high as 550 or 600 deg. F. by employing this method with oils now available. The limiting factor as far as high temperatures are concerned is the temperature at which the oil will crack. Overheating and possible burning of the tubes of the heater can often be attributed to the carbon deposited during the cracking or burning of the oil.

A high efficiency can be obtained by the circulation of a hot oil, due to the fact that the same oil is reheated continuously, and that no heat is lost by either rejecting the heated oil from the system or reheating make-up material. The two factors which limit the efficiency of the system are the economy developed in the oil heater and the radiation losses suffered by the oil in traveling from the heater to the heating tank. It is obvious that the oil heater should be located as close as possible to the heating tank and that the pipe lines carrying the oil to and from the tank should be well insulated. The radiation losses at fairly high temperatures in the tank are very large. Whereas it might not pay to go to the expense of lagging a tank which contains the material at 200 deg. F., it would be entirely a different matter if the temperatures were 400 deg. F. or above. Other conditions remaining constant, doubling the temperature difference between the material and the outside air will double the heat lost by radiation.

Design and Operation of Oil Heater

Having reduced the radiation losses to a minimum, the residual overall efficiency of the system depends entirely upon the design and operation of the oil heater. It should be remembered in this regard that the flue gas temperatures from the heater cannot be lower than the cool oil returned from the heating tank. Let us assume, for example, that the heater is designed along counter-current principles of flow with the coolest oil meeting the coolest gases. In this way the flue gas temperatures are reduced to the lowest possible point. But if the oil is being circulated at a high temperature with a small drop in going through the heating coil, it will necessarily follow that the gases will leave the heater at a fairly high temperature. A definite problem will serve to bring out this point. In certain acid-treating processes it is necessary to obtain temperatures of 400 deg. F. For this purpose the circulating oil passing through the heater will be raised in temperature to 475 deg. F. In passing through the heating coil and back to the heater inlet the oil loses 50 deg. F., which means that the oil at 425 deg. F. will meet the waste gases just before they are discharged. In order to make the surface at this end of the heater effective.

the gases must leave at a temperature slightly above the oil which they are to heat. For this reason the gases could probably not be cooled below 500 deg. F.

Assuming that complete combustion is being obtained in the heater, an efficiency of 70 per cent could be maintained even with the waste gases at 500 deg. F. To get the ultimate efficiency of the actual transfer of heat from the fuel to the product, deduction must be made for radiation losses. If all parts of the equipment are well insulated, this loss in the average case should not exceed 10 per cent. On this basis, therefore, a high-temperature effect could be obtained at about 63 per cent efficiency, and even in unfavorable cases this should not fall below 50 per cent.

As has already been stated, the temperature which can be developed with this method depends upon the temperature at which the oil can be circulated without danger of cracking. Even where the oil is to be circulated at temperatures which are well below those at which cracking might be expected, extreme care must be taken to avoid local overheating. Improper circulation or faulty combustion in the furnace might cause overheating and cracking of a portion of the oil in some tube section. The deposit of carbon resulting prevents transfer of heat through the tube to the oil passing on the inside, resulting in overheating and possible burnouts.

The danger of leaks in the oil heater and consequent fire hazard have been the subject of some objections to this system. However, if all joints of the heater are located outside the path of the hot gases, there is no danger of an oil leakage causing a fire and thus this danger is eliminated. Provision should also be made that a leak in a tube itself will not pour oil down into the combustion chamber.

The use of a circulating oil for heating in this way has been in very common use for the last 10 or 12 years. The close control possible has brought it into great demand in the many processes in which temperature fluctuations would be ruinous to satisfactory results. A list of products which have been treated in this way would require more space than is available in this paper, but among them might be mentioned some of the more important, such as paints, food products, acids, soaps, asphalts, vegetable oils and various chemical products.

Use of Superheated Steam

Superheated steam may be successfully employed for high-temperature heating in many different ways. All of these methods, however, may be classified under two heads according to whether the steam is actually mixed with the material to be heated or is employed indirectly in coils or jackets.

The direct use involving the injection of steam directly into the mass of the material to be heated is the more simple of the two methods and its advantages are more apparent. Fundamentally superheating steam is not only raising its temperature but is also increasing its total heat content. Just how much certain degrees of superheating add to the heat in a pound of saturated steam at 100 lb. pressure is shown in the following portion of the steam tables:

Degree of Superheat		Total Heat per lb. Above 32 deg. F. in B.t.u.	Percentage Increase in Heat Content Over Sat. Steam
Saturated	0	1,189	0
	100	1,243	5
	200	1,293	9
	300	1,342	13

It is therefore apparent that if it is desired to heat up a specified weight of liquid to a certain temperature it can be done with a smaller weight of steam by superheating. The figures given are based upon a comparison between dry saturated steam and steam with varying degrees of superheat. In actual practice the comparison is even more favorable to superheating, because the saturated steam suffers considerable heat loss, producing condensation. This appears as moisture in the steam, the amount varying with conditions such as the distance the steam must be piped to the heating tank. Superheating eliminates this moisture and thus makes an additional saving.

An idea of how superheating cuts down radiation losses may be gained from the following record of test on a long pipe line. It will be noticed that besides eliminating moisture superheating also reduces the drop in pressure.

Test Taken on 4-In. Line 500-Ft. Long, and Well Covered

Initial boiler pressure, lb.	120
Drop in pressure in line, lb.	3
Superheat at superheater, deg. F.	140
Superheat at end of line, deg. F.	90
Loss of superheat, deg. F.	50

In the heating of many substances the required temperatures cannot be obtained with saturated steam at ordinary pressures and often these pressures cannot be raised because of the condition of the boiler and steam piping. In instances where such conditions exist the steam has been superheated before being blown into the material and the necessary temperature increase obtained. The heating of vegetable oils for purposes of deodorization is an excellent example of this application. In the deodorization of these oils certain odoriferous constituents are volatilized. The temperatures at which these substances can be vaporized is in many cases above that of medium-pressure saturated steam. As steam can be superheated to a high final temperature regardless of its pressure, the oils can easily be raised to the desired point by the installation of a superheater. Also in many processes the agitation obtained by blowing superheated steam into the mixture is an important consideration.

Use in Closed Coils or Jackets

The successful use of superheated steam for heating in coils or jackets is by no means a simple problem, although in some cases it can be utilized with good economy and satisfactory results. It should be definitely noted, however, that it cannot be used in the same way as saturated steam. Often attempts are made to obtain high temperatures in a material in a kettle by merely substituting superheated steam for saturated steam in a closed coil. The results obtained are practically always disappointing.

Let us assume that we have a kettle equipped with a heating coil which has a trap on the outlet. Superheated steam is allowed to fill the coil. Before any of this steam can condense, the superheat must be given up. Consequently part of the coil is filled with saturated steam and no more superheated steam can enter until this is condensed. The temperature effect produced by this portion of the coil is therefore that of the saturated steam. The part of the coil nearest the inlet is filled with superheated steam, but even this heating surface does not afford a higher temperature. As shown in the section of the steam tables previously cited, superheating a pound of steam 100 deg. F. adds

5 per cent to the total heat content. On the other hand, it increases its volume 17 per cent.

The part of the coil filled with superheated steam therefore contains 17 per cent less steam than it would if the steam were saturated. As this superheated steam has only 5 per cent more heat per pound, it is obvious that there would be less heat units present than in the case of saturated steam. A temperature effect is after all dependent upon the transfer of the requisite number of heat units to produce the necessary increase; therefore the cutting down of the total heat content of a part of the coil will not produce any higher temperature. In addition to the fact that there are less heat units present, these heat units are given off but slowly because superheated steam parts with its heat so reluctantly. It therefore follows that superheated steam cannot usually be employed in a closed jacket or coil to obtain a higher temperature than saturated steam would have afforded.

If superheated steam is to be used to obtain high temperatures, then it must be allowed to circulate at a high rate through the coil or jacket and must leave the heating surface usually with some degree of superheat remaining in it. Thus it would be possible to heat a material up to 700 or 800 deg. F. by superheating steam to 1,000 deg. F. and allowing it to blow through a coil in a kettle. In this case, however, during the latter part of the operation the steam would have to leave the coil at temperatures above 800 deg. The practicability of this method of heating depends upon whether the heat remaining in the steam when it leaves the coil can be utilized. In some plants it has been found possible to connect up the coils of several kettles in one continuous series, staging the operation of the kettles down in temperature so that the steam can leave the last one at a fairly low temperature. The superheated steam of the highest temperature enters the high-temperature kettle and travels on to where its lower temperatures still provide a heat head. Usually this steam has no remaining superheat upon leaving the last coil and is then used in feed water heating or in some operation where the saturated steam can be condensed and the latent heat recovered.

Use With Series of Coils or a Series Superheater

The method of passing superheated steam through several coils in series gives the steam a long travel through small pipes and usually exhausts practically all the pressure in the steam. In certain cases the amount of material to be raised to a high temperature is so small that only a small coil is required. Superheated steam can be passed through such a coil with a small drop in pressure and the high-pressure saturated steam upon leaving the coil can be fed to engines or pumps. In this application the saturated steam has acted merely as a conveyor for the high-temperature effect of superheat to the process. As far as the economy of the saturated steam on the engine equipment is concerned nothing has been lost except a few pounds pressure. Moreover, if the material to be heated required a high temperature, the steam would leave the coil with considerable superheat remaining and the economy thereby produced on the engine would more than make up for the slightly lower pressure.

A series superheater has also been employed to resuperheat steam several times, alternately heating it and delivering the high-temperature heat units to a process. As this method involves using the same saturated steam to get a high-temperature effect by superheating it five or six times, only a small weight of steam is required and the economy obtained is very high.

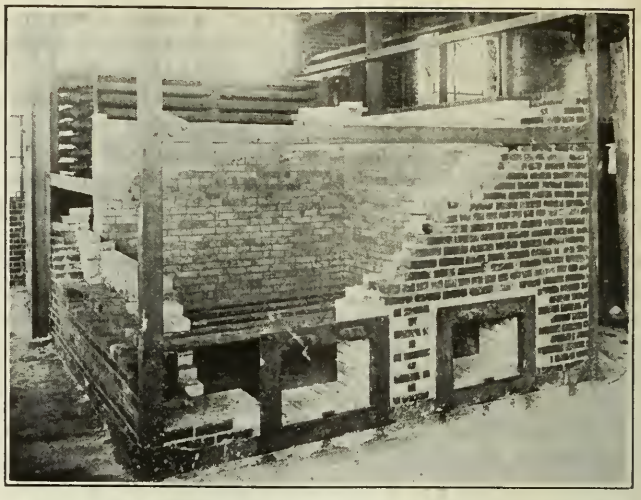

FIG. 1—DIRECT-FIRED TUBULAR HEATER FOR VEGETABLE OILS (UNDER CONSTRUCTION)

View shows armored heating surface placed behind protecting bridge wall.

In one plant where this system is employed they have been able to demonstrate an efficiency of 75 per cent. The design and installation of such a system are complicated and are usually intrusted to experts in the use of superheated steam.

Direct Heating of Materials

While it will not be attempted in this paper to discuss all the heating problems which can be solved successfully in a direct-fired kettle, it still seems worth while to point out what can be accomplished in obtaining high-temperature effects in a delicate material by means of a heater of tubular construction. At present many materials are being heated in this way which could not be handled with uniformly good results in an ordinary kettle or cylindrical still.

The obvious objection to the kettle or cylindrical form of heater is the difficulty of heating a material with any degree of uniformity. In these vessels only a small part of the material is in contact with the heating surface at the bottom where the vessel is exposed to the furnace. The result is that this material becomes very much overheated while the greater mass in the cooler parts of the vessel are insufficiently heated. Even though artificial means of establishing a circulation are resorted to, the movement set up is usually poor and cannot be counted on to maintain a uniform temperature in the product. This objection is sufficient to prevent the use of this method of direct heating in the case of many processes.

Development of Special Tubular Heaters

On the other hand, a properly designed tubular heater will often eliminate this disadvantage and make it possible to solve in this way many problems in which a slight overheating would be disastrous to the material being heated. If the heating surface consists of a series of pipes or tubes through which the material is pumped continuously and if the heat from the furnace is applied so as to avoid concentration at any point, the material will be heated gradually and evenly from

the time it enters the heater until it reaches the outlet. Moreover, the temperature in the material will gradually increase through the heater and can be brought to the proper maximum at the outlet by varying the rate of circulation and the firing.

Although it is admitted that a careful study of furnace construction and methods of applying heat generated in a furnace to a tubular heating surface should give uniform heating, the successful development of such a heater has presented many problems. Complete combustion is usually accompanied by high temperatures in the combustion chamber. The radiant heat thus evolved has a constant tendency to overheat the tubular heating surface unless some steps are taken to protect the tubes from this powerful source of heat. The first heaters of this type were built with the tubes located directly above or in the rear of the combustion chamber. With this design, however, the destructive effect of radiant heat in many cases led to frequent burning out of the hottest tubes. In other words, the radiant heat would be poured into these tubes faster than the heat-absorbing material circulating in the inside could absorb it. As radiant heat always travels in straight lines, the next step in the development of these heaters was to screen the tubular heating surface from the direct rays of heat. This was accomplished by placing the heating surface behind a bridge wall which separated it from the fire. The adoption of this design did much to eliminate the troublesome effect of radiant heat. Even so, when a heater of this design was fired hard, the heat from the combustion chambers would eventually become intense enough to raise the brick roof to a red heat. This incandescent brick in turn would reflect the radiant heat down on to the upper rows of heater tubes and would, under severe conditions, still cause local overheating and tube failures. The final step in the development of these heaters was the installation of heating surface of special construction opposite and above the main section of heating surface. Such a heater is shown in Fig. 2. The front part of the tubes directly over the furnace is screened from radiant heat by special tile. The rear part of the tubes directly over the heating surface behind the bridge wall has no tile protection, but the steel tubes are covered with a special solid cast-iron casing only a small portion of the surface of which is exposed to radiant heat. As these two opposing heating surfaces are both cooled by the liquid passing through the tube and hence are at approximately the same temperature, there can be no exchange of heat or radiation.

The tubes back of the bridge wall absorb the heat generated in the furnace almost entirely by convection and therefore at a much lower rate than by radiation. This feature tends to prevent overheating in any of the tubes and therefore makes it possible to heat the most sensitive materials without danger of spoiled products. This construction also furnishes a durable roof and improves the heater efficiency by reducing the radiation losses from the roof.

Direct Heating of Vegetable and Mineral Oils

The heating of vegetable oils for deodorization purposes is one of the difficult problems which has been solved in a tubular heater. In this process a uniform rise in temperature is essential and for many years it was believed that superheated steam offered the only satisfactory method of heating with the necessary close control. The oil must be raised to a certain temperature to obtain proper results and if any of the oil is

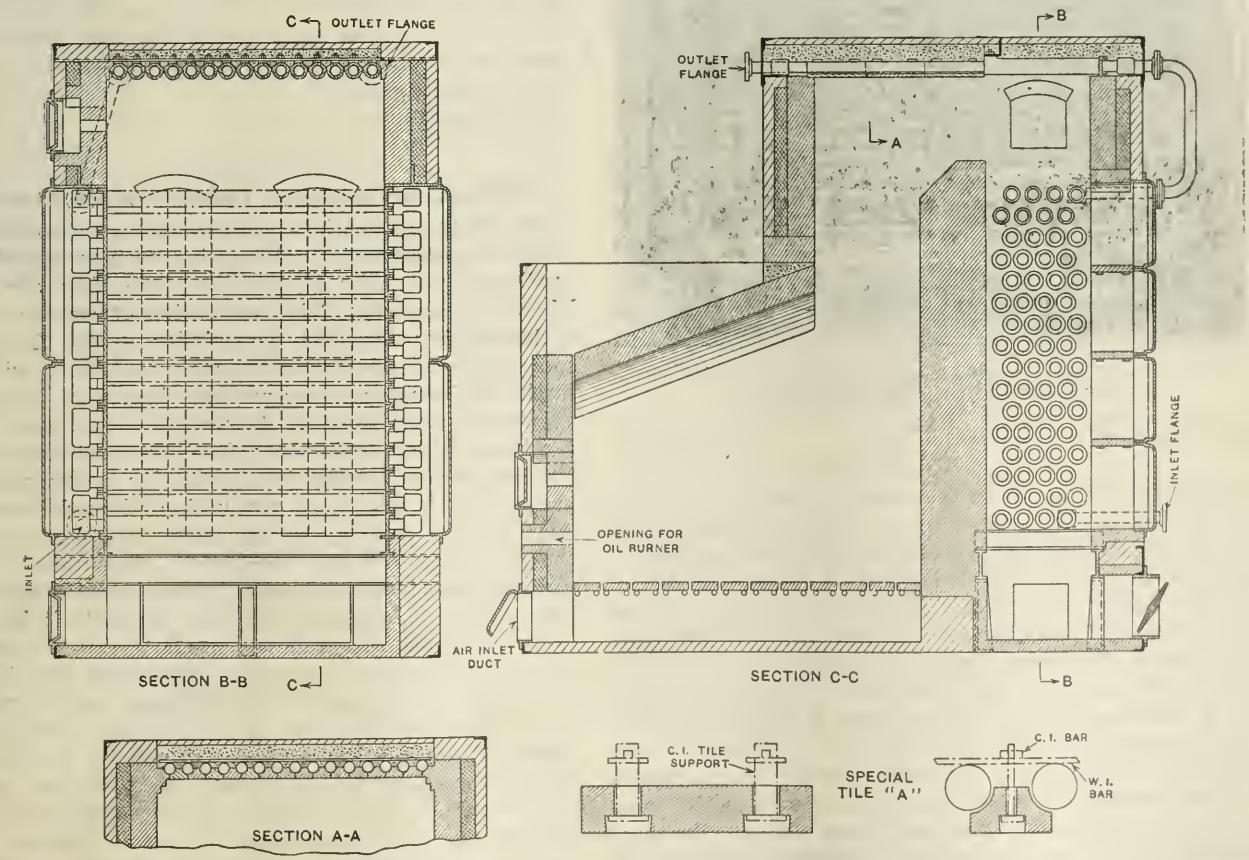

FIG. 2—SECTIONAL VIEWS SHOWING ROOF CONSTRUCTION OF SPECIAL TUBULAR HEATER FOR LIQUIDS OR GASES

unevenly heated and has a temperature below or above this predetermined limit a complete refining is not accomplished—in fact, the whole batch may be ruined. Many vegetable oil refineries are now using tubular heaters with excellent results as far as the quality of the product is concerned and greater economy than could be obtained with other methods.

As an average it may be stated that the efficiency of one of these special heaters would be about 60 per cent, although an efficiency of 67½ per cent has actually been demonstrated in some installations. The average efficiency of heating with steam in the case of vegetable oils probably does not exceed 20 per cent. The saving in time required to heat a given batch of oil through a specified temperature rise is also an important advantage. In one of these heaters it is possible to treat in 1 hour a weight of oil which would require from 2 to 4 hours in a steam still.

In the mineral oil refineries the tubular heaters have also made considerable progress in the last few years. In the cylindrical stills commonly used in refineries of this country many troubles have been encountered due to improper circulation and faulty combustion. Oil is admittedly a poor conductor of heat. As a result the oil in contact with the bottom of the tank is likely to

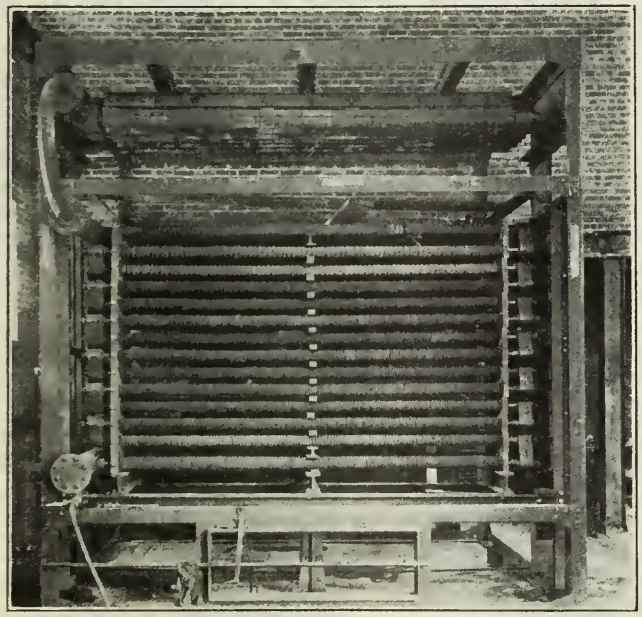

FIG. 3—SPECIAL TUBULAR HEATER FOR USE IN OIL REFINERY (UNDER CONSTRUCTION)

This view taken from rear of the heater shows special heating surface designed to absorb radiant heat.

"crack," while the oil in the cooler portions of the still fails to reach the temperature at which the desired cut can be made. The percentage of the total surface of the cylindrical still which is exposed to the furnace or the hot gases is comparatively small. The result is that this section of the plate is very much overworked and the plates oftentimes become insulated on the inside with carbon deposit and burn out. This overworking of a small portion of the surface is eliminated in a tubular heater, where every part of every tube is actually absorbing heat. Not only is more space exposed to the products of combustion but also a better heat transfer is obtained per unit area due to the high velocity of the oil in positive circulation through the tubes. This improved transfer obtained through the metal wall acts to prevent local overheating such as is encountered in the bottom plates of a tank still.

Almost any liquid which can be pumped can be handled in a tubular heater in this way. Besides mineral and vegetable oils, several heaters are now operating in roofing plants heating up the asphalt coating. Many gases have also been successfully heated to a high temperature in heaters of this same general type. In one case a highly flammable gas is being heated to a temperature above 1,000 deg. F. under a pressure of 1,500 lb. per sq.in. In all high-temperature heating problems it is well worth while to ascertain whether the material under consideration cannot be treated directly. From a consideration of the many materials handled in this way it is evident that in many cases direct heating can be utilized with much better economy than is possible with any indirect system.

Waste Heat

Where waste gases at fairly high temperatures are available, heat interchange apparatus enables effective use to be made of this waste heat in obtaining high temperatures in processes. Ordinarily waste gases are at too low temperatures to be of use for this purpose, but in the case of some furnaces or kilns the gases are available at temperatures of 1,000 or 1,200 deg. F. In this case they can be used with great economy, and advantage should be taken of this source of heat available with no additional fuel costs. Just as in the cement plants, waste-heat boilers are installed to utilize the gases from the kilns, so in chemical and other industrial plants hot waste gases can and are being used as the means of obtaining high temperatures in a process. In many of these industries the cost of obtaining high temperatures constitutes a large proportion of the total cost of the manufacture of a product, and it is therefore worth while for plant executives and engineers to study the efficiency of such processes with a view to reducing these costs.

Power Specialty Co.,
New York City.

Refining Midwestern Crude Oil to Be Studied

The Bureau of Mines is planning a comprehensive series of experiments to determine the practicability of producing the finer grades of lubricating oils from Western crude oils. The production of certain grades of lubricating oils, such as cylinder stocks, from mid-continent crudes is one of the most important problems in the oil industry at the present time.

Until recently these special products have been manufactured almost exclusively from Pennsylvania crude, but due to the increase in demand for products of this nature and to decreased production of crude from the Appalachian district, it has been necessary to seek other sources for the production of cylinder stocks. Cylinder stocks are now made from mid-continent crude, but in order to make satisfactory products it is necessary to subject the crude to special treatment for the removal of asphalt and other undesirable constituents. It is planned to make use of the experimental refinery at the Bartlesville station of the Bureau of Mines as a means of determining the best methods for handling the different types of mid-continent crudes for the production of cylinder stocks, also to determine the most satisfactory operating conditions for manufacturing products that can compete with lubricating oils made from Pennsylvania crude.

The German and American Synthetic-Ammonia Plants*—V

Costs of Construction and of Ammonia Production in the Plants at Oppau, Germany, and Sheffield, Ala., Are Compared and the Synthetic-Ammonia Problem Is Considered From the Viewpoints of the Chemist, Engineer, Operator and Executive

By R. S. TOUR

THE entire construction cost chargeable to the Oppau plant will total perhaps 250,000,000 marks. If the original pilot plant, the coke plant, the ammonia-utilization plants—i.e., ammonium sulphate, and nitric acid—be neglected and corresponding reductions made in the general facilities investment, the cost chargeable to the manufacture of ammonia alone is about one-half the entire cost, or some 125,000,000 marks. Of this about one-third is chargeable to buildings and construction, and two-thirds to equipment and machinery. The former includes buildings, foundations, roads, trackage, and all general construction; the latter covers special equipment or machinery and includes its installation cost. This is an estimate of actual pre-war (1914) cost and would mean an investment of about $270 per annual short ton of ammonia capacity, or $100,000 per daily ton. This cost applied only for the conditions existing in Germany at the time considered. In 1916, the construction costs at Merseburg showed an increase of more than 50 per cent over the Oppau figure in view of the rising labor and material charge. The 1918 estimate, based on the construction costs for the last one-fourth capacity of the Merseburg plant, had increased 150 per cent over the 1914 figure. (1914—$270; 1916—$400; 1918—$700.)

It is difficult to arrive at the labor necessary for operation. During the war there were at Oppau more than 6,000 workmen, not counting prisoners of war. This number was reduced after the war to about 5,000, directed by about 50 engineers through many superintendents and foremen. These figures include all departments of ammonia utilization, as well as construction, repair and maintenance. About 3,500 men and 35 engineers are chargeable normally to the manufacture of ammonia, including repair and maintenance of the plant. Of this number about 2,500 are required directly on operation. The labor charge of 2,500 men represents about 66 man hours per ton. The wages paid at Oppau in 1914 might average about 0.6 mark per hour. By 1918, wages had gone up in about the same proportion as the construction costs above—i.e., to 1.5 marks.

Fuel and Upkeep Charges

The only raw material necessary at Oppau is fuel. Estimates based upon reliable data indicate the following quantities of fuel per ton ammonia:

a. For water gas generators (Hydrogen production)	2 tons coke
b. For lean gas generators (Nitrogen production)	
c. For gas producers (Power and steam)	1 ton coal
d. For boilers (Steam and power)	2 tons lignite

The power and steam consumption is all included under (c) and (d). The power developed as such seems to be of the order of 3,000 kw.-hr. per ton of ammonia. The steam developed by gas engine exhaust or by boilers and consumed directly (not in steam engines) is perhaps 8 tons per ton of ammonia.

For the maintenance and repair charges (including materials and labor) we may assume 2 per cent per annum for buildings and construction and 8 per cent for equipment and machinery, which averages 6 per cent for the ammonia installation. For depreciation and amortization, we may allow 4 per cent for buildings and 7 per cent for equipment, which also averages 6 per cent for the installation. A charge for development and obsolescence is properly made on this type of plant and this has been allowed at 6 per cent on equipment and machinery only. As the process becomes more standardized and better developed this charge will decrease till it may be absorbed as depreciation and amortization, then taken at 10 per cent. These differentiations are delicate ones, since certain repair charges may be classed as depreciation while certain obsolesence charges may properly be classed with amortization. The total plant-upkeep charge per annum can be conservatively taken at 16 per cent of the investment for this type of installation.

	Buildings and Construction, Per Cent	Equipment and Machinery, per Cent	Average for Plant, per Cent
Maintenance and repair	2	8	6
Depreciation and amortization	4	7	6
Development and obsolescence	0	6	4
Total plant upkeep	6	21	16

In addition there are such fixed charges as interest, insurance, and taxes, which we may sum up at 9 per cent. The total for plant upkeep and fixed charges

PLANT PRODUCTION COST PER TON OF AMMONIA AT OPPAU, GERMANY, IN 1914

	Marks	Dollars
Labor Operating:		
35 engineers at 10,000 marks per annum	3.2	
66 man-hours per ton at 0.6 mark per hr	39.6	
	42.8	($10.27)
Fuel:		
2 tons coke at 20 marks	40	
1 ton coal at 15 marks	15	
2 tons lignite at 10 marks	20	
	75	($18.00)
Plant Upkeep:		
Repair and maintenance at 6 per cent	68.2	
Depreciation and amortization at 6 per cent	68.2	
Development and obsolescence at 4 per cent	45.5	
	181.9	($43.66)
General Works Expense:		
Unclassified expenses, 10 per cent of above	30	
Incidental materials, 5 per cent of above	15	
	45	($10.80)
Fixed Charges:		
Interest, insurance, taxes (at 9 per cent)	102.3	($24.55)
Total production cost per short ton of ammonia	447.0	$107.28
Total production cost per pound of ammonia	0.2235	0.05364

*For Parts I-IV see Chemical & Metallurgical Engineering, vol. 26, Nos. 6, 7, 8 and 9, pp. 245, 307, 359 and 411.

(25 per cent) represents over half the production cost of ammonia.

In the accompanying table is given an estimate for the cost of ammonia per ton as produced at Oppau in the form of aqua in 1914-1915, at the time the plant was developed. The cost in German marks for 1918, based on Merseburg experience and prices then existing, may be taken at about 2½ times the 1914 figure. The 1918 figure may be indicative of the present-day cost in Germany, although in view of the unsettled conditions and the prevailing rates of exchange any figures given for post-war conditions are to a large extent meaningless.

Construction Costs for the American Plant

The actual construction cost of the entire plant at Sheffield as built under emergency conditions was about $13,000,000. Thus included the nitric-acid and ammonium-nitrate plants, as well as the village for housing the employees. Of the total amount, about $7,000,000 is chargeable to synthetic-ammonia manufacture if all else be neglected and necessary deductions be made in general facilities. The plant was in many ways not completed and an additional $1,000,000 must be allowed for this purpose. This additional allowance does not consider the changes or improvements necessary for successful operation, but is to cover the incomplete installation of Unit No. 3 at the plant, the omission of properly equipped repair shops, and the future requirement of a laboratory and office building. The total of $8,000,000 represents costs under emergency conditions and may be reduced by 25 per cent for an estimate of normal construction costs at the close of the war. Based on the rated capacity of 10,000 tons per annum, the normal investment per annual ton of ammonia would thus be about $600, which at first sight compares favorably with the later construction costs of the German plants. However, in making any comparison, the following points must be kept in mind: (1) The rated capacity of the Sheffield plant may not have been its production capacity. (2) The investment in Germany included gas producers, gas engines, etc., which were necessary there to reduce the power charges and which in the United States are in general not necessary. For purposes of estimating costs for present-day construction in the United States, we can not allow less than $500 per annual ton of ammonia for plants of capacities comparable with that at Sheffield.

Based on a $500 investment per annual ton of ammonia, plant upkeep and fixed charges will represent a cost of about $125 per ton of product. The additional cost for labor, materials (fuel, power, steam, water) and other direct operating expenses will be of a like magnitude. No attempt is made here to develop these latter costs since they would depend upon the specific conditions existing at any particular plant. The total plant production cost, whether it be $250 or $300 per ton ammonia, of course includes no distribution, sales, or main office expense. It is evident from this superficial survey of costs that improvements of efficiencies at different steps of the process, with corresponding slight reductions in fuel, labor or power consumption, will not in any large proportion decrease the cost of the product. Any great saving must be accomplished by the use of the byproduct, carbon dioxide, from the process or by a reduction in the investment.

The only byproduct from the process is carbon dioxide, which is available to the extent of 40,000 to 45,000 cu.ft. per ton of ammonia. Its utilization requires the installation and operation of some additional process using the carbon dioxide and preferably a process using the ammonia as well. This calls to mind, first, the ammonia-soda process, turning out as final products ammonium chloride and soda ash. This combination of processes is in every way logical, but not as simple as it might appear. Interdependence of the two processes will make operation increasingly more difficult. Although the byproduct, carbon dioxide, would be of direct use in the ammonia-soda process, still lime would remain necessary for causticizing. The marketability and desirability of the ammonium chloride, as well as its preparation from the liquors, are also important factors. The complicating features just mentioned can be overcome in time should necessity require. A much less intricate, though less valuable, utilization of carbon dioxide is that for the double decomposition of gypsum in the presence of ammonia, yielding ammonium sulphate as the product and discarding the calcium carbonate. The German plants are using both of the above combinations, finding advantages in each. They have also experimented with the direct combination of ammonia and carbon dioxide for conversion to urea as the final product. The latter would be a very desirable solution of the entire problem of ammonia and carbon-dioxide utilization.

Some reduction in investment per unit production may be obtained by plants of very large capacities, but as long as these plants consist of multiple items of apparatus, each of comparatively small capacity, such reduction of investment can be only of a secondary order. Any large reduction in the investment must presuppose fundamental modifications of the process, as installed either in Germany or the United States. Such changes must be basic in character and represent definite reductions in the quantity or in the cost of equipment necessary for operation.

Concluding Remarks

The German process and combination of processes reached their present state of development with the financial aid of the government and under military pressure. As has been stated previously, a pilot plant had been built and preliminary experimentation completed by 1914, before the final construction and operation of the large Oppau plant to supply Germany's war needs. It is a question whether private capital would have of itself invested such large sums in the Oppau and Merseburg plants in normal times or without governmental aid. It is a further question as to whether post-war conditions are as favorable for private capital as were the pre-war conditions. We know, however, that since the plants have been built and operated successfully during the war to produce large quantities of ammonia, those plants must continue to operate and furnish ammonia for home consumption and export. The cost figures from those plants may mean but little, for a great part of their construction cost and development has been written off as a war charge.

The synthetic-ammonia industry in this country is at present in a status similar to that in Germany at the time the pilot plant at Oppau was being developed, although there is not here the enormous pressure and stimulus for development that the government put behind the German installation. It would be obviously unfair to compare the experimental plant at Sheffield

with anything but the original pilot plant in Germany. The main Oppau plant was the final development from the experimental stages through which any new and complex process must pass. Unless the Germans should take up actual construction in this country and make available their store of experience and knowledge, the industry in this country must develop its own industrial installation.

The Problem From Various Viewpoints

It is said that the industrial development of the direct synthetic-ammonia process is the greatest of modern chemical engineering problems. The true aspects of the problem, however, are somewhat beclouded by the difference in viewpoint of those following or aiding in its developments. The research chemist realizes quite rightly that the chemical problems involved are of the simplest nature except for the final step of catalysis of hydrogen and nitrogen to synthesize ammonia. He, therefore, feels that if he can develop an active and satisfactory catalytic material, the entire problem is in general solved and it remains but for the engineer to design and erect the plant. The designing engineer, on the other hand, feels that the development of a catalyst is a specific laboratory problem with which the research chemist is properly equipped to cope, but that the design of dependable equipment to operate at high pressures with temperatures at times approaching a red heat, and with gases or liquids sometimes corrosive on the materials of construction, is the really serious obstacle to success. He is appalled at the lack of data and precedents at hand for his work and is certain that if he succeeds all else is relatively simple and it only remains to erect and operate the plant. The operating chemical engineer to some extent appreciates both the above viewpoints, since he realizes to what extent his success depends on the success of both the chemist and the engineer, but he further feels that the determination and proper control of the many complicated and interdependent operating variables and steps of the process are in the last analysis the real basis of success. The industrial interests in control of commercial development have still another viewpoint. They appreciate only to a small extent the problem of the research chemist, the designing engineer, or the operating chemical engineer, but rightly feel that the success of the above men is for them a failure if the resulting investment, fixed charges or operating expenses make the cost of the product prohibitive.

Successful development of the synthetic-ammonia process can be attained only by a full appreciation of all the above viewpoints properly weighed against one another and by the most conscientious co-operation among the chemists, engineers, operators and executives. A new plant availing itself of the experience gained in operation at Sheffield, and of information obtained since then, should show very great improvement over the Sheffield plant, and there is no reason why the process could not finally be developed successfully in this and other countries as well as in Germany, if the demand for the product is sufficient to justify the investment.

Tax Returns of Precious Metal Companies

Companies engaged in the smelting and refining of precious metals in 1919 paid a total tax in that year of $6,615,353. The number of companies making returns was 567. Of this number 505 had net incomes totaling $26,285,275.

The Possibilities for Commercial Development of Muscle Shoals*

By Richard C. Tolman
Director, Fixed Nitrogen Research Laboratory

THE Muscle Shoals plant is designed to produce 220,000 tons of cyanamide per annum, which is later transformed into ammonium nitrate, amounting to 110,000 tons, as the final product of the plant. The raw materials which are used in the process are air, limestone, coke and a certain amount of coal for drying and heating purposes, and power, which might come either from the Wilson dam or from the steam power plant. The final product which the plant now makes is ammonium nitrate, which was to be used, mixed with TNT, in explosives.

Besides ammonium nitrate, there are several other nitrogen compounds which could be produced, first of which may be mentioned ammonium sulphate. This would necessitate setting up sulphuric acid units which were shipped from the Old Hickory plant. Another product, in the making of which we would employ phosphoric acid, would be ammonium phosphate. Another product which could be made there, by a method which we have worked out at the Fixed Nitrogen Research Laboratory, is urea. This material is manufactured at the present time in Germany and has been manufactured to some extent in this country. It is used at the present time, in the largest quantities, as a stabilizer for celluloid, and because of the size of the moving picture industry, considerable quanities of urea are used for that purpose. It is our belief that this material is being imported from Germany. We have tried to work out at our laboratory a process for this material, which we believe is somewhat similar to the process used in Germany, although we believe we have made improvements on the process used by the Germans.

Ammonium Nitrate as a Fertilizer

Then we have ammonium nitrate, which might well be made in certain quantities even during peace time, because it is used in peace time in permissible explosives and might work to some extent into fertilizer products. The main problem with ammonium nitrate as a fertilizer compound is that although it is an excellent plant food, nevertheless it is a very deliquescent substance. We have made a number of experiments in regard to the various possibilities of ammonium nitrate as a useful component of fertilizer products. We have gotten up methods for graining and oil-coating the ammonium nitrate, and it might be sold in that form. We have also experimented with a double salt of ammonium sulphate and ammonium nitrate. This double salt is less deliquescent than the ammonium nitrate, although not perhaps entirely satisfactory. Another method is to mix potassium chloride with ammonium nitrate. The two salts react together to form a mixture which is non-deliquescent, and that material contains two substances which are useful in fertilizer and which are used in fertilizer practice. Still another method is to mix ammonium nitrate and potassium sulphate together.

Use of Cyanamide in Fertilizer

Since the total capacity of this plant in the form of cyanamide, which is the cheapest form of nitrogen which it produces, would be 220,000 tons, it is not

*Abstracted from Dr. Tolman's testimony before the Military Affairs Committee of the House of Representatives in considering Henry Ford's offer for the Muscle Shoals plant.

believed that any large proportion of the product of the plant could be sold as cyanamide. The material cannot be used in mixed fertilizers, for the following reasons: If used in large amounts, it reacts with the acid phosphate to destroy its availability and it is also likely to produce dicyanodiamide, which is a substance poisonous to plant life. It can, however, be used in quantities of about 50 lb. to the ton of mixed fertilizer, but that would not absorb anywhere near the whole production.

We have made experiments which show that it can be more successfully mixed with basic phosphate, a material now produced by the Tennessee Coal & Iron Railroad Co. in Birmingham, and that it can be mixed with Thomas slag, a material which has been imported from Europe, and that it can be mixed with calcined phosphate, a new material which is not yet on the market.

Production of Organic Chemicals

Nitrogen, when fixed in the form of cyanamide, is combined directly with the carbon atom, and that leads to the possibility of the production of a variety of chemicals which could not be produced by other methods of nitrogen fixation. We believe the plant could produce quite a variety of organic chemicals.

Additions to the plant would have to be made in varying amounts to manufacture this variety of products. Some of the addditions would be relatively unimportant, such as putting in hydrating and oiling equipment for oiling the cyanamide. To put in phosphoric acid furnaces to make the ammonium phosphate would be more expensive.

One of the special chemicals that can be made with the help of nitrogen in the cyanamide form is nitroguanidine, which is a substance that the Ordnance Department is now experimenting with as a constituent of smokeless powder. Nitroguanidine can be obtained from nitrogen only in the cyanamide form. It is believed that there is a considerable possibility that nitroguanidine will be an important constituent of smokeless powder in the future. It was used by the Germans to some extent during the war. At the present time the only place on this continent where you can get the material to make nitroguanidine is the plant of the American Cyanamid Co. at Niagara Falls, Canada. If the smokeless powder used in the future should contain 50 per cent of nitroguanidine, which is perhaps an upper limit, the amount necessary to keep 100 divisions in the field per annum would be far larger than the total output possible at the Muscle Shoals plant. The reason why this material is a desirable substance for smokeless powder is because it has a high explosive force and yet explodes at a very low temperature, is a pure chemical substance, and is non-deliquescent.

A statement as to the possibilities of commercial success in the operation of the Muscle Shoals plant for the production of commercial fertilizer is a difficult matter, because it is trying to make predictions with regard to the future. However, the Fixed Nitrogen Laboratory feels that with ammonium sulphate at its present market price, in the neighborhood of $50 per ton, if the Muscle Shoals plant is to be run commercially to produce ammonium sulphate as its main product, the plant cannot be run and made to pay expenses.

If the Muscle Shoals plant be regarded as mainly producing ammonium sulphate, then with the price of ammonium sulphate at $65 a ton, the Fixed Nitrogen Research Laboratory feels that the plant can just about pay expenses and perhaps make a little profit, provided whoever runs the plant charges himself with a low enough figure for the water power which he uses and does not make his capital charges too high. The plant might about break even, with ammonium sulphate selling at $65 a ton, assuming a power cost of about three-quarters of a mill per kilowatt-hour and capital charges on a sum not larger than five or ten million dollars. These are our best guesses, because one cannot make precise predictions in a field of this kind.

As to the possibilities of the Muscle Shoals plant, if the plant be developed for a variety of materials, including ammonium nitrate, ammonium phosphate, urea and special chemicals of various kinds, under these circumstances, I think the plant can be made a commercial success, provided the man who obtains it surrounds himself with the proper chemical and scientific talent.

Research on Wood Conservation and Economy in Painting Planned

The Engineering Division of the National Research Council has projected a "paint on wood" research which is now being planned by the secretary of this division and G. H. Pegram and A. H. Sabin, members of a special committee responsible for the project. It is hoped that a committee will be organized representing the committee of the Engineering Foundation, American Institute of Architects, National Lumber Manufacturers Association, with representatives of painters, furniture manufacturers, piano and vehicle manufacturers and other principal users of paint and wood who will cooperate through the National Research Council in the investigation which will probably be done experimentally at the national Bureau of Standards and the Forest Products Laboratory.

Arrangement has been made with the two government laboratories named for contribution of their information and assistance regarding wood or wood treatment and paint and paint testing respectively. Among the objects sought are: Control of dimensional changes of wood due to absorption and loss of moisture; preservation of wood for economic reasons, including conservation of forests; economies in use of protective and finish coatings for wood and of the labor required for their application.

The research is to be put in the immediate charge of a well-trained technical man of varied experience, one who has not been connected directly with the lumber, wood-working or paint industries. Principal financial support aside from contributions made directly or indirectly by governmental bureaus, Engineering Foundation and National Research Council, is to be sought from producers and workers of wood and large users of protectives. Estimated cost is $8,000 to $12,000 a year for ten years. The Engineering Foundation or National Research Council will act as treasurer to receive and disburse funds.

New Metalliferous Solvent Reported Developed in Australia

Australia is preparing for commercial use a newly developed substance known as fibroferrite, according to advices to the Department of Commerce. It is said to possess valuable properties as a solvent. Its composition is given as follows: Ferrous sulphate, 50 per cent; oil of vitriol, 15 per cent; ferric sulphite, 10 per cent; alums and sulphur, 20 per cent; inert material, 5 per cent. The substance is said to possess properties which make it valuable in connection with the manufacture of red oxide of iron, disinfectants and dyestuffs.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Industries Offer Full Aid in Dye Investigation—Senator King Repeats Monopoly Charges

Monopoly, interlocking directorates, trusts, and similar appellations and charges constitute the basis of much of the attack made on the dye industry by Senator King. This is perhaps as conspicuous a point as has been raised during the past week in the proceedings before the Senate committee on investigation of this industry.

In contrast with the vitriolic attack upon the industry is the promise by Francis P. Garvan, of the Chemical Foundation, that the committee would be assisted in every way by presentation of any records or appearance of any person that might assist the investigators. The representatives of the chemical industries making dyes urge that no chance be lost to make the fullest possible presentation of the facts in the situation, as they state this will go far to dispel any feeling of improper relationship within the ranks of American dyestuff manufacturers.

It is charged by Mr. Garvan that the attacks made upon this industry can be traced back to an organized campaign of the German dye monopolies to block development of the domestic industry in the United States. This basis of discussion falls within the scope of the inquiry, as it is authorized to include not only a study of the domestic dye industry itself, but also the practices of dye importers.

The decision of Senator Shortridge of California to appeal to President Harding and Secretary of State Hughes to take prompt action to exercise whatever right the United States has to reparation dyes was made known informally at the close of Friday's session, after Albert M. Patterson, president of the Textile Alliance, had emphasized, in sworn testimony, the necessity of prompt action by the United States Government to prevent interruption of the supply of reparation dyes to the textile industry of the United States.

The State Department, in December last, terminated an arrangement whereby the Textile Alliance acted as agent for the department in importing reparation dyes allocated to the United States by the reparations commission, and distributed these dyes to the American textile trade. Since then, Mr. Patterson said, the reparations commission has declined to sell such dyes to private individuals and will soon cut the supply off altogether unless the United States Government will nominate some agency to continue or resume importation and distribution for the United States. Unless the government acts, therefore, Mr. Patterson said, the German dyes needed here will be furnished by the German dye cartel or trust instead of the reparations commission, at prices dictated by the German monopoly.

"I intend to call upon the President and the State Department, probably tomorrow, and urge that if the United States has a legal right to these dyes, the government proceed promptly to exercise that right," said Senator Shortridge. "I shall recommend that some government body or some agency be nominated to import and distribute those dyes in the United States, assuming, of course, we have a right to them. Personally, I am inclined to think we have."

Chemical Foundation Welcomes Investigation

Francis P. Garvan, former Alien Property Custodian, and now head of the Chemical Foundation, announced early in the hearing that "on behalf of myself and anybody connected directly, indirectly or remotely with the Chemical Foundation, I make haste to waive consideration of any kind whatsoever. We have been here trying for two years to have an investigation of this sort started, and while, of course, the thought never entered our heads, we are only too happy to place ourselves at your service without any consideration being asked or expected."

Senator King contended in substance that the average price of dyes in the American market today is much above pre-war prices and that the prices of intermediates have advanced in proportion. This advance he declared largely was due to special tariff and embargo legislation which he said had been passed for the benefit of the American dye industry.

Senator King declared that the Allied Chemical & Dye Corporation and the du Pont interests today have "practical control" of the manufacture of intermediates in this country. He attacked the Textile Alliance, declaring that "if it is not dominated by the American dye interests, it is working hand in hand with them to impose upon the textile industry extortionate and exorbitant prices."

He declared that it is economically wrong to prohibit importations either of intermediates or the finished products. If tariff protection is necessary, it should be "fair and just," he said. Propaganda for an embargo on importation of dyes has been and is being carried on, Senator King charged, by the Chemical Foundation, the Textile Alliance and the American Dyes Institute, which he described as "alleged eleemosynary institutions." The first, he alleged, controls all former German dye patents and formulas in this country; the second, he said, has controlled the distribution of reparation dyes in the United States, and the third, he charged, made it possible for American dye makers to "meet and agree as to prices, limit territory, restrict and regulate production and to prevent excess production."

King Questions Motives of American Dyes Institute

Senator King said the American Dyes Institute had no authority in its charter to carry on the activities he charged to its account, and also said the Textile Alliance has been acting outside the authority conferred upon it by its charter. The latter, he said, could be set aside in the courts, as a result. He further alleged that the Textile Alliance is under the domination of the Allied Chemical & Dye Corporation and the du Pont interests, adding that on the advisory committee of the Chemical Foundation and on the executive committee of the Textile Alliance are members of the "Allied" and of the du Pont interests. The du Ponts, he said, were the largest subscribers to the stock of the Chemical Foundation. The latter, he said, was conceived by Mr. Garvan and Joseph H. Choate, Jr.

The Chemical Foundation, said Senator King, has expended considerable money in propaganda. Mr. Garvan challenged a statement by King that the Foundation controlled the patent for manufacture in this country of synthetic indigo, informing Senator Shortridge that this patent lapsed years ago.

Condemns Seizure of German Patents

With the aid of a chart, Senator King sought to point out the connection between the office of the Alien Property Custodian and the organization of the Chemical Foundation. Francis P. Garvan, president of the Chemical Foundation, King said, was Alien Property Custodian; Joseph H. Choate, Jr., general counsel for the Foundation, was a dollar-a-year man in the office of the Alien Property Custodian; Ramsay Houget, patent attorney for the Chemical Foundation, was a dollar-a-year man in the office of the Alien Property Custodian; the trustees of the Foundation constituted the advisory sales committee of the Alien Property Custodian's office.

Senator King said that after the armistice, the Alien

Property Custodian, then A. Mitchell Palmer, sold, by authority of former President Wilson, 4,500 German patents to the Chemical Foundation for $250,000, although "I have been told that they were worth from $10,000,000 to $50,000,000."

Mr. Garvan was chief of the bureau of investigation in the office of the Alien Property Custodian when the patents were sold, it was developed, and later succeeded Palmer as Custodian.

The sale, Senator King further charged, was made to "officials who participated in the sale and this would be prima facie evidence of fraud in the case of private individuals."

Claims That Textile Alliance Is Aiding Monopoly

The Textile Alliance, Inc., he charged, is working "hand in glove with the domestic dye companies of the United States and is aiding them in maintaining a monopoly." Referring to the former control over the distribution of German reparation dyes in this country by the Alliance, Senator King declared the organization had acted far beyond the power of its New York state charter of incorporation and said the State of New York should proceed to disincorporate it. The Alliance, he claimed, is carrying on an aggressive campaign at Washington to continue as the sole importing agency of German reparation dyes.

In answer to questions from Senator Sterling of the subcommittee, Senator King denied any hostility to the American dye manufacturers, asserting he was not opposed to "fair and reasonable" tariff protection for them, and insisting he wished them to prosper. He declared his sole object was to attack the monopoly which he belives exists, and denounced all monopolies.

Harding Asks Definite Action on Dye Situation

The following letter written to Senator Frelinghuysen, of New Jersey, by President Harding was presented by Senator Frelinghuysen to the Judiciary sub-committee, of which Senator Shortridge, of California, is chairman.

Mr. Fleisch's full name is F. A. Fleisch and he is vice-president of the Textile Alliance, Inc.

> I have been going over the memorandum left with me by Mr. Fleisch of the Textile Alliance. I have also taken the matter up with Under Secretary Fletcher, and will pursue the matter further immediately upon the return of the Secretary of State. At the moment my best judgment is that we will get no effective arrangement made except through a resolution by Congress. I quite agree that we ought to get the benefit of such reparation credit as might come to us through the German export of dyes to this country, through the reparation commission, and we ought to protect our textile manufacturers against the grant of undue advantage to their competitors in the Old World. It would be easy to do this if Congress had not tied the hands of the administration in dealing with the reparation commission. I am writing to suggest that you confer with some of your associates regarding a resolution which will deal with the dye question definitely and directly.

Edgar Nathan of New York City, counsel for Kuttroff, Pickhardt & Company, Inc., importer of dyestuffs, obtained permission to make a statement in reply to what he termed as "unjust and misleading statements" made regarding his clients by representatives of the Textile Alliance, Inc. The officers and directors of his company, he said, are American citizens with a long record of honorable and satisfactory dealing with American consumers of dyes.

Mr. Nathan said his clients had dealt largely in dyes of American, English, French and Swiss manufacture as well as German dyes and that today their principal business is in American dyes. For many years they had the exclusive sales rights in the United States and Canada of the products of the Badische Anilin & Soda Fabrik of Germany, now one of the principal parts of the German dye cartel. Mr. Nathan said this company was not a member of the German cartel when first its relations with his clients began.

Practically every attack made upon the American dye and organic chemical industry can be traced back to a campaign of the German dye cartel, or monopoly, to block development of the industry here in order to regain control of the American market, Francis P. Garvan declared.

Blames German Intrigue for Situation

Mr. Garvan presented to the committee a story of German intrigue, beginning long before the war and continuing today, to expand in the United States German at the expense of American business. The German dye trust, he charged, really controls the business and property of its agents in this country.

The reparation system made it possible, Mr. Garvan explained, to supply dye consumers in this country with the 10 per cent they need.

"If we can continue to get this 10 per cent from the Germans through the reparations commission, the textile trade can be supplied reasonably," said Mr. Garvan. "But there is a danger that unless this is done, the textile trade will become impatient. The German dye cartel hopes to be in a position to supply us this 10 per cent on its own terms so that it can be used as a club upon the American textile trade and upon Congress to force us to take 100 per cent."

Defends Chemical Foundation

"Expressed in a few words, the main criticism against the Chemical Foundation seems to be that I, as Alien Property Custodian, transferred to myself or the Chemical Foundation, of which I was president, patents which some say were worth $1,000,000 for $250,000, so that by the German process of reasoning I derived a profit of $9,750,000.

"Senator King said we had no right to seize or sell this property; that it was in violation of the treaty of 1828. The United States Supreme Court decided in a case brought against me as Alien Property Custodian that the treaty applied only to German merchants actually in this country at the time war came on. We seized no property of any German citizen residing in America, except in the case of aliens interned because of activities against the United States Government."

Motives which caused the Alien Property Custodian to seize during the war German patents for the manufacture of dyes and drugs and to be certain that they were placed in American hands were summarized by Mr. Garvan thus:

1. Decision to make United States industry independent of the German dye trust so that no foreign power would control dyestuffs, key of many industries.
2. Resolve that the public health in the United States should not be dependent upon drugs the manufacture of which was controlled abroad.
3. Necessity of providing the United States with adequate chemical foundation for national defense.

When the United States became a belligerent, Mr. Garvan said, it was determined as a matter of national policy to seize and sell to American citizens German-owned property, including patents. The first sale by the Alien Property Custodian was the Bayer Company, manufacturer of aspirin, then owned by one of the six members of German dye cartel, he explained.

Garvan Tells of Sale of Patents

When it came to the question of disposing of the patents of the other five German trust members, it was recognized that to sell them at public auction would be dangerous, as they might fall into unfriendly or speculative hands. They were, accordingly, sold, with approval of the President, to the Chemical Foundation, which issues licenses for manufacture under the patents held by it and has never refused a license to any American manufacturer, he said.

The value of these patents, Mr. Garvan testified, was most uncertain, as in the first place they did not give the key to manufacture and, in fact, were worthless without expenditure of large sums of money in research work and for the establishment of a manufacturing plant. That American manufacturers were able to make use of these patents was a "great triumph" for American industry.

U. S. Chamber of Commerce Referendum Vote Shows Opposition of Business to Bonus

A referendum vote of the membership of the Chamber of Commerce of the United States commits the organization definitely in opposition to the cash bonus for ex-service men. A two-thirds majority of votes cast is necessary to commit the Chamber. In this case the vote against the bonus was 72 per cent. The vote will be placed immediately before Congress, now considering veteran legislation.

Although the Chamber had declared previously at two annual meetings against the cash bonus, the referendum ballot was sent out 6 weeks ago, with the desire on the part of the Chamber, according to Elliot H. Goodwin, a vice-president, "to be perfectly fair and to record any change in public sentiment if change there had been." Votes were cast by business organizations in 375 cities, 46 states, in the District of Columbia, Alaska and Hawaii, and by American Chambers of Commerce in Cuba and Mexico. Both classes of the National Chamber's membership, local chambers of commerce and trade associations, recorded themselves again the bonus by a more than two-thirds majority, although the vote of the trade associations was the heavier. The vote of the local bodies comprising the membership of the Chamber was even more strongly opposed.

The Chamber also committed itself in favor of a national system of reclamation through adequate federal appropriations to afford ex-service men an opportunity to cultivate the soil and of national legislation and appropriations to enable ex-service men to obtain vocational education.

General Fries Declares Continuation of C.W.S. Not Incompatible With Treaty

The treaty regarding submarines and gas adopted by the Limitation of Armament Conference does not attempt to abolish any service nor impose any limitations on research, development or proving, or even upon the accumulation of supplies of gas or any other materials of chemical warfare. The treaty simply prohibits "the use in war of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices . . . ."

This is the interpretation of Brigadier General Amos A. Fries, chief of Chemical Warfare Service, in a statement regarding the effect of the action of the Conference on that branch of the Army. The statement continues:

"The good faith of the United States cannot be questioned if it continues the Chemical Warfare Service exactly as now constituted and doing exactly the same work as it is now doing. It is now, and would be then, simply a precaution against any other nation breaking its plighted word. There would seem to be less right to question the good faith of the United States for keeping its Chemical Warfare Service than to question its keeping its agreement not to use submarines improperly against merchant shipping, for the reason that submarines are constructed, maneuvered and supplied solely for the purpose of offensive action. Offensive action against merchant ships requires no different training, no different supplies or no different machinery than does the use of submarines against battleships.

"It is sometimes argued that we should keep up in research, but that it should not be done in a service called Chemical Warfare. If we attempt to camouflage preparations, we are immediately open to charges of perfidy in that we are secretly studying the use of gas while openly declaring that we do not intend to use it in war. That charge would be practically impossible to controvert. That a man is forbidden to carry a pistol does not in any way prevent his keeping one in his home and under proper regulations indulging in target practice so that he may successfully use it to keep out intruders. That is unquestionably the position of Great Britain and France, or Mr. Balfour and Minister Sarraut would not have had their statements to that effect recorded and made public as a part of the proceedings of the Conference. Proper preparedness is never a threat of aggression.

"It is submitted that the above is the patriotic and only proper interpretation of the treaty, and that no consideration should be given to any other interpretation."

Ladies Conduct Interesting Meeting of Chicago Section, A.C.S.

Each year the ladies of the Chicago Section of the American Chemical Society are given full charge of one regular monthly meeting. This year Feb. 24 was selected, and the enthusiastic attendance threatened to tax the seating accommodations at the City Club.

Miss Elizabeth Weirick, presiding, introduced the speaker of the evening, Miss Ruth O'Brien, associate professor of textile chemistry at Iowa State College. The opportunities for chemists in modern cleaning and dyeing establishments were pointed out by Miss O'Brien in an instructive and interesting manner. Through her intimate knowledge of conditions in cleaning and dyeing establishments throughout the country the speaker was able to indicate most convincingly the problems requiring scientific knowledge for their solution. Although essentially chemical in its nature, dealing as it does with animal and vegetable fibers, stains, cleaning agents, bleaching and finishing processes and dyes—this widespread industry engages very few chemists.

Miss O'Brien outlined the processes employed at the present time and showed how many of them had developed empirically. Like many other industries, the details of the processes vary from plant to plant, each operator being confident that his success lies in his own trade secrets. At the present time, however, the need for scientific counsel is beginning to be realized and real progress should result from the interest shown by the National Cleaners' and Dyers' Association. Miss O'Brien has been co-operating with this association and has just completed a short course in cleaning and dyeing at Iowa State College for members of the Iowa State Association.

The usual group meetings were also conducted by the ladies, the topics being as follows: "Standard Arts," by Miss Mary Hall of the Weyman-Bruton Co.; "Chemical Changes in Fats in Cooking," by Miss Katherine Blunt, University of Chicago; "A New Insight Into the Bromination of the Double Bond Between Carbon Atoms," by Prof. Ethel M. Terry, University of Chicago; "Chemical Analysis of Blood," by Dr. Chi Che Wang of the Michael Reese Hospital.

Industrial Developments of the Week

Rubber — The Erie Tire & Rubber Co., Sandusky, Ohio, has increased its operating schedule to a 24-hour basis for an indefinite period.

The Goodyear Tire & Rubber Co., Akron, Ohio, has increased production from 20,000 to 22,000 tires a day and will maintain this schedule for an indefinite time. About 500 men have been added to the working force.

The Seiberling Rubber Co., Portage, Ohio, is arranging for an immediate increase in manufacture from 839 tires a day to 1,265 tires, with corresponding advance in inner tube production from 1,000 to 1,500 per day.

Leather—Robert H. Foerderer, Inc., Philadelphia, Pa., has increased production 137 per cent as compared with this time last year. The number of employees at the plant is now 122 per cent greater than in March, 1921.

Oil—The Empire Refineries, Inc., is arranging for the immediate resumption of production at its plant at Gainesville, Tex. Other refineries of the company are increasing their outputs.

The Waco Refinery, East Waco, Tex., has placed its plant on a production basis of 2,000 bbl. of oil per day.

Ceramic—The Robinson Clay Products Co. has placed all of its plants in this district on a full running time basis. Orders on hand insure this operating schedule for some time to come.

Iron and Steel—The Gulf States Steel Co., Birmingham, Ala., has blown in its last blast furnace, following an extended idle period. The unit will be used for pig-iron production for the ingot mills of the company.

The Carnegie Steel Co. has blown in a blast furnace at its plant at Clairton, Pa., and plans to place three other units in service at an early date. The furnaces have all been out for more than a year.

The Hanna Furnace Co., Cleveland, Ohio, has relighted its blast furnace at Dover, Ohio, which has been out for

the past 13 months. About $600,000 has been expended for repairs and betterments. The plant will give employment to 150 men.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., will soon place its No. 4 furnace at Ensley, Ala., in blast, following a shut-down for some time past. The unit will be used for iron production for the open-hearth furnaces. The company is operating its tie-plate plant and car works under full production. The rail mill is increasing operations and the ingot department is now operating at about 77 per cent normal.

The Atlas Steel Co., Dunkirk, N. Y., has resumed operations at its plant, following a period of curtailment. Employment will be given to a large force of men.

The Glasgow Iron Co. has resumed operations at its seven puddling furnaces at the Universal Midland plant, Pottstown, Pa.

The Bethlehem Steel Co. has resumed operations at another open-hearth furnace at its Steelton, Pa., works, making six of nine furnaces now in service.

Cement—The Texas Portland Cement Co., Dallas, Tex., is arranging plans for capacity production at its mills early in March. The plant is running on a 24-hour basis, giving employment to about 250 men.

Coke—The Mt. Pleasant Coke Co. has resumed operations at its Beatty plant at Mount Vernon, Pa. The present capacity will be increased at an early date. The company recently fired over 300 ovens at its plant at Carpentertown, Pa.

The H. C. Frick Coke Co. is planning to increase operations at its plant in the vicinity of Mount Vernon, Pa.

Metals—The American Smelting & Refining Co. is arranging to increase the working force at its Perth Amboy, N. J., plant by more than 200 men. The company has taken a large smelting contract from the Phelps Dodge Corporation, New York, which will be handled at the Perth Amboy plant.

The Anaconda Copper Co. has resumed operations at its copper refinery at Great Falls, Mont., following a recent increase in output at the electrolytic plant. It is planned to give immediate employment to about 1,000 men, increasing shortly to 1,200 men. Normally, the smelting would give employment to 1,500 men.

The Mt. Shasta Gold Mining & Milling Co., Montague, Cal., has resumed production at its Black Hawk silver properties. Plans are under way for enlargements in the mill to increase the present capacity.

The Butte & Superior Copper Co., Butte, Mont., is planning to increase its present working force from 700 to 1,000 men. The company is now operating at the Black Rock concentrator at about 80 per cent of capacity and will bring production up to normal within the next few weeks.

Application of Muscle Shoals Power to Chemical Processes Denounced

The worst possible use to which the power at Muscle Shoals could be put, in the opinion of Colonel Hugh Cooper, would be its application to chemical processes. This was one of the main reasons which he advanced, while testifying before the Military Affairs Committee of the House of Representatives, as to why Henry Ford's offer for Muscle Shoals should not be accepted.

"It is not wise from the standpoint of public interest in the South to take out of its water-power reserves so great a horsepower for chemical purposes," he declared. "If this plan is consummated, the people in the South who are clamoring for the acceptance of this proposal soon will be crying for its abrogation.

"Twenty years ago at Niagara Falls they started to build what is now a 400,000-hp. plant. At that time they could not get a market for the power, so they took in the chemical people. Chemical interests and the water-power interest tied up and built up a great industry, all in chemistry. As a result, this water power at Niagara Falls did not get as far as Buffalo, 23 miles away. Two years ago Buffalo had to pay $10,000,000 for a steam plant, yet the city is within 23 miles of one of the greatest water powers in the world.

"Now there is a wide movement in the State of New York to alter the water-power situation at Niagara Falls. At this very moment they are passing legislation that is absolutely conclusive and compelling so that the power generated at Niagara Falls can be distributed throughout the tributary territory and no more of it go into chemistry.

"I do not want to be understood as saying that that these chemical industries at Niagara Falls are a curse to the country. They have accomplished a great good and the country would have been in bad shape during the war without all of them. There is a limit, however, to the water power which should be assigned to chemistry. The people of New York, after 20 years of experience with the chemical industries, are storming the Legislature to stop the use of power in chemistry in a territory that is buying coal for power use. Chemical industries do not use much labor. Take the Aluminum Company, for example. It has 150,000 hp. in its works at Messina. The town is no larger than it was 20 years ago. The South needs cheap, reliable energy to be distributed over a large territory. If you put the power at Muscle Shoals into chemistry, it will be like taking vertebræ out of a man—there would be nothing to which the ribs could be fastened. When these people get over their present spell, they will see the errors in their enthusiasm. I think it would be a tremendous calamity to the South if the greatest water power it has should be taken out of the field of public utility for 100 years."

J. W. Worthington, chairman of the executive committee of the Tennessee River Improvement Association, in his testimony before the committee, when called upon to explain if it would be wise to permit the No. 1 plant to be converted into an automobile factory, said in part:

"No prudent person would use the Haber process in view of what happened in Germany a few months ago when the Oppau plant blew up. It is rather singular, if that plant could be operated successfully—and admittedly it never has been—that the General Chemical Co., which designed it and which let the government have the process, refused Mr. Glasgow's proposal to take the plant for 3 years, when the United States would not charge a penny for its investment for the use of the plant if only the General Chemical Co. would agree to spend $500,000 in further development, investigation, research and operation. It stands today as a failure. At Syracuse, N. Y., byproduct hydrogen is available. The plant was located at Syracuse to be near the coke ovens. Suppose Plant No. 1 had proved to be a success. Even then it would not be operated by Mr. Ford. He would double it up with No. 2."

Joint Meeting of Middle Western A.C.S. Sections

A full program for the afternoon and evening of March 14 is planned for the joint meeting of the sections of the American Chemical Society co-operating in the publication of the *Chemical Bulletin*. The meeting is to be held at Northwestern University, Evanston, Ill., where excellent facilities are provided for all parts of the program. The afternoon general meeting will be addressed by H. E. Howe, editor of the *Journal of Industrial and Engineering Chemistry*, on "Chemistry's Publication Problem." The evening will be devoted to group meetings of the inorganic, organic, synthetic, biologic, educational and non-technical groups. Among the speakers at these group meetings will be H. I. Schlesinger of the University of Chicago, who will speak on "The Theory of the Chamber Process," J. A. Wilson of Milwaukee, on "The Analysis of Vegetable Tanning Materials," and Roger Adams, of the University of Illinois, on "Platinum Black Catalysts."

New Power Project for Pacific Coast

Application has been made to the Federal Power Commission for permission to construct the transmission line which will link the power systems of California with those of the Columbia River Valley. The application was filed by the California-Oregon Power Co., Medford, Ore. The transmission line for which license is asked is to extend from Prospect power house to Springfield, Ore., a distance of 100 miles.

American Institute of Chemical Engineers Announces Plans for Summer Meeting

The summer meeting of the American Institute of Chemical Engineers will be held at Niagara Falls, N. Y., June 19 to 22. Headquarters will be at the Clifton Hotel.

For the program of papers a symposium on acid manufacture is being arranged. This will include the manufacture and concentration of sulphuric, nitric and hydrochloric acids, as well as phosphoric acid. A number of excellent papers have already been promised for this symposium.

One day will be spent in Buffalo visiting the industries in that locality. Another day will be devoted to a lake trip to Toronto, Canada, and inspection of the chemical plants in that vicinity.

Technology of Lubricants Subject at Delaware Section, A.C.S., Meeting

An interesting address on the subject of "Why Oils Lubricate" was given by Prof. Robert E. Wilson, director of the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology, at the Feb. 15 meeting of the Delaware Section of the American Chemical Society, at Wilmington, Del. The talk was based on the results of research work at the laboratory. Prof. Wilson pointed out the shortcomings of present specifications for lubricants and discussed the action of various lubricants in different uses.

C. F. Chandler Foundation Medal Presented to Edgar F. Smith

One of the most pleasant details attending the award of the Charles Frederick Chandler Foundation medal to Edgar F. Smith, president of the American Chemical Society, at Columbia University, March 2, was the fact that the token was presented by the man whose name and likeness it bears. In handing the medal to Dr. Smith, Dr. Chandler spoke of their long personal friendship and declared that there was no one to whom he would rather present the honorary award. He referred to the wonderful growth of Columbia University since 1864 when he became associated with it, a time when the student enrollment was 150 and the headquarters of the college were located in the deaf and dumb asylum.

In accepting the honor conferred upon him, Dr. Smith spoke reminiscently of his student days at Göttingen where he and Dr. Chandler studied under the same masters. He also mentioned the close relationship between Columbia University and the University of Pennsylvania, especially between the chemistry departments of the two institutions.

The Chandler medal is the result of a foundation established by the friends of Professor Chandler in 1908. Previous awards have been made to L. H. Baekeland, W. F. Hillebrand, W. R. Whitney and F. G. Hopkins.

Dr. Smith delivered an address on "Samuel Latham Mitchill—a Father in American Chemistry." Mitchill was the first professor of chemistry at Columbia College and the first Senator from the State of New York. It was particularly to his achievements in the field of chemistry, however, that the speaker gave attention.

Mitchill gained prominence in 1792 as the first public champion of anti-phlogiston views in America. He supported Lavoisier, whereas Priestley, who came to America in 1794, remained the protagonist for phlogiston until the day of his death. He gave a vivid picture of the controversy that raged. In 1797 Mitchill founded the *Medical Repository*, a journal originally intended to serve the medical profession but which later broadened its scope to take in the whole field of science. The *Repository* was strongly opposed to the phlogiston theory.

As a teacher, for such he was primarily, Mitchill was characterized by the extreme clarity of his methods and the breadth of his views and interests. It was his practice to introduce into his teachings all the new ideas and current developments in the state of the art. As professor of chemistry at Columbia he established a chemical museum in which were included exhibits of chemical products and minerals.

Among the earliest experiments conducted by Mitchill was his investigation of evaporation. In these experiments the first inklings of physical chemistry are discernible. It is worthy of note that the early chemists realized the importance and scope of this branch of the science but on account of the pressing needs of the country were forced to devote their energies to the practical applications.

Mitchill's mind was of a very speculative nature. His writings in 1802 still show the influence of the phlogiston theory but this later disappears. It was at this time that he published his belief that all matter consists of atoms, infinitely small, held together by balanced attractive and repellent forces. In his experiments on wood ashes he discovered the presence of potassium phosphate in the ash. As a result of these studies he conceived the conviction that potassium was combined with oxygen in potash and it is believed by some that this furnished Sir Humphry Davy with the clue that led to his isolation of metallic potassium.

Early in his career he had thought seriously of the causes of the decay of matter. His medical training no doubt added interest to his consideration of this problem. The most important result of his work was his conception of an imaginary element which would check organic decay and destroy the noxious products. He called this element septon, and believed it to be a combination of the "chlor" element of muriatic acid with oxygen. He declared that "septon is a fiend to animal life" and applauded the virtues of the oxychlorides of calcium and sodium as disinfectants. In this work, Mitchill was assuming the role of the present sanitary chemist and his work antedates the well known European "discoveries" by about 30 years.

He died in 1831, honored by more than 100 American and European scientific societies and famed for his work, not only in chemistry but in mineralogy, medicine, education and the public life of America.

Federal Board for Vocational Education to Fill Vacancy

The United States Civil Service Commission announces an open competitive examination for information assistant. Vacancies under the Federal Board for Vocational Education at $2,400 to $3,600 a year, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from this examination, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion.

The duties of this position will consist of popularizing the activities and purposes of the Federal Board for Vocational Education through magazines, trade journals and the daily press and of winning public co-operation for the cause of vocational education and rehabilitation of persons disabled in industry or otherwise. It is desired that in addition to possessing journalistic qualifications, the appointee should have had trade and industrial connections and that he should be able to make personal appeals for co-operation by platform or otherwise to industrial, labor and agricultural organizations.

Competitors will not be required to report for examination at any place, but will be rated upon education and experience and published papers or articles prepared by them. Applications will be received on Form 2118 prior to March 28, 1922.

Government Needs Explosives Chemists

The United States Civil Service Commission announces that there are a number of vacancies in the Ordnance Department of the Army in positions of chemist qualified in the chemistry of explosives. These positions offer salaries ranging from $1,800 to $3,600 a year, depending upon the qualifications of the appointee and the duties to which assignment is made. Applicants are not assembled for written tests, but are rated upon the subjects of (1) education, training, and experience, weighted at 70 per cent, and (2) publications or thesis, to be filed with applications, weighted at 30 per cent.

Full information and application blanks may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or with the secretary of the U. S. Civil Service Board at the post office or custom house in any city.

General Sentiment of National Council Opposed to Metric System

The National Council of the U. S. Chamber of Commerce adopted a resolution rejecting the proposal for a referendum on the metric system at this time. An interesting discussion preceded the adoption of the resolution.

A point that had great influence on the gathering was made by George B. Chandler of the Connecticut Chamber of Commerce when he said: "If you will analyze the support of the affirmative on this question, you will find among all those proponents there is only one representative of industry. That is very significant. The others are representative of the theoretical."

W. C. Wilson, assistant to the president of the American Institute of Weights and Measures, made the principal antimetric argument. He read a concise statement from W. R. Ingalls, the president of the American Institute of Weights and Measures. Mr. Ingalls said that the greatest obstacle to the adoption of the metric system would be its cost to the people. In the manufacture of metals alone, the cost would be something like half a billion dollars, he said. Mr. Wilson, in his address said:

"If the metric system offers such extraordinary advantages as are claimed for it, is it reasonable to suppose that American manufacturers, who have stood in the forefront of industrial progress and who are thoroughly familiar with the metric system, are so blind to their own interest and so lacking in business intelligence that they must have it crammed down their throats by compulsory legislation?"

George B. Blow, of the Illinois Valley Manufacturers Association, who is a manufacturer himself, advocated the adoption of the metric system vigorously. "England is very much in the same condition as ourselves," he said. "She is clamoring for metric weights and measures because she has found out that the country is losing foreign business to the metric countries. England is finding out that Germany and other metric countries are getting business from them, particularly in South America. We have no right to vote down a proposition to submit anything to a referendum. This matter should go to referendum as recommended by the committee."

Charles L. Parsons, secretary of the American Chemical Society, among other things said: "I want to speak for a whole profession. The chemists of America are united in one immense society with 15,000 members. The chemists of America use the metric system daily. They are absolutely united in favor of it. I have no sympathy with the argument of cost. If we followed that argument we would be riding buggies while the rest of the world would be using automobiles."

Educational Conference on Business Training of the Engineer

The United States Commissioner of Education is calling a second public conference on commercial engineering on behalf of a committee on commercial engineering appointed by him to investigate business training of engineers and engineering training for students of business. The conference will be held May 1 and 2 at the Carnegie Institute of prominent deans of schools of engineering and of commerce and of engineers and business men who are nationally known for their interest in the reduction of the costs of production, distribution, transportation, etc.

Outstanding topics at the Pittsburgh conference will deal with the new problems that have recently arisen in modern industries, the solution of which demands a more scientific approach. This will include the training of the engineer for a better understanding of problems relating to community development and for the management of overseas engineering projects.

No Nichols Medal Award for 1921

No award of the Nichols Medal will be made this year, it is announced. The medal is awarded to the writer of the most exceptionally meritorious article appearing during the year in the journals of the American Chemical Society. The passing of the award is due to lack of articles of sufficient merit.

Personal

O. M. Butler, who was assistant director of the Forest Products Laboratory at Madison, Wis., has tendered his resignation, effective March 1. He will leave Madison for Washington, D. C., to join the American Forestry Association to direct its technical activities.

Ernest W. Dean has resigned as petroleum chemist of the Bureau of Mines, Pittsburgh, Pa., to join the staff of the Standard Oil Company of New Jersey as director of the standard inspection laboratory. Mr. Dean's successor in charge of the Pittsburgh petroleum laboratory of the Bureau of Mines is N. A. C. Smith, formerly of the Washington office.

Frank R. Eldred and Frederick C. Atkinson announce the organization of Eldred & Atkinson, Inc., chemical adviser and engineer, with offices at 48 East 41st St., New York City, and 1857 Gent Ave., Indianapolis, Ind.

Henry Harnischfeger, president of Pawling & Harnischfeger Co., Milwaukee, Wis., left on Jan. 28 on a combined business and pleasure trip around the world. He is accompanied by Mrs. Harnischfeger, and they plan to go to Japan, the Philippines, China, Burma, Ceylon, India, and up through the Suez Canal to Naples and Europe.

Pierre E. Hayes, formerly with Linde Air Products Co. and the Prest-O-Lite Co., announces the establishment of a consulting engineering office in the Ellicott Square Building, Buffalo, N. Y. His services will be available for the conduct of research, development, test or survey work involving chemistry, physical chemistry, thermodynamics or engineering economics.

David W. Jayne and Herbert G. Sidebottom, formerly associated with The Barrett Co., New York, have entered business together under the corporate name of Jayne & Sidebottom, Inc. They will act as manufacturers' agents in the sale or purchase of chemicals commonly used in the textile, paint, rubber, dye, chemical, pharmaceutical, paper, leather and allied industries. Their offices are in the Whitehall Building, 17 Battery Place, New York.

Colonel E. Lester Jones, director U. S. Coast and Geodetic Survey, Washington, D. C., spoke on March 2 at the Franklin Institute on "Surveying From the Air."

L. Charles Mazzola, assistant superintendent of the Metal & Thermit Corporation, spoke on March 3 at a meeting of the chemical society, which was held in conjunction with the mechanical society of Polytechnic Institute. His subject was "Thermit and Its Application."

Edwin J. Prindle, patent attorney, of Prindle, Wright & Small, New York, was presented by the Commissioner of Patents with the pen with which President Harding signed the Patent Office bill.

Kirby Thomas of New York has been examining the limestone deposits in Parkers Landing, Butler County, Pa.

The American Institute of Mining and Metallurgical Engineers announces the election of new officers of the Institute of Metals Division, as follows: Chairman, W. B. Price, Scovill Manufacturing Co., Waterbury, Conn.; vice-chairman, George K. Elliott, Lunkenheimer Co., Cincinnati, Ohio; secretary and treasurer, W. M. Corse, Monel Metal Products Corporation, Bayonne, N. J. The executive committee is composed of George K. Elliott, Lunkenheimer Co., Cincinnati, Ohio; C. T. Bragg, Michigan Melting & Refining Co., Detroit, Mich.; H. M. Lane, H. M. Lane Engineering Co., Detroit, Mich.; Lawrence Addicks, New York City; William Campbell, Columbia University, New York City; J. A. Capp, General Electric Co., Schenectady, N. Y.; E. E. Thum, Chem. & Met. Eng., Tenth Ave. and 36th St., New York City; George F. Comstock, Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.; W. A. Cowan, National Lead Co., Brooklyn, N. Y., and H. M. Williams, General Motors Research Corporation, Dayton, Ohio.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

A Statistical Study of the Pulp and Paper Industry

The manufacture of paper pulp and its further fabrication into the various grades of paper is one of the chemically controlled industries for which accurate and comprehensive statistics are available. Through the services of the Federal Trade Commission, the commodity division in the Department of Commerce, and the active co-operation of the entire industry, paper manufacturers and consumers, and the general public as well, are provided with a reliable means for following conditions in this important industry.

These compilations prove beyond a doubt that the paper industry has already passed through the worst stage of the present business depression and is now distinctly on the road to improvement. To be sure, the total production figures for 1921 show a decrease of about 27 per cent as compared with 1920, but the real gain is in the monthly outputs. From Table I it will be noted that during the first 7 months of 1921 production dropped off at an alarming rate. From

TABLE I—DOMESTIC PRODUCTION AND SHIPMENTS OF ALL GRADES OF PAPER BY YEARS 1917 TO 1921

(Quantities in Net Tons.)

Month and Year	Monthly Production 1921	Monthly Production 1920	Monthly Shipment 1921	Monthly Shipment 1920
Total for All Grades				
January	420,468	650,293	385,923	646,715
February	407,966	564,500	383,679	532,336
March	440,777	641,343	416,668	656,658
April	422,012	634,402	425,584	622,913
May	383,995	645,413	386,671	662,587
June	403,657	657,322	405,959	668,082
July	370,429	658,518	379,672	657,360
August	442,519	654,158	448,054	652,998
September	477,926	643,018	489,128	648,295
October	542,408	621,964	560,558	613,324
November	535,876	518,144	531,606	499,281
December	508,284	445,539	503,567	423,986

Year	Annual Production	Annual Shipments
1921	5,356,317	5,317,069
1920	7,334,614	7,284,535
1919	6,190,361	6,225,904
1918	6,051,523	6,089,776
1917	5,919,647	5,838,286

420,500 net tons in January the output fell to 370,500 tons in July. Since then, however, the industry has made a remarkable recovery and is now on a production basis which compares favorably with the average for the last 5 years. According to the announcement of the Federal Trade Commission, we produced 506,195 net tons of paper in January, 1922, while the 5-year average for that month is only 504,175 tons.

The trend of production in the paper industry is shown graphically in Fig. 1, which is taken from the Harvard Economic Service's recent report on "The Volume of Manufacture." The adjusted index of 100 is based on the monthly averages for 1919. In discussing the relation of output to productive capacity of the paper industry, Babson makes the following statement: "Operations for 1921 were in the neighborhood of 60 per cent, as against about 90 per cent in 1920 and the rough average of 80 per cent for the 20 years previous thereto. The industry presented no evidence of undue expansion during the war, but since 1919 has increased in capacity at a rapid rate. From 1899 to 1919 the machine capacity grew about 220,000 tons per year. In 1920, however, the capacity increased 900,000 tons over 1919, and in 1921 further increased 650,000 tons over 1920. The number of companies engaged in the business decreased slightly between 1914 and 1919. Production is now estimated at about 70 per cent of capacity. It should be noted that the present capacity exceeds any probable demands during this year."

Production of all grades of paper decreased in 1921 as compared with 1920, the percentage of reduction varying from 39 per cent in the case of wallpaper to 17 in the case of tissue paper. Bag paper, which includes that made into flexible commercial containers such as grocery bags and flour sacks, and fine paper, such as writings, bonds and ledgers, also had very high rates of decrease. Book paper, which includes all periodical paper and miscellaneous grades

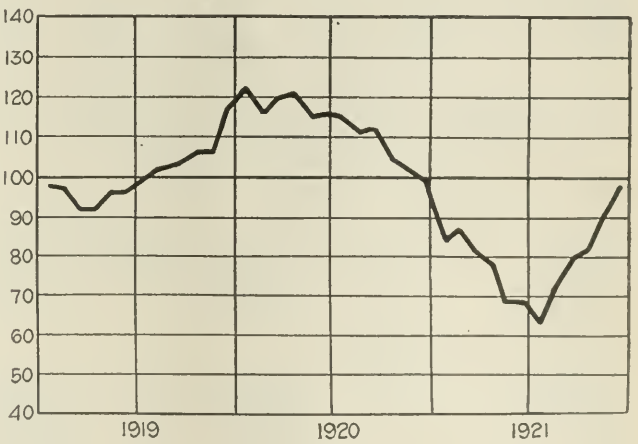

FIG. 1—THE TREND OF PRODUCTION IN THE PAPER INDUSTRY, 1919-1921

of machine finished, supercalendered and coated stock, decreased from 1,104,464 net tons in 1920 to 725,992 tons in 1921. It will be noted that stocks, on the other hand, were considerably larger during 1921 than in the preceding year.

Pulp Production and Stocks

A similar comparison of the production of wood pulp and the other kinds of pulp used in paper making is afforded by Table III. It will be noted that the decreases are in almost exactly the same proportion as in the case of paper. The bleached sulphite pulp shows the maximum reduction in output. Production for all grades of pulp in January, 1922, was 266,921 net tons, as compared with an average of 270,850 tons for the same month in 1919-1922. The Federal Trade Commission has the following to say regarding the ratio of stocks to average production:

"Comparing the stocks on hand at the domestic pulp mills at the end of January, 1922, with their average

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.46
Last week	151.21
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The index number has shown a gain of 6.25 during the past week and is now 14 points higher than the quotation for Jan. 25, 1922, which was the lowest level reached during the current year. This week's increase is due principally to the higher prices for ammonium sulphate, barium chloride, caustic soda and cottonseed oil. The only price reductions among the index commodities were for bleaching powder, soda ash and glycerine.

daily production based on the reports covering the years 1917, 1918, 1919, 1920, and 1921, the figures show that:

Ground wood pulp stocks equal 28 days' average output.

News grade sulphite mill stocks equal 9 days' average output.

Bleached sulphite mill stocks equal 5 days' average output.

Easy bleaching sulphite mill stocks equal 3 days' average output.

Mitscherlich sulphite mill stocks equal 6 days' average output.

Sulphate mill stocks equal 17 days' average output.

Soda pulp mill stocks equal 9 days' average output.

Mill stocks of "other than wood pulp" equal 5 days' average output.

Total mill stocks of all grades equal 16 days' average output."

TABLE II—PRODUCTION AND STOCKS OF PAPER BY GRADES IN 1921 AS COMPARED WITH 1920

(Quantities in Net Tons.)

	Production		Per Cent of Decrease in	Stocks on Hand at the Mills—Maximum Quantity During the Year		Minimum Quantity During the Year	
	1921	1920	1921	1921	1920	1921	1920
Total newsprint	1,226,189	1,511,968	19	41,789	27,955	23,015	16,934
Standard news	1,130,943	1,380,239	18	35,517	25,104	18,227	14,576
Book	725,992	1,104,464	34	40,253	28,434	28,880	20,826
Total paperboard*	1,664,931	2,313,449	28	70,780	53,104	57,169	38,249
Boxboard	1,122,336	1,378,166	19	35,233	25,451	28,696	16,361
Wrapping	651,605	831,889	22	62,811	35,800	45,241	19,570
Bag	130,863	211,923	38	3,792	3,595	2,885	2,015
Fine	242,485	389,322	38	41,143	32,260	33,389	27,127
Tissue	148,142	177,447	17	9,122	6,839	5,811	5,237
Hanging	69,725	113,824	39	10,522	3,027	4,799	960
Felt and building	286,111	366,941	22	13,553	14,116	6,513	6,585
Other grades	210,274	313,387	33	20,580	17,160	17,475	13,621
Total for all grades	5,356,317	7,334,614	27	297,337	214,396	244,657	165,340

*Figures for boxboard prior to March, 1920, were included under Total Paperboard.

TABLE III—DOMESTIC PRODUCTION AND STOCKS OF PAPER PULP IN 1921 COMPARED WITH 1920

(Quantities in Net Tons.)

	Production		Per Cent of Decrease in	Stocks on Hand at the Mills—Maximum Quantity During the Year		Minimum Quantity During the Year	
	1921	1920	1921	1921	1920	1921	1920
Ground wood Pulp	1,268,012	1,578,300	20	226,089	152,973	115,363	92,823
Sulphite, news grade	623,493	843,514	26	24,626	20,549	20,930	12,731
Sulphite, bleached	360,063	518,081	38	16,614	6,682	4,581	3,808
Sulphite, easy bleaching	62,344	72,394	14	1,774	1,386	581	569
Sulphite, mitscherlich	60,005	82,687	27	3,990	2,768	1,064	915
Sulphate pulp	148,165	212,888	30	9,354	7,850	6,200	2,248
Soda pulp	272,287	431,971	37	10,390	6,938	6,281	3,313
Other grades	7,069	7,821	10	208	238	15	26
Total for all grades	2,801,438	3,807,656	26	286,216	183,876	158,555	121,338

TABLE IV—IMPORTS AND EXPORTS OF PAPER (POUNDS AND VALUE) AND PULP (NET TONS)

Paper

	1921		1920	
	Pounds	Value	Pounds	Value
Imports:				
Newsprint	1,584,962,674	$79,123,368	1,459,737,288	$68,600,950
Book paper	1,414,781	199,355	4,340,425	496,132
Wrapping	11,414,472	528,849	4,941,824	460,289
Hanging	.....	363,269	.....	353,791
All other grades	.....	3,039,230	.....	2,741,238
Exports:				
Newsprint	33,641,462	2,162,975	91,951,913	5,983,611
Book paper	40,167,065	5,892,609	95,689,512	13,765,694
Paperboard	.....	2,323,949	.....	5,553,094
Wrapping	26,044,152	2,293,892	61,264,501	6,994,381
Bag	.....	846,909	.....	2,593,459
Fine	.....	4,355,642	.....	8,908,230
Tissue	.....	1,080,380	.....	2,654,529
Hanging	.....	590,549	.....	1,251,743
All other grades	.....	6,143,155	.....	11,091,952
Total imports	.....	83,254,071	.....	$72,652,400
Total exports	.....	25,690,060	.....	58,796,693

Pulp

Imports	1921 Net Tons	1920 Net Tons	1919 Net Tons	1918 Net Tons
Chemical wood pulp:				
Bleached sulphite	95,206	128,206	42,755	16,757
Unbleached sulphite	233,064	344,969	239,952	253,454
Bleached sulphate	4,082	17,277	5,145	3,759
Unbleached sulphate	174,004	182,697	145,911	118,761
Ground wood pulp	190,744	233,148	202,253	185,478
Paper stock other than wood pulp	117,405	254,755	110,195	29,397
Total	814,505	1,161,052	746,211	607,606

Exports	1921 Net Tons	1920 Net Tons	1919 Net Tons	1918 Net Tons
Domestic wood pulp	28,483	32,133	40,095	22,324
Rags and other materials made from vegetable fibers	20,206	42,282	27,271	16,121
Total	48,689	74,415	67,366	38,445

Imports and Exports

Recent increase in the total imports of finished paper, combined with a 50 per cent reduction in exports during 1921, has been a matter of considerable concern to paper manufacturers. Newsprint, the bulk of which is imported from Canada, is the only grade of which the United States is a heavy importer. In 1921 newsprint showed about a 10 per cent increase both in quantity and value. Our foreign trade in paper during 1920 and 1921 and in pulp during the period 1918 to 1921 is shown in Table IV.

The Outlook for 1922

The most pressing problem now facing the paper manufacturers is the need for reducing costs of production. Although costs have receded considerably from the peak reached in 1920-21, they are still much higher than in 1913. To quote a second time from Babson: "Briefly, the outlook for the paper industry during 1922 is for continued readjustment of costs to prices with, nevertheless, a somewhat better demand for manufacture than was the case during 1921. Production should average about 70 per cent, or 6,200,000 lb. The most active period will probably be during the spring and fall months, with very quiet conditions in the summer. The spring activity will not be so good as the fall activity, due to the presence of fairly high stocks. Moreover, an improvement in general business conditions during the fall will then furnish greater stimulation."

Volume of Manufacture Will Increase in 1922

In a detailed report on this subject published Feb. 25, 1922, the Harvard Economic Service makes the following statement regarding future manufacture:

"There is a growing conviction that 1922 will witness a substantial increase of industrial output. Underlying factors are undoubtedly improving; liquidation is proceeding relentlessly; wages are being adjusted; prices are gradually assuming greater stability; agricultural prices in particular are exhibiting a definite tendency to rise. As these factors exert their favorable influence, production will undoubtedly respond. It seems to be generally conceded that consumption for the past year and a half has materially exceeded production. Stocks have been steadily reduced and there has been an increasing resort to current manufacturing to supply current consumption. It is this fact which accounts fundamentally for the rise in the volume of manufactures since last summer. There is every reason to believe that the same forces will operate cumulatively to stimulate production during 1922. With the evident improvement in underlying conditions, a rise in the volume of manufacture during 1922 is confidently predicted."

Many Far-Western Engineers Are Unemployed

Walter V. Brown, manager of the Employment Service of the American Engineering Council, has received a particularly discouraging report from his Californian representative regarding employment conditions on the Pacific Coast.

"The great question," said this report, "is: What is to become of the large percentage of engineers, long out of work and likely to stay so? Engineers do not earn so much that they can be idle for a year with impunity. Many here have gone into other business and others are ready to do the same at the first opportunity. There have been too many engineers turned out by the universities in late years. The market is glutted and it will be a good reaction if we see fewer in the near future."

Annual Reports and Dividend Announcements

Air Reduction Co.—C. E. Adams, president, stated in a recent letter to stockholders that the gross income of the company decreased from $7,189,767.37 in 1920 to $5,338,869.17 in 1921; and the net profits earned on the outstanding stock, before federal taxes, decreased from $1,256,439.93 in 1920 to $630,524.24 in 1921. The latter sum, however, was sufficient to pay the regular dividends out of current earnings.

Among other developments reported in the annual report was announcement of the purchase of control in the National Carbide Corporation. This assures the company of an ample supply of carbide for its own acetylene charging plants as well as for customer demands. Through the purchase of the Compressed Carbonic Co. in Baltimore, the company enters the liquid carbonic field and has already made satisfactory progress. During the year a new oxygen plant was built in Pittsburgh and a new acetylene plant in the Boston district. Commercial production of the "Airco Ignition Gauge" began in October, its active principle, neon, being obtained as a byproduct in the operation of the company's oxygen plants.

Allied Chemical & Dye Corporation—The regular quarterly dividend of 1¾ per cent was declared Feb. 28 on the preferred stock of this company, payable April 1, 1922, to stock of record on March 15, 1922.

Atlas Powder Co.—For the year ended Dec. 31, 1921, this company reported a net income of $634,484, which after allowing for preferred dividends was equal to $1.71 a share on the $5,515,985 common stock. In 1920 the company earned $1,434,693 and paid $16.32 per share on its common stock.

President W. J. Webster, in his letter to stockholders, pointed out that during the last 4 months of 1921 the company had actually earned $15.20 a share on its common stock, but because of greatly reduced inventory could show only $1.71 in its report.

Celluloid Co.—A dividend of 2 per cent upon the capital stock of this company has been declared, payable March 31 to stock of record March 8.

International Salt Co.—The regular quarterly dividend of 1¾ per cent has been declared on this company's capital stock. The dividend is payable April 1, 1922, to stockholders of record on March 15.

National Lead Co.—The report of this company for the year ended Dec. 31, 1921, shows a net income of $3,481,512, as compared with $4,735,509 in 1920. After deducting preferred dividends, the income in 1921 is equivalent to $8.59 per share on the common stock of $20,655,400. The 1920 dividend was $14.67.

United Dyewood Corporation—Dividends on both preferred and common stock of this corporation were announced March 1. The preferred dividend of $1.75 per share and the common of $1.50 are payable April 1 to stockholders of record March 15.

The St. Louis Market

St. Louis. March 2, 1922.

The recent activity in the heavy and industrial chemical market is still apparent with evidence of a broadening demand. Prices on the whole are very steady and the general trend appears to be toward higher levels. This is especially true on goods of foreign origin, where prices are being increased solely by the rising exchange. The weak spots in the market are becoming fewer and apparently the pressure toward downward revisions has passed, and prices today are based on actual production value and replacement conditions. Increased business is also manifested by the fact that the sales for February exceeded those for the corresponding month of last year by a large margin.

Alkalis

The alkali market remains firm with no price change since our report of Feb. 16; 76 per cent solid *caustic* is quoted at $3.40 per 100 lb. in carlots f.o.b. point of production, with 1- to 10-drum lots at $4@$4.10 delivered to buyer's door. The flake can be had at from 35 to 40c. per 100 lb. over the solid in all cases. There is no change in *soda ash*, prices still ranging from $2.40@$2.75 per 100 lb. for 58 per cent light in less than carlots. There is little doing in carlot buying. A buyers' market now prevails in *sal soda*, with a considerable range of prices.

General and Special Chemicals

Producers of heavy commercial mineral acids report the market very strong, especially the *nitric acid* group, price being based on 40 deg. at $7.40 per 100 lb. f.o.b. point of production and find no difficulty in getting business. *Sulphuric acid* is also very strong. *Muriatic acid* has had an overproduction; however, the price is firm. The decline of 1c. per lb. on *boric acid* last week has given way to a better demand and there is a freer movement. The low stocks of imported *citric acid* are stimulating a demand for domestic goods. This should be an opportune time to anticipate requirements, as prices have declined to a level where further reduction would net a loss to the producer. *Carbolic acid* is moving in a fair way. There has been no change in the *gallic acid* and *pyrogallic acid* movement. While the activities in the *phosphoric acid, U.S.P. sirupy*, market have not been altogether at a standstill, the increase has not been sufficient to give prices a firmer tone, but factors believe that complete recovery will be made in a short time and that a firmer market will then exist. Producers still report a sold-up position on *white arsenic* and are quoting in carlots at 7c. St. Louis. With the continued advance in the sterling exchange, *bismuth salts* and *iodide salts* are in greater demand than ever, and producers are well situated to meet this increase.

Glycerine has eased up some, and can be had at 16c. in drums, a decline of ¼c. in last week's price. *Sulphur* has shown a little more life recently, and while the price remains constant, it has been moving in greater volume. Inquiry and demand for *zinc sulphate, U.S.P.* continue to increase, with a fair demand for the technical grade, the latter being quoted at $2.95 in carlots f.o.b. St. Louis.

Linseed oil is still firm, the raw oil price having reached 92c. last week, and is now being offered at 91c. *Castor oil* advanced ¼c. during the last few days, now being held firmly at 13¼c. in drums; in quantities of 200 gal. this price can be bettered 1c. *Turpentine* is somewhat easier, and is being offered today at 91½c. in barrels.

A very unusual condition now prevailing in the paint industry is pessimism. The paint grinders, usually optimistic, are now showing signs of losing faith, and their attitude is evident in their purchasing. One of the largest paint grinders in St. Louis recently made the statement that at the rate he was now going it would be unnecessary to purchase any more raw material this season. Prices remain unchanged and demand very poor.

The New York Market

New York, March 6, 1922.

Changes in the price levels for a number of basic commodities are the outstanding developments of the week. Although the general trend of the market is undoubtedly upward, a number of leading producers have announced lower prices for such products as bleaching powder, glycerine, and zinc sulphate. On the other hand, there have been significant increases in the case of ammonium sulphate and cottonseed oil. Prices for caustic soda have not changed appreciably among the manufacturers, but the dealers report a noticeable firmness to the market. The export inquiry for caustic has continued and a few sales of moderate volume were reported.

There was no relief seen in the nitrite of soda market. A scarcity of imported material, together with a limited amount of domestic goods on the spot market, was chiefly responsible for the present situation. Some large producers of bleaching powder have reduced prices in order to compete successfully with importers. The first-hand market, as a result, reached the lowest price since May, 1919, when sales were recorded at 1½c. per lb. Prussiates have remained fairly firm, with odd lots in moderate demand. Zinc sulphate in carload quantities is a trifle lower.

Acetate of Soda—Some producers are not inclined to accept business in this chemical under 4½c. per lb. It is stated that large sales have been made to the dyestuff industry on this basis. Low-priced material that was

offered so freely has been partly absorbed and offerings are much scarcer.

Barium Chloride—Higher prices have been established on spot and it is doubtful if better than $58 per ton can be done for any quantity. Some sellers quote up to $60 per ton. The demand is good, with a higher market expected in the near future.

Bichromate of Potash—Sales of small lots on spot were recorded at 10¼c. per lb. Large sellers have shaded this figure to 10⅛c., while in some quarters as low as 10c. was heard. Business in only fairly moderate.

Bichromate of Soda—Trading on spot has shown no unusual activity. Dealers have sold small lots at 7¾c. per lb. Shipments are quoted at 7½c. The call for contract deliveries is steady among leading manufacturers.

Bleaching Powder—Foreign competition is being met by domestic producers and sales have gone through at the works as low as 1¾c. per lb. Imported material has been offered at $1.80 per 100 lb. ex-dock New York. The demand is not as active as in the early part of February.

Caustic Soda—Leading producers are maintaining the contract price of 2½c. per lb., basis 60 per cent, f.o.b. works. The demand is holding steady and shipments for the month of February have shown an increase over January. Dealers are quoting 3½c. per lb. for March shipment.

Lead Acetate — Large factors in this commodity have announced a cent per lb. reduction on all varieties. Prices range from 9§@12c. per lb. Business was reported a trifle better since the reduction.

Nitrite of Soda—Second hands are in possession of some limited quantities of domestic goods which are being offered at 8c. per lb. Producers are asking 8½c. per lb., f.o.b. works. Imported material is offered sparingly, with some small-lot sales recorded at 8c. per lb. early in the week. These sellers demand 8½c. at the close. The market is very firm.

Silicate of Soda—Large producers report sales to the consuming industries at $2.25 per 100 lb. in carload quantities for the 60 deg. Bé. Prices on the 40 deg. range from 85c. to $1.20 per 100 lb., depending on quantity.

Soda Ash—Lower prices have been established for soda ash at the works. Manufacturers offer light, 58 per cent, at $1.10 per 100 lb. in bulk, $1.20 in bags and $1.40 in barrels, basis 48 per cent, f.o.b. works. Spot and prompt shipments command a premium of 10c. per 100 lb. Dealers report sales of less than carload quantities at $1.95.

Zinc Carbonate—Producers are holding spot material at 14c. per lb. in barrels and 16c. in kegs. Moderate trading was reported at these figures.

Zinc Chloride—Domestic sales were reported by producers at 7½c. per lb. in carlots and 8c. in smaller quantities. The demand is fair.

Zinc Sulphate—Leading factors have reduced prices in large quantities ½c. per lb. and quote $2.75 per 100 lb. for prompt shipments. Business has improved to a noticeable extent since this reduction.

Vegetable Oils

Cottonseed Oil—The market during the past week was comparatively firm, reflecting the growing scarcity of crude material. New high figures were established at the close of trading. All short interests in the market were virtually liquidated. Winter oil on spot for domestic consumption was held around 13¼@13½c. per lb. Crude cottonseed sold at a new high mark, sales passing at 10¼@10½c. per lb., buyers' tanks, f.o.b. mills.

Linseed Oil—The market was easier, with fairly liberal offerings of imported material in several directions.

Fertilizers

Ammonium Sulphate—The market on this product has become one of the outstanding features in the chemical market. Spot supplies have practically disappeared and futures have been offered in only a very limited way. The export inquiry has become more active and unfilled orders for large quantities have been on the market for the past weeks. Material in double bags, f.a.s. N. Y., was quoted at 3c. per lb. Goods at the works are nominal, with a stray offering heard now and then at 2¾c. per lb.

The Iron and Steel Market

PITTSBURGH, March 3, 1922.

There has been a slight further increase in steel mill operations, the rate of steel ingot production at present being set at 29,000,000 tons a year, against 28,000,000 tons a fortnight ago, less than 18,000,000 tons at the end of December, and 23,000,000 tons last October and November, the highest rate since February a year ago.

Latest reports, not generally circulated as yet, are that there has been a noticeable falling off in buying of important finished steel products in the past week or 10 days. This might be regarded as quite natural in the circumstances, but the period of observation is too short to justify definite conclusions. A period of 30 days would be better.

The buying of steel has been widespread in character and is thoroughly healthy in that respect. There is even a fair percentage of railroad business, fully as much as could be expected in present railroad conditions. Even the agricultural implement trade, long the slackest of all the steel consumers, has been doing a little business. Demand for steel for the building trades is good rather than merely fair, seen particularly in standard steel pipe, both black and galvanized, and in sheets for metal lath, ceiling, eaves trough and conductor pipe, etc. The automobile trade is taking a natural proportion.

More Price Weakness

Some fresh price weakness has developed, although only in certain lines. Bars, shapes and plates, which got to an unexpectedly low level when they reached 1.40c. recently, are by no means rallying around that price, as in the Pittsburgh district lower prices have been made on certain large orders, while east and west the divergences from Pittsburgh basing have been more pronounced, the probability being that approximately 1.40c. f.o.b. mill has been done, representing very much less than 1.40c. f.o.b. Pittsburgh. In tubular goods the concessions from the regular lists have grown rather sharply in the past week or two, so much so that there is question whether new lists will not have to be issued.

In sheets the prices established more than 3 months ago, 2.25c. for blue annealed, 3c. for black and 4c. for galvanized, are still maintained, but this price steadiness, instead of being regarded as a support or stimulus to the steel market in general, is now regarded rather as an anomaly. The sheet prices present the curious phenomenon of affording a slight profit to the producers. Tinplate is in this category also, but that is not phenomenal, since tin plate is different from all other steel commodities and is promised a full demand for this year if not indeed a record demand.

The market in wire products is perhaps a trifle steadier. The special price of $2.40 on nails, as against the regular or official price of $2.50, has now become practically general, but on the other hand plain wire, instead of yielding correspondingly, seems to be steady at its regular price of 2.25c.

Pig Iron

Recent sales of basic pig iron on the basis of $17.75 valley are now regarded as making the market rather than as being exceptional and $18 is considered merely an asking price. Bessemer has sold in carload lots in the past week at its old price of $19.50, although there is little doubt that the $19 basis, done recently on a fair-sized lot, would apply on any tonnage. Foundry iron has sold more often at $19 valley than at $18.75.

Connellsville furnace coke has no more than held its recent advance to a range of $3.25@$3.50. Demand for coal, an important factor in coke prices, has decreased in the past 10 days, and the expectation that Connellsville operators could do better in the coal market than in the coke market is not yet justified. Foundry coke, however, has gone up some more, being now quotable strong at $4.25@$4.75, depending on brand, representing a straight advance of 50c. in 2 or 3 weeks.

The Pittsburgh Steel Co. and the Jones & Laughlin Steel Co., long absent from the scrap market, have in the past few days bought more than 10,000 tons of heavy melting steel, the reported price being $15. Dealers had been bidding $14 @$14.50 for odd lots as they appeared.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.40 – $0.42
Acetone	lb.	$0.12½ – $0.12½	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.60	2.65 – 3.00
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.30 – 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9.50	9.75 – 10.00
Boric, crystals	lb.	.11 – .11¼	.11½ – .12
Boric, powder	lb.	.11½ – .11½	11½ – 12½
Citric	lb.	..... –	.44½ – .45
Hydrochloric	100 lb.	1.15 – 1.25	1.30 – 1.75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – 12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – 12
Lactic, 22 per cent tech	lb.	.04 – .04¼	.04½ – 05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06½ – .06½	.06½ – .07
Nitric, 42 deg.	lb.	.06½ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.12 – .12½	.13 – .14
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½ – .09½
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10.00 – 11.00	..... – .....
Sulphuric, 60 deg., drums	ton	12.00 – 14.00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16.00 – 16.50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.25 – .26
Tartaric acid, imported, powdered	lb.	..... –	.26 – .29
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.36 – .37
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.36 – .37
Alum, ammonia, lump	lb.	.03½ – .03½	.04 – .04½
Alum, potash, lump	lb.	.03½ – .03½	.03½ – .05
Alum, chrome lump	lb.	.07½ – 08	.08¼ – 08½
Aluminum sulphate, commercial	100 lb.	1.65 – 1.85	1.90 – 2.40
Aluminum sulphate, iron free	lb.	.02½ – .02½	.03 – 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07½	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06¼ – .07	.07½ – .07½
Amylacetate tech	gal.	..... –	2.00 – 2.40
Arsenic, white, powdered	lb.	.07 – .07½	.07½ – 08
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – 13
Barium chloride	ton	58.00 – 60.00	61.00 – 70.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07¼ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	1.75 – 2.00	2.05 – 3.00
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – 06¼
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.20 – .21	.21½ – .26
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – 05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27.00
Calcium chloride, granulated	lb.	.01¾ – .02	02¼ – 02½
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.90 – .92
Carbon bisulphide	lb.	.06 – .06½	.06½ – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10¾	.11 – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04¼ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03½	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06½ – 07
Chloroform	lb.	..... –	.37 – 40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 30.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.55 – 5.65	5.70 – 6.25
Cream of tartar	lb.	..... –	.24 – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – 1.00
Formaldehyde, 40 per cent	lb.	.09 – .9½	.09½ – 10½
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth—imported powdered—net	ton	30.00 – 32.00	..... –
Fusel oil, ref.	gal.	..... –	2.50 – 3.00
Fusel oil, crude	gal.	..... –	1.40 – 1.75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16 – .17
Iodine, resublimed	lb.	..... –	4.05 – 4.15
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.10 – .12
Lead arsenate, powd.	lb.	.15 – .15½	15½ – 16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06½ – .08
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2.75 – 3.00
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1.80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	10½ – 10½	10½ – 10¾
Potassium bromide, granular	lb.	..... –	.13 – .17
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – 16
Potassium carbonate, 80–85%	lb.	.04 – .04½	.04½ – 05½
Potassium chlorate, crystals	lb.	.05½ – .06	06¼ – 08
Potassium cyanide	lb	..... –	.42 – 45
Potassium hydroxide (caustic potash)	100 lb.	5.65 – 5.75	5.80 – 6.50
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07½ – .07½	.08 – .09
Potassium permanganate	lb.	.13 – 14	.14½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	25½ – .26	.26½ – .26½
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.06½ – .07	07¼ – .07½
Salammoniac, gray, granular	lb.	.06½ – 06½	.07 – .07½
Salsoda	100 lb.	1.60 – 1.70	1.75 – 2.00
Salt cake (bulk)	ton	17.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 1.90	1.95 – 2.40
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04½ – .04½	.04½ – .05
Sodium bicarbonate	100 lb.	2.10 – 2.15	2.20 – 2.50
Sodium bichromate	lb.	.07½ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04½	.04¾ – .05½
Sodium chlorate	lb.	.06¼ – .06½	.07 – .07½
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10½ – .11
Sodium hydroxide (caustic soda)	100 lb.	3.45 – 3.50	3.55 – 4.00
Sodium hyposulphite	lb.	.03¼ – .03½	.03½ – .04
Sodium nitrite	lb.	.08 – .08¼	.08½ – .08¾
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.18¼ – .18½	.18½ – .19
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.50 – 2.60	2.65 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.15 – 1.25	1.30 – 1.90
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04⅛ – .04½	.04¾ – .05
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04½
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, red	lb.	.05 – .05½	.05½ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran.	lb.	.07½ – .08	.08¼ – .08¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08½ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.29 — .30
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.27 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.15 — .16
Ortho-cresol, in drums (100 lb.)	lb.	.18 — .20
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.10 — 1.15
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Dipnenylamine	lb.	.59 — .70
H-acid	lb.	.90 — 1.00
Meta-phenylenediamine	lb.	.95 — 1.00
Monochlorbenzene	lb.	.12 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06½ — .07
Naphthalene, flake	lb.	.06½ — .07½
Naphthalene, balls	lb.	.07½ — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — 80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — 18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	.11½ —	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.25 —	1.30
Resorcinol, pure	lb.	1.80 —	1.95
Salicylic acid, tech., in bbls.	lb.	.18 —	.20
Salicylic acid, U. S. P.	lb.	.22 —	.23
Salol	lb.	.80 —	.82
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.25 —	.27
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Candellila Wax.....25-26c. per lb.
Carnauba Wax—No. 3—North Country....15½-16c. per lb.

All other prices remain quotably unchanged.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.30 —	5.35
Rosin E-I	280 lb.	5.40 —	5.45
Rosin K-N	280 lb.	6.05 —	6.80
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.85 —	....
Wood turpentine, steam dist	gal.	.83 —	....
Wood turpentine, dest. dist	gal.	.82 —	....
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.30 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, bulk	100 lb.	$2.85 —	3.00
Blood, dried, f.o.b., N. Y	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb	2.45 —	2.50
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	34.00 —	37.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Prices remain the same as March 1st report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls	lb.	.14 —	.14½
Coconut oil, Ceylon grade, in bbls	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls	lb.	.09¾ —	.10
Corn oil, crude, in bbls	lb.	.10½ —	.10⅝
Cottonseed oil, crude (f. o. b. mill)	lb.	.10⅝ —	.10¾
Cottonseed oil, summer yellow	lb.	.11½ —	.11⅝
Cottonseed oil, winter yellow	lb.	.13¼ —	.13⅜
Linseed oil, raw, car lots (domestic)	gal.	.85 —	.86
Linseed oil, raw, tank cars (domestic)	gal.	.81 —	.82
Linseed oil, in 5-bbl lots (domestic)	gal.	.89 —	.90
Olive oil, denatured	gal.	1.15 —	1.20
Palm, Lagos	lb.	.08¼ —	.08½
Palm, Niger	lb.	.06⅝ —	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls	lb.	.13 —	.13¼
Rapeseed oil, refined in bbls	gal.	.86 —	.87
Rapeseed oil, blown, in bbls	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.10¼ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	nominal	

FISH

Light pressed menhaden	gal.	$0.53 —	....
Yellow bleached menhaden	gal.	.56 —	....
White bleached menhaden	gal.	.55 —	....
Blown menhaden	gal.	.60 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$800 00	$1,000.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70 00 —	120.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	12.50 —	17.50
Barytes, ground, white, f.o.b. mills	net ton	23.00 —	23.50
Barytes, ground, off color f.o.b. mills	net ton	17.00 —	21.50
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24 00
Barytes, crude f.o.b. mines	net ton	6.00 —	7.00
Casein	lb.	.11 —	.12

All other prices remain unchanged.

Refractories

Quotations the same as previous report.

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11½ —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 78-82% Mn, English and German c. i.f. Atlantic seaport	gross ton	58.00 —	62.50
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.37 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.00 —	4.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	21.00 —	22.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	20.00 —	21.00
Coke, foundry, f.o.b. ovens	net ton	4.00 —	4.25
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.23 —	.25
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.48 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.35
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29.50
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.40
Zinc, spot, New York	4.95–5.00
Zinc, spot, E. St. Louis	4.50–4.55

OTHER METALS

Silver (commercial)	oz.	$0.64½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	1.90@2.00
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	85.00@ 90.00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	49.50

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

ROBERSTDALE — The Sanford-Seever Orchard Co. is planning for the construction of a new gas-producer plant at its properties.

DOTHAN—Fire, Feb. 14, destroyed a portion of the refining plant of the Dothan Syrup Co., with loss estimated at about $75,000, including equipment.

Arizona

JEROME—The United Verde Copper Co. is completing plans for the construction of a new crushing plant at Clarkdale, Ariz., estimated to cost about $1,500,000, with machinery. Contract for foundation work has been let to Twohy Bros., Phœnix, Ariz., at a cost of approximately $150,000.

California

BURBANK—The American Aluminum-Metal Products Co. has awarded a contract to R. W. McCrea, Huntington Park, Cal., for the erection of its proposed new local plant, comprising a group of seven buildings, estimated to cost in excess of $90,000. Richard D. King, 519 Van Nuys Bldg., Los Angeles, is architect.

Florida

CHULUOTA—The Petrous Mfg. Co., recently organized with a capital of $50,000, is planning for the erection of a 2-story plant, 40 x 85 ft., for the manufacture of cement brick and kindred products. The works will be equipped for an initial daily output of 30,000 bricks. Frank Wheeler is president; J. A. Rogers is secretary and treasurer in charge.

FORT PIERCE—The Gulf Sugar Corp. has completed plans and will soon commence the erection of a new sugar refinery on local site, with initial capacity of about 100 tons per day.

SEABREEZE—The Town Council has plans under way for the installation of a water-softening plant in connection with extensions and improvements to the waterworks system.

Georgia

ATLANTA—The White Provision Co. is planning for the erection of a new fertilizer works at its plant. The capacity of the lard refinery will be increased with the installation of new equipment. The company will also build a new electric power plant. The capital has recently been increased to $1,000,000 for expansion. W. H. White, Jr., is president.

Illinois

BRISHENE—The Western Union Telegraph Co., Van Buren near Scott St., Joliet, Ill., has plans under way for the erection of a new creosoting plant for pole treatment at Frankfort, near Brishene, estimated to cost about $60,000, including equipment.

Indiana

BLOOMINGTON—The Bloomington Brick & Tile Co. has plans nearing completion for the construction of a new plant at Unionville, near Bloomington, for the manufacture of brick, tile and other burned clay products, estimated to cost about $250,000, including machinery. The company is arranging for the financing of the project. A. W. Beecher is president.

Kentucky

CATLETTSBURG—The Great Eastern Refining Co., recently organized with a capital of $200,000, A. J. Dalton, Huntington, W. Va., president, is planning for the erection of a new oil-refining plant at Leach, near Catlettsburg, with initial capacity of about 500 bbl. A site has been selected and work will be commenced at an early date. The equipment installation will include agitators, stills, tanks, and general operating machinery. T. H. Gilman is general manager.

Maryland

BALTIMORE—The Standard Oil Co., Pratt and Commercial Sts., has completed plans for the construction of a 2-story chemical mixing and pumping plant on Third Ave., near Second St.

TEXAS—The J. B. Logan Lime Co. will install a new 30-in. grinding mill at its plant.

BALTIMORE—The Pompeian Romanza Corp., recently organized with a capital of $1,760,000, has acquired the plant, property and equipment of Musher & Co., manufacturer of olive oil products, at Fayette and 11th Sts., for a consideration said to be $600,000. The new owner will use the plant for the manufacture of edible oils, compounds, etc., and will commence operations at an early date. It is headed by W. W. and W. H. Cook, and W. H. Hamilton.

Massachusetts

MALDEN—The Silex Co. of Massachusetts has acquired the factory of the Franklin Rubber Co., 926 Eastern Ave., for the operation of a plant for the manufacture of glass products.

FALL RIVER—The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, manufacturer of refined oil products, is planning for the erection of a new plant at the foot of Slade St., Fall River, estimated to cost close to $1,000,000, including equipment. Metzger & Fisher, Otis Bldg., Philadelphia, are contractors for certain features of the project.

Michigan

CADILLAC—The new plant of the Cadillac Lumber & Chemical Co., to be located at Sault Ste. Marie, Mich., will consist of a number of buildings, estimated to cost in excess of $150,000, including machinery. The plant will have a department for the production of acetate of lime, with capacity of about 2 cars a week; for the manufacture of wood alcohol, charcoal and other affiliated products. Work will be commenced early in the spring, and will be pushed to completion. It is expected to give employment to more than 400 persons. The present plant will be removed to this location. The company is operating with a capital of $1,000,000.

IONA—The Michigan Porcelain Tile Co. has completed plans and will take bids at once for the erection of a new 1-story and basement plant, 120 x 155 ft., estimated to cost about $42,000. P. Lindout, 5th floor, Michigan Trust Bldg., Grand Rapids, is architect. H. Kidder is general manager.

Missouri

ST. CHARLES—The Weldon Spring Quarry, recently organized, is planning for the establishment of a lime-fertilizer plant, in connection with its quarry properties in this section, with a daily capacity of about 2 carloads of material. A rock-crushing plant will be installed with daily output of about 6 carloads of crushed material.

KANSAS CITY—The Lion Oil & Refining Co. is planning for the installation of new equipment at its plant, including agitator, tanks, etc. The company will construct a new pipe line to cost about $80,000. Victor H. Smith is general manager.

New Jersey

NEWARK—The United Butchers' Fat & Reducing Co., Doremus Ave., has filed plans for the erection of its proposed new plant, consisting of a main factory to cost about $23,000, power house, garage and other operating buildings. The plant will be used for the manufacture of soaps, greases, etc.

PERTH AMBOY—Fire, Feb. 23, destroyed a portion of the chemical plant of the Novo Laboratories, 651 Catherine St., with loss estimated at about $15,000.

New York

NEW YORK—The New Amsterdam Gas Co., 130 East 15th St., has filed plans for the construction of a new laboratory and switch house, 63 x 107 ft., at its plant at 403-7 East 40th St., to cost about $100,000. William Whitehill, Buckley-Newhall Bldg., 6th Ave and 41st St., is architect and engineer.

NEW YORK—Fire, Feb. 21, damaged a portion of the plant of the Redding Chemical Works, Inc., 329 East 47th St., manufacturer of printing and lithographing inks. An official estimate of the loss has not been announced.

Oklahoma

SAYRE—The Common Council will install a new filtration plant in connection with extensions and improvements in the waterworks system.

MADILL—The Common Council is planning for the construction of a filtration plant and other improvements at the municipal waterworks to cost about $500,000.

Pennsylvania

LOCK HAVEN—The American Aniline Products Co. is planning for the erection of a 2-story and basement plant building, 200 x 250 ft., to replace the factory recently destroyed by fire with loss of about $150,000. The new structure will cost a like amount. Headquarters of the company are at 80 5th Ave., New York, N. Y.

FAIRCHANCE—The Quertinmont Glass Co., manufacturer of window glass, has preliminary plans under way for the erection of a new plant at Fairchance, to be of "five-pot" initial capacity, giving employment to more than 500 operatives. A new process of glass manufacture will be used. It is expected to have the plant ready for operation in the fall, with additional plant units to be built in 1923. Jules J. Quertinmont is president.

PITTSBURGH—Fire, Feb. 17, destroyed a portion of the plant of the Walker Chemical Co., McCartney St., West End, with loss estimated at about $10,000.

CHESTER—The Scott Paper Co., foot of Market St., Philadelphia, Pa., has taken bids for the rebuilding of a 2-story factory at its works at Chester, 45 x 85 ft.

PITTSBURGH—The Creative Chemical Co. has filed plans for the erection of a new 1-story building at 4616-20 Friendship Ave.

HIGHSPIRE—The Keystone Carbonic Gas Co., recently organized, has acquired the local plant of the Highspir Distillery Co., for the establishment of a new plant for the manufacture of acid gas. The plant will be remodeled and improved, and a carbonic gas laboratory, totaling about 21,000 sq.ft. of floor area, constructed. S. S. Bailey is president, and E. W. Powell, secretary.

Tennessee

GREENBACK—The Greenback Brick Co. is planning for the erection of a new plant for the manufacture of brick and other burned clay products, with initial capacity of about 30,000 bricks per day. J. L. Jones is proprietor and general manager.

MT. PLEASANT—Fire, Feb. 23, destroyed the grinding plant of the Charleston Mining & Mfg. Co., with loss estimated at about $100,000, including machinery. It is planned to rebuild.

Texas

DALLAS—Fire, Feb. 20, destroyed a portion of the plant of the Hesse Envelope Co., Carter and Caruth Sts., manufacturer of paper products, with loss estimated at about $100,000, including machinery. George S. Otey is president.

Virginia

WOODSTOCK—The Hygrade Manganese Co., operating properties in the Cedar Creek Valley section, has taken out a state charter, with capital of $100,000, to provide for general expansion. The company will acquire lands to the extent of 3,000 acres and open up new properties as required. N. H. Manafee is president, and Charles B. Massie, vice-president.

West Virginia

NITRO—The Southern Dyestuffs Co. is planning for the installation of machinery in a number of buildings at its local plant for the manufacture of dyesuffs and intermediates. The extension will give employment to about 200 men.

KANAWHA CITY—The Libbey-Owens Sheet Glass Co. will make extensions and improvements in its plant at Kanawha City, to cost about $200,000, including a new power plant and other buildings.

New Companies

THE PYRALAC CHEMICAL CO., Newark, N. J., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are Ira Bingham, M. M. Fast and George N. Bick, 71 Paris St., Newark.

THE KEMO PRODUCTS CO., Rochester, N. Y., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are E. N. Barber, R. G. Fisher and S. E. Godden. The company is represented by Lynn Bros., attorneys, Rochester.

THE AMERICAN TIRE WORKS, INC., Pawtucket, R. I., has been incorporated with a capital of $50,000, to manufacture automobile tires and other rubber products. The incorporators are John T. Burke, D. and Nathan Siegelman, 50 Central Ave., Pawtucket.

THE SILVER FLASH OIL CO., 115 North Charles St., Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are Otto C. Peterman, Silas Murray and Stanley C. Edmister.

THE CROWN FOUNDRY CO., Hersheel St., East Peoria, Ill., has been incorporated with a capital of $16,000, to manufacture iron, steel and other metal castings. The incorporators are Frank Barr, J. D. Armstrong and O. B. Slater.

THE NEW YORK COAL-TAR PRODUCTS & CHEMICAL CO., New York, N. Y., has been incorporated under Delaware laws with a capital of $1,000,000, to manufacture chemicals and affiliated products. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia, Pa.

THE KEYSTONE REFRACTORIES CO., Jersey City, N. J., has been incorporated with a capital of $10,000, to manufacture firebrick and other refractory products. The incorporators are J. W. Young, F. W. Beisman and L. E. Turk, 3 Foy Place, Jersey City.

THE SUNNYSIDE BRONZE FOUNDRY, New York, N. Y., has been incorporated with a capital of $5,000, to manufacture bronze and brass castings. The incorporators are K. Rippel, J. Forman and O. S. Berger. The company is represented by Abraham Lipton, 160 Broadway, New York.

THE TYCOON OIL CO., Erlanger, near Covington, Ky., has been incorporated with a capital of $50,000, to manufacture petroleum products. The incorporators are J. B. Respress, Erlanger; Benjamin Berkshire, Petersburg, Ky.; and E. B. Terrell, Covington, Ky.

THE ATLAS CHEMICAL LABORATORIES, INC., 1717 Mosher St., Baltimore, Md., has been incorporated with a capital of $50,000, to manufacture chemicals, acids, fertilizers and kindred products. The incorporators are B. L. Auld, John E. Auld, Sr., and Joseph Lichtenberg.

THE INDE-PENN OIL & REFINING CO., 223 North Galena Ave., Dixon, Ill., has been incorporated with a capital of $50,000, to manufacture petroleum products. The incorporators are Chester V. Chapman, Floyd D. Chapman and George F. Prescott.

THE ZENITH CHEMICAL CO., 285 South 20th St., Newark, N. J., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by Bernard W. VonSmuda, 343 16th Ave., Irvington, Newark.

THE LEVIN CO., 607 Nogalitos St., San Antonio, Tex., has been incorporated with a capital of $10,000, to manufacture lubricants and kindred oil products. Nathan Levin is president, and W. P. Gee, vice-president.

THE ACID-PROOF BRONZE CO., Pittsburgh, Pa., has been incorporated under Delaware laws, with capital of $200,000, to manufacture special bronze and other metal products. The incorporators are John P. and W. R. Kegg, and J. J. Elling, Pittsburgh. The company is represented by the Corporation Service Co., Wilmington, Del.

THE GREAT NORTHEASTERN CHEMICAL CO., 1362 Dorchester Ave., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by Richard Fine.

JAYNE & SIDEBOTTOM, New York, N. Y., have been incorporated with a capital of $10,000, to manufacture chemicals and kindred products. The incorporators are D. W. Jayne, H. G. Sidebottom and L. T. McManus. The company is represented by McKerchery & Link, 40 Rector St., New York.

THE TAYLOR-KENTUCKY OIL CO., 716 Fidelity Bldg., Baltimore, Md., has been incorporated with a capital of $750,000, to manufacture petroleum products. The incorporators are Morgan J. Cramer, Josiah and John R. Speer.

THE STAUDT & NEUMANN CO., 13 South Broadway, Aurora, Ill., has been incorporated with a capital of $36,000, to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are Louis C. and Albert J. Staudt, and Herbert L. Neumann.

THE METZ PLATINUM REFINING CO., 42 Walnut St., Newark, N. J., has filed notice of organization to manufacture refined metals. Werner P. Metz, 470 Belmont Ave., heads the company.

THE COMMONWEALTH DRUG & CHEMICAL CO., Philadelphia, Pa., has been incorporated under Delaware laws, with a capital of $100,000, to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are R. Lincoln and Hodge Lester, and H. L. Adams, Philadelphia. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE TRI-CITY BRICK CO., Second Ave. and 18th St., Rock Island, Ill., has been incorporated with a capital of $60,000, to manufacture brick, tile and other burned clay products. The incorporators are S. M. and J. L. Buckley, and H. O. Binyon.

THE RADIUM CHEMICAL CO., 44 Front St., Worcester, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by James W. Lecuyer and Frank S. Walker.

THE NEW JERSEY METAL TREATMENT CO., Newark, N. J., has been incorporated with a capital of $4,000, to manufacture special metals. The incorporators are Adolph Doll and Alexander Ross, 482 18th Ave., Newark.

THE QUAKER PAINT CO., Philadelphia, Pa., has been incorporated with a capital of $25,000, to manufacture paints, varnishes, etc. Ferdinand Ambacher, 1236 West Airdrie St., Philadelphia, is treasurer.

THE MODERN BRASS FOUNDRY CO., Indianapolis, Ind., has been incorporated with a capital of $25,000, to manufacture brass, bronze and aluminum castings. The incorporators are Fred W., Ralph N. and Pulaski E. Smith, all of Indianapolis.

THE K. I. HERMAN CHEMICAL CORP., 38 South Dearborn St., Chicago, Ill., has been incorporated with a capital of $300,000, to manufacture chemicals and chemical byproducts. The incorporators are K. I. Herman, R. E. Maurer and George J. Koreck.

THE PEERLESS CORK CO., 26 Prospect St., Newark, N. J., has filed notice of organization to manufacture cork products, seals, etc. The company is headed by Charles A. Hauser, 61 Linden Ave., Irvington, Newark.

THE LIBERTY COLOR & CHEMICAL CO., Philadelphia, Pa., has been organized to manufacture chemicals, chemical byproducts, dyes, etc. The incorporators are Thomas J. Grady, Thomas D. O'Brien and Robert J. Tracey. The company is represented by Charles A. Waters, 1208 Widener Bldg., Philadelphia.

THE ASSOCIATED REFINERIES CO., Denison, Tex., has been incorporated with a capital of $15,000, to manufacture petroleum products. The incorporators are V. H. Williams, M. R. Murray and George P. Blair, all of Denison.

HAYES-DEPRATO, INC., Ferndale, Mich., has been incorporated with a capital of $50,000, to manufacture paints, varnishes, etc. The incorporators are W. A. Wooliver, N. J. Deprato and W. P. Hayes, 6104 Crane Ave., Detroit, Mich.

THE PHOSPHO ALBUMEN CO., Newburgh, N. Y., has been incorporated with a capital of $30,000, to manufacture chemical specialties. The incorporators are R. H., J., and R. H. Cathcart, Jr., Newburgh. The company is represented by J. Witschief, attorney, Newburgh.

THE ROYALCROSS CO., Brooklyn, N. Y., has been incorporated with a capital of $50,000, to manufacture extracts, oils, etc. The incorporators are A. M. Wilson and M. Levine. The company is represented by J. B. Baer, 2 Rector St., New York.

THE FRAZIER CUSHION CORD TIRE CO., Wheeling, W. Va., has been incorporated with a capital of $75,000, to manufacture automobile tires and other rubber products. The incorporators are M. J. Cullinan and F. L. Schmidt, Wheeling; and Tuman Frazier, Martins Ferry, O.

THE OSCEOLA TURPENTINE CO., Deer Park, Fla., has been incorporated with a capital of $25,000, to manufacture turpentine and affiliated products. J. G. Henderson, Deer Park, is president; and J. H. Blount, secretary-treasurer, Jacksonville, Fla.

THE INDEPENDENT FLUORSPAR CO., Wilmington, Del., has been incorporated under state laws with a capital of $100,000, to operate fluorspar properties and produce commercial fluorspar. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

Capital Increases, etc.

THE DUFFNEY BRICK CO., Mechanicsville, N. Y., has filed notice of increase in capital to $110,000.

THE NEW EGYPTIAN PORTLAND CEMENT CO., Detroit, Mich., has filed notice of increase in capital from $500,000 to $1,000,000.

THE LIBERTY CHEMICAL WORKS, 352 East Illinois St., Chicago, Ill., has filed notice of increase in capital from $20,000 to $30,000.

THE MUSKOGEE VITRIFIED BRICK CO., Muskogee, Okla., has filed notice of increase in capital from $100,000 to $125,000. F. C. Nicholson is president.

THE ALUMNADA LEAD CO., Warren, Ariz., has filed notice of increase in capital from $1,000,000 to $1,300,000.

THE WEIRTON STEEL CO., Wierton, W. Va., has arranged for a bond issue of $1,000,000, for general operations and financing. E. T. Weir is president.

THE MORTON SALT CO., 80 East Jackson Blvd., Chicago, Ill., has filed notice of increase from $5,200,000 to $6,200,000.

CORD A. MYER, Tarrytown, N. Y., manufacturer of cement, has filed a voluntary petition in bankruptcy with liabilities stated at $257,315.

The plant of the ZIRCONIUM CO. OF AMERICA, Monument and 11th Sts., Baltimore, Md., manufacturer of metal products, has been acquired at a receiver's sale by William T. Larkin.

C. W. Johnson has been appointed receiver for the AETNA REFINING CO., Louisville, Ky., operating an oil refinery.

THE SUTHERLAND PAPER CO., Kalamazoo, Mich., has filed notice of increase in capital from $1,000,000 to $1,500,000.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: March 10—American Chemical Society; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting: June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

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Laying the Foundation For Our Foreign Trade

NOT all the news that comes from Washington these days is proving a menance to business. Happily the recent rumors that the Department of Commerce is to receive an increased appropriation have at last been confirmed. The Senate Committee on Commerce has reported out a bill which, if finally approved, will give the Bureau of Foreign and Domestic Commerce about $450,000 more than its appropriation of last year. To be sure, $750,000 had been asked by Mr. HOOVER and this amount had received the approval of the Director of the Budget, but in view of the tight-fisted policies of the present Congress on all except vote-getting expenditures, the country can well rejoice at the committee's apparent far-sightedness.

It is to be hoped that this is the beginning of a broader view of our foreign trade. Consular service and other active agencies for trade information lie at the very foundation of commerce and logically that is where we should begin to build. The dominating overseas trade of Great Britain and pre-war Germany had been developed around consular and commercial services that formed a network extending to the four quarters of the globe. England in particular has spent centuries in developing sources of trade information and keeping the avenues of commerce open to her merchants.

It is largely to these activities that the British merchant marine owes its enviable development. With merchants and agents in every port selling and urging the sale of British goods, the groundwork was laid for a foreign trade which naturally was carried in British vessels. Perhaps our own lawmakers may yet realize that subsidies for American shipping and government extension of credits are necessary only because we have neglected our foreign commerce. An intensive study of foreign markets is logically the first step in reconstructing our fast diminishing export trade.

An additional justification of the increased appropriation for the Department of Commerce is to be found in the program awaiting the recently authorized foreign debt commission. The recommendations of this commission in regard to the ten billion dollars now owed to the United States must be based on accurate knowledge of economic conditions in Europe. Naturally its members will look to Secretary HOOVER and his department for much of this essential information.

Finally, the chemical industry has its own selfish reasons for rejoicing. Secretary HOOVER'S plans for enlarging the work of his department call for a number of new commodity divisions and among the first to be established will be the one devoted to the dye and chemical industries. The need for this division is already evident and we are looking forward patiently to its organization. The increase in appropriations, which will make possible these extended activities, must yet be approved by the Senate and agreed to by the conferees, but it is hoped that the good work once started will proceed to its completion.

"Free Information Service"

SOME consulting chemical engineers have apparently had misgivings over the recent announcement by the National Research Council of "free information service." They have thought this announcement was an evidence that the Council was about to enter into competition with them and encroach upon the legitimate field by free consulting service. If this were the fact, there would be great point in the comment which has been made; but fortunately it is quite clear that such is not the Council's intent.

The Research Information Service, which made the announcement referred to, is one of the divisions of the Council. Its purpose is to assist investigators by answering questions or placing these investigators in touch with sources of information from which aid of any sort may be had. Many times the ability to get a needed fact, a needed reference, a needed piece of apparatus, will accelerate research tremendously. Indeed, this may be sufficient to permit continuance of work that otherwise would be abandoned through discouragement of the investigator. One of the purposes of the Service is to supply such assistance. In this effort it should inspire the commendation of all.

In general the Service is being extended only slightly beyond the field of assistance to the private individual or the investigator in collegiate work. Its effort in technical and commercial problems is limited by the meager funds available. In most cases the queries which come to the Council would not otherwise go to any commercial or consulting agency. But by assistance to the few industrial inquirers who ask aid, the Information Service undertakes primarily to build up an appreciation of and a desire for more results of research. And where the inquirer appears to be a firm or individual who should make use of professional consultants, reference is made to such sources.

Free service by the Council, an endowed quasi-public body, in competition with the consulting profession would be inexcusable. The Council recognizes this fact. Instead, it desires to build up the most friendly co-operative arrangement with the consulting profession at large. Indeed, it hopes that the appreciation of research and the stimulus to research from its work will be such as to increase the demand for consulting service and thus make more widespread the use of experienced and competent advisers. On this basis certainly the consulting profession can co-operate.

The Chemist And the Lawyer

ON FEBRUARY 13 last *The Financier* of London published an article several columns in length on "Chemicals and Chemical Engineering." The purpose was to show the rapid rise of British chemical industry under the stress of war, the ubiquitous need of the chemist throughout industry, the prompt and efficient answer that the British chemist made to the call for his services, and the gradual let-down that has taken place in British chemical industry since the war.

All we need to do is to change a few names and the article would be timely here. The reason for the let-down we believe to be the same in both countries. It is only partly economic. Another very potent cause applies, we believe, to both American and British chemists in similar measure, and we propose to look for it among the chemists themselves rather than among manufacturers or purchasers of materials or the general public.

The relation of the chemist to industry is substantially the same as that of the lawyer to business. The lawyer draws contracts and provides for the avoidance of error in transactions. With his aid associations are formed and selling and distribution are carried on. But the chemist produces the goods. Why is it, then, that the actual producer of goods is a kind of hired man, as often as not required to punch the time-clock, while the lawyer receives the manufacturer in his own office, charges him a month's salary of a chemist for an hour's discussion and a letter in relation to matters of less importance than the work of the chemist?

During the war the chemist, being needed, was exalted until he scarcely knew himself. His advice was constantly asked for and taken, and he sat in the seats of the mighty. The war over, he finds himself in most cases back in the position of a hired man again. Why is it?

It is not competition that does it, for there are more lawyers than chemists, and there is, in point of fact, more real work for chemists to do than there is for lawyers. True, there is a certain glamour, a tradition of distinction, that attaches itself to the legal profession which is lacking in that of chemistry, but in spite of this, the profession of law has many members who are unfit for decent society; a large number of them have no background of culture whatever. On the other hand, there are always enough lawyers of eminence and prominence to maintain the tone; to keep up what the Chinese call the "face" of the profession; to present a very taking front.

Chemists are lacking in this quality of well-known-ness among their number, and the question is fair whether they have not principally themselves to blame. If we consider the relations of present-day lawyers to public affairs compared to that of present-day chemists, it looks almost as though chemists were not interested. There is one chemist in the U. S. Senate, and we have lately read of a professor of chemistry who is president of a local chamber of commerce. We are disposed to make a fuss over it as a triumph. Instead of being a triumph it is a confession.

How many American chemists are there who can speak with the grace, the *savoir faire*, the distinction of Dr. EDGAR FAHS SMITH? If there are any they are remarkably silent! The literature of chemistry is no more technical or uninteresting to the layman than that of law. But men who make this very legal literature are wanted for every possible activity all the time, while nobody knows about the chemists.

We believe the era of chemistry will come about when chemists assume a great obligation to the general welfare; when they guide public opinion by expressing themselves with such facility that everyone can understand, while the substance of their discourse is of value to the public.

This is not to be brought about by a publicity agent or by propaganda. It will come as a result of constant and useful public service, and from the quality of public teaching that begets understanding and faith.

The Haber Process Pinned Down to Facts

ASIDE from its importance from the military standpoint and to the agricultural and fertilizer interests, the fixation of nitrogen by the Haber process has been of peculiar interest to the chemical industry since its commercialization in 1913, partly because it came to us so thoroughly labeled "Made in Germany." An air of mystery has been thrown around the details of the process and we have been regaled by stories of the Krupp superlathes which turn out tremendous seamless tubes of a marvelous new alloy for the German plants. Most of the mystery has been dispelled by the practical experience at Sheffield and today the Haber process is established on a commercial scale in America. Some residue of the original fascination, however, makes the subject of lively general interest, while those actively participating in the recent development eagerly seek reliable detailed information on different phases of the process.

It is therefore with an appreciation of their value that we call attention to the series of articles reporting the work of the Fixed Nitrogen Research Laboratory on the synthesis of ammonia which begins on another page of this issue. As an example of truly scientific research, these experiments might well be cited as a model. The laboratory has made a thorough study of the various ammonia catalysts and the general principles and problems involved in the synthesis. It is with the latter that the present series deals particularly. Among other problems, the increasing conversion with rising temperature, counteracted at a certain point by the increased rate of decomposition, presents an interesting study of great industrial importance. Again, the effect of pressure, temperature, rate of flow and catalyst poisons in the gas have been studied under conditions which made possible the accuracy of the research laboratory, yet which are unusually comparable to operating practice. It is well known that the chief difficulty in the Haber process has been the proper mechanical construction of the plant to withstand the action of the gases under the necessary high pressures. For this reason the detailed descriptions of the small-scale testing plants developed in these experiments will be of interest.

In the Haber process the gases are purified by catalysis and their combination is effected by catalysis. In another step which is on the verge of commercial application, the same ammonia is oxidized to nitric acid by catalysis. In view of these and a dozen other recent applications of the same phenomenon, we can but wonder how much more catalysis may do for us in the future. Certainly such research work appears unlimited in potential value.

Pig-Iron
Production in 1921

ON ACCOUNT of the physical disabilities of the iron industry in 1917, 1918 and 1920 we have the curious statistical fact that there has just been the longest interval in 43 years without a new record being made in a year's production of pig iron. The official report just issued shows a production in 1921 of 16,688,126 gross tons, last year having added a fifth to the years that have failed to break the record made in 1916, 39,434,797 tons. Not since the period 1874 to 1878 inclusive has there been a 5-year interval without a new record. Otherwise the comparison fails entirely, for after 1873, which was a panic year despite its record pig-iron production, there was practically no new construction for several years, while after 1916 there was new construction, the capacity not being available when iron was particularly wanted, in 1917, 1918 and 1920, because the railroads could not move sufficient fuel. Another difference is that the last year of this latest 5-year period, 1921, was by far the poorest year of the five, while in 1878 the iron industry was getting ready to make a new record.

Pig-iron production, in gross tons, from 1870 to 1921, inclusive, has been as follows:

1870.....	1,665,179	1916.....	39,434,797
1880.....	3,835,191	1917.....	38,621,216
1890.....	9,202,703	1918.....	39,054,644
1900.....	13,789,242	1919.....	31,015,364
1910.....	27,303,567	1920.....	36,925,987
1915.....	29,916,213	1921.....	16,688,126

On the basis of the 1916 production, with allowance for increases in capacity, the present capacity may be estimated at fully 45,000,000 tons, so that production in 1921 was about 38 per cent of capacity. There is room for argument that if iron and steel had been less scarce in 1920 the production in 1921 would have been larger. Production had been subject to three curtailing influences, the iron and steel strike begun Sept. 22, 1919, the bituminous coal strike and an insufficiency of transportation. Prices of steel and of manufactures of steel were forced to extremely high levels. At the beginning of 1921 there were high-priced stocks and the ultimate consumer was discouraged. To cite a commodity, usually exceptional, to test the rule, there were large stocks of canned food and other products in tin plate containers, the liquidation of which was very slow, the result being that tin plate, which usually holds up well in poor times, had a phenomenally poor year in 1921.

The iron industry has been particularly hard hit by the smallness of demand because there is a much smaller percentage than ever before of obsolete or obsolescent equipment. As the blast furnace has been improved from time to time, it is natural that a smaller proportion of the existing capacity is behind the times than used to be the case. Production, moreover, has tended to center more in certain districts, where the producers are more or less on an equality. Not infrequently in the past there have been times when the percentage of relatively high-cost furnaces was so great that the low-cost furnaces could make profits even though the total demand was much under the full capacity, whereas even now, when the rate of production is about 30 per cent greater than the average rate in 1921, there are many furnaces idle whose equipment and location cannot be criticized.

The layman is sometimes confused in attempting to harmonize the concept that steel is made from pig iron and some pig iron is used for making iron castings with the fact that in recent years our production of "steel" has exceeded the production of pig iron. Last year's production of steel ingots was about 19,500,000 tons, but in finishing the steel a loss of about 24 per cent occurs, to reach the material statistically reported as "finished rolled steel." The scrap involved, together with old material, is used in making steel, while for years the production of iron castings has been growing at a much slower pace than the production of steel.

Panic Prices
For Coal

EVERY factor now indicates a strike of serious proportions in the coal mines on the first of April. It is highly improbable that the Secretary of Labor, the Secretary of Commerce or any other government official can find any means for preventing this, despite the commendable efforts being made to that end. However, the situation is not by any means as black as painted by many; and there is no cause whatsoever for panic prices for coal.

Official estimates indicated that on the first of January of this year there was in stock in the hands of consumers about 47,500,000 tons of bituminous coal, which represented for these consumers on the average approximately 6 to 7 weeks' supply. During January production continued at least slightly above the rate of current consumption, and during February it is estimated that coal flowed into storage in considerable quantities every week. This condition will doubtless continue with even marked increase during the current month; and the end of the coal year will be reached with a certainty of average stocks throughout the country amounting to nearly 2 months' supply of bituminous coal. This is an exceptional, but very fortunate, condition for the end of a coal year, since normally at the beginning of spring the bituminous coal stocks of the country are reduced to a low figure as a matter of ordinary operating routine.

Another important factor must be taken into account also. This is the fact that the maximum probable interruption of coal production in union mines from strikes is not at all likely to cut off as much as half of the total production. Not only are there always some mines and some workers in various mines who do not go on strike, but also there are large sections of the bituminous coal territory which are operated on a non-union basis. It has been estimated on the basis of official figures that the maximum effect of the coal strike in union fields will probably not lower the production below six million tons per week. This is practically enough coal to run the country during the summer season with sub-normal business conditions prevailing as they now do. Certainly if six million tons per week is produced regularly during a strike period, this with existing stocks would care for the entire industrial demand of the country for many months.

It is worth while bearing these facts in mind. There will be great temptation to rush into the market and purchase coal as soon as the usual sources of supply are in any way interfered with. But this is wholly unnecessary, especially if carried to the extent of paying panic prices for the fuel. If American industry will "keep its feet on the ground," there will be no excuse for a runaway market.

Readers' Views and Comments

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read your editorial on "When Does an Employment Contract Terminate?" in the Feb. 22 number of CHEMICAL & METALLURGICAL ENGINEERING with a great deal of interest. I also read the opinion of the Chicago attorney. I agree with you absolutely, that technical men should be protected from every danger of blacklist, boycott or attempted curtailment of their usefulness to themselves or society through the operation of contracts signed while seeking employment. I also heartily agree with your stand that a court precedent should establish that a contract terminated in one particular is thereby terminated in every other. It seems to me that this is a matter of vital interest at the present time and that you are doing a noble work to bring the matter to the attention of the readers of your magazine.

W. M. CORSE.

Monel Metal Products Corp.,
Bayonne, N. J.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial, "When Does an Employment Contract Terminate?" has very greatly interested me. It is a subject that has so many angles to it and is so dependent on the indeterminate personal equation that I hesitate to commit myself on the matter within the space of an ordinary communication.

Employment contracts exist in great variety, each corporation acting on the initiative of some one of its officers and in many cases without the scrutiny of an attorney with wide experience in drawing this class of contract. It is therefore impossible to discuss within a few words the broad general aspect of the individual contracts, for the real vital principle at stake varies so greatly in the form of statement, and language is here the key to the situation.

From the standpoint of *intent* I am quite certain that all reputable corporations have in mind the desire to prevent traffic in confidential information in their possession. Many such acquisitions have been purchased at considerable cost, and the purchaser is frequently obligated by contract not to convey the same to others. In other cases the specific information has been acquired by research and development at great cost, and the obligations of the executives to the stockholders require the guarding of the latter's interests. It is entirely fair and just to base a contract on such property and to place a restriction clause in an employment contract covering such property rights and their disposition.

Assuming the right of property in such matters, our problem becomes one of a fair disposition of the same. The fundamentals of all contracts are good faith and equity. Good faith in dealings between the corporation and the employee implies a detailed presentation of the character of the service to be rendered. This should be covered in great detail, and frequently be supplemented by additional contracts if necessary.

In the next instance, the contract should specifically provide for service as such, and in addition and separate from the first, restrictions on the disposition of discoveries, inventions, confidential information and future traffic in the latter items. The service clause should be for a definite period of time, a month, a year, or longer. Provision should be made for its termination because of unsatisfactory service after due notice, otherwise if the whole burden incident to unsatisfactory service rests on the employer, employment will become too difficult in general. General business depression should not be a terminating factor, any more than it is on raw material contracts. The weakness lies in the machinery to adjust such differences as might arise in connection with the service clause, this at present being more burdensome to the employee than to the employer.

The restrictive clauses are more complicated. Real property is conveyed with restrictions as to its use. These restrictions are limited as to expiration date; in the case of patented articles to the date of expiration of the patents. The restrictive clause in the employment contract should similarly be limited as to expiration. Now it is pretty well recognized that chemical processes, for example, become obsolete in a comparatively few years. I believe that so-called secret processes rarely persist in their original form for 5 years. The equitable form of contract would therefore terminate the restrictive clause in a reasonable and comparatively short time. This period has nothing to do with the period of service, and their termination would not be simultaneous.

The restrictive clauses should be explicit to be fair. I am not in sympathy with the attempts frequently made to broaden the scope of such clauses to cover everything. No attempt should be made to cover any more than the specific activities directly concerned. Provision should be made for supplementary contracts if necessary to cover advances in the state of the art. With good faith shown in the incorporation of such clauses in the contract, there can arise no criticism on the part of the employee, for no individual meriting at any time such confidence as to become a party to such contract can be so narrow in his adaptability as not to find means of livelihood outside the narrow restricted field intended to be covered. I should even very closely scrutinize a plea of hardship.

I therefore believe that a perfectly fair employment contract can be drawn which will protect the employer in his just intent as discussed above, and future criticism on the part of the employee forces on the latter the burden of proof that he signed such in good faith. Compensation under such contracts is generally above the normal for the same class of general service, and the extra compensation must be looked upon as a surplus against the imposed restricted future activities.

The real remedy for abuses, if such exist, is to make unnecessary this form of contract. This can be done by eliminating the necessity of maintaining processes secret, through a comprehensive and adequate patent law whereby the granting of a patent assumes novelty, without the burden of adjudicating the same through endless litigation.

Raising of the ethics of the profession would go a

long way, for I believe that if all members of the chemical profession are governed by the highest motives of loyalty and fair dealing, there will be no misunderstanding concerning employment contracts on the part of either the employer or the employee.

These two remedies are such remote possibilities that a more practicable method of immediate application would be to have our major engineering societies take up the matter of a uniform employment contract, providing such has not already been done, and under the guidance of proper legal assistance and with the cooperation of representative employers in as many fields of activities as is practicable, I am certain an equitable form of contract could be drawn. W. S. LANDIS.

New York City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest your editorial in the Feb. 22 issue of CHEMICAL & METALLURGICAL ENGINEERING, also the comment as formulated by Wellington Gustin.

It has always appeared to me that arrangements made between technical men and financial interests have been too vague and often leave a confusing impression. A contract drawn up between a chemical engineer and his employer should never include terms which forbid for all time the technical man in question carrying out other lines of work of similar nature, should the company find it necessary to discontinue his services. No man should agree to limit his value on this earth by any such arrangement.

I am firmly convinced, however, that the manufacturer should have adequate protection, having in mind particularly an extremely small percentage of technical men who purposely might seek employment in a certain industry for purely dishonorable purposes. I think it entirely just and legal that a contract include terms which for a reasonable time prohibit the technical investigator either publishing or applying for patents on subjects which are directly concerned with work within the industry.

In other words, I think there should be established a reasonable time interval during which the manufacturer may protect his own interests by suitable patent publications. This could usually be done within a period of not greater than 2 years. It is also fair to assume that a technical man in a responsible position will disclose important information to his employer and agree to apply for patents and assign such patents to the company in question. Such an agreement could also appear in the contract terms. I believe that arrangements of this type would encourage disclosures of progress through patent publication, and would discourage the accumulation of a rather large amount of technical information which is now zealously guarded by so-called secret processes.

A reasonable time limit within which the technical investigator would be committed to public inactivity so far as the particular work in question is concerned would surely offer adequate protection in most cases which might arise. It would also provide an opportunity for the investigator to continue work along lines in which he may have become interested and which may result in findings of extreme importance. In all events, special cases would always be open to litigation and could be judged according to precedent and equity.

Research Department,
Brown Co.,
Berlin, N. H. GEORGE A. RICHTER.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In regard to the editorial, "When Does an Employment Contract Terminate?" and also the comment of Wellington Gustin under the same title, the following may put into bas-relief certain phases of the subject under discussion which have been so well covered by those articles.

The employer is almost the exact antithesis of the employee and his functions are almost exact antitheses of the functions of the employee. The differences may be summed up tersely as follows:

The employer deals with humanity, while the employee deals with scientific knowledge, ingenuity and materials. It is the employer's business to accomplish as much as he can by utilizing humanity, and his success is measured by the ability which he displays in utilizing humanity. In the same way the employee's success depends on the use he makes of his scientific knowledge, ingenuity and materials.

Now, while the employer delves into the storehouse of knowledge and materials held by the employee, the employee has not as a rule thought it necessary to delve into that knowledge of human nature upon which in a large degree business depends. And right here is where the employee loses out. It thus happens that the employer is in a position to work upon the credulity of the employee who has not taken the trouble to inform himself of his rights and privileges. The courts have many times decided that the employer who furnishes materials and defrays all expenses of fruitful research thereby acquires a shop right in the invention, but that the inventor is entitled to the patent rights unless otherwise assigned. On the other hand, if the inventor makes his invention at his own expense and in his own time, the employer has no claim on even a shop right in such an invention. This knowledge is known by the employer, but is not usually known in time by the employee if known at all. The employer uses such knowledge as this to insert into the contract of employment that the employee shall assign all inventions during his period of employment to his employer. In a sense this is coercion, for a man in face of present necessities will sign away any rights for the future which he regards as fanciful, illusive or only existent in the fancies of his employer.

The employee furthermore does not as a rule take advantage of such business opportunities as are open to him. He not only does not do this, but he deliberately puts his neck in a noose and then complains if the holder of the noose is tempted to pull it tighter than he thinks comfortable.

The business man has no hesitation in advertising his goods and stock in trade. He is not held back by any false modesty from claiming that he and he alone is giving more value to his customer than any one else. This is so much the custom that such action is regarded as a matter of course.

The employee may be a shining light and yet may have it hidden within the walls of a factory so that others have no knowledge that such a light exists. You certainly cannot blame an employer having a gold mine for not advertising it when such advertisement might result in the payment of increased royalty or might lose for him the gold mine altogether.

Now having shown that the employer has no object in advertising his employee, it necessarily follows that the employee will remain unadvertised unless he is

advertised by one who will benefit by such advertisement and that one is himself and no other.

The employee's ability, knowledge and accomplishments are his stock in trade, and it is up to him to create a demand for his wares. While modesty is an admirable quality in polite circles, it has no place in business, especially that false modesty which enforces a sort of peonage on the employee. The law of supply and demand is as applicable to labor as to materials and the employee should know this and create a demand for his services by some sort of advertisement. When there is a large demand for his services, then the employee will receive compensation commensurate to his worth and the demand.

Nor is there a lack of opportunities for judicious and dignified advertising. The technical journals are open to a man who has something worth while to say and the technical societies are anxious to obtain the co-operation of a man of sound ideas who has back of him the record of accomplishment. By this I do not mean that the employee should divulge any of his employer's secrets while in his employ, for there is no justification whatsoever of such a proceeding. But the employee obtains a vast amount of knowledge which may be correlated in new ways, giving valuable scientific results. These usually are his own property and part of his stock in trade. These things he can use himself or give to someone else to use for him in acquiring the sought-for reputation.

While the obligations of the employee to the employer are easily defined, the obligations of this same man to his former employer when he is no longer the employee are scarcely definable at all, inasmuch as these are governed almost entirely by the original contracts and by the ethics of the particular case.

Contract or no contract, the employee owes complete loyalty to his employer. Mutual confidence, trust and respect are the foundation stones for both parties.

I believe that applies in the great majority of cases and I do not believe that more than 1 or 2 per cent of a scientific staff deliberately obtain employment for the purpose of obtaining secrets.

Now having touched on the above principles, let us get a little closer to the subject in question.

In making a contract the employer has a right to safeguard his existing property, including secret processes, if he can. The only protection he has, however, is so to adjust conditions that the employee has a mutual interest in the secret. He can bring suit for money damage against the employee, but this right is weakened by lack of money responsibility of the employee. In case of enticement he can bring suit against the offending corporation, but enticement would be difficult to prove in cases where the employer let his staff go whether because of business depression or some other reason. In exercising his right of discharge, he made a choice in which he presumably considered the problem of dissipation of the firm's stock of knowledge and his chances before the law court. In exercising his right of discharge, self-interest will compel him to act in such a manner that the firm shall suffer the least and the axe will fall upon him who can least easily obtain a job in a competing concern. And this is the man who neglected to make hay while the sun was shining.

The reason is obvious, for the man with a wide reputation can in a consulting capacity disseminate this knowledge far and wide, thus making competition keener, with the result that it will be cheaper to keep him on the payroll, even if there is nothing for him to do, than cast him adrift where he can do untold harm. On the contrary, the man of a retiring disposition is scarcely to be feared, for he has already shown that he has the lack of business initiative and such initiative cannot be developed on the spur of the moment. In an equity case the complainant must come into court with clean hands. The issues could be thoroughly befogged in an equity court. Not only would this be the case, but the facts concerning the secret process would have to be divulged, in which case the process is no longer secret and the appeal to equity has defeated its own purpose.

It seems to be a fact that employment contracts really have but little value for the employing party unless made with persons having moral responsibility, because the financial responsibility usually isn't there.

There is one phase of this question which should be carefully considered. Is it consistent with public policy that a man should be required to sign away the patent rights of something which he has not yet invented and knows not the value? Should not the employer be forbidden by law to insert such a clause into any contract with any employee? As it is, this is a sort of coercion or peonage in that the employer will always give the job to him who thus signs away his rights, not knowing their value. Is it not consistent with public policy that such insertions of a coercive nature be declared null and void? When such an invention has been made, the employer will usually have a shop right and will have the advantage of knowing its full value better than any outsider. He can then make terms with the inventor and such terms being made in light of full knowledge will have more of the elements of justice.

Another phase of this matter seems at least worthy of mention. When an employer hires the employee in such a capacity where it is known that he will obtain secrets and in all probability make valuable discoveries and where the employer assumes the financial burden of all the experimental work, the employer has certainly some rights. It is scarcely just to expect him to stand the financial losses indissolubly connected with those experiments which turn out failures, while the employee reaps all the benefits of those experiments which turn out to be successes. Such a condition would be against public policy, as it would mean the end of research and consequently tend to check progress.

I am inclined to agree with the general position of the editorial that it would be against public interest to make enforceable a contract binding a man not to use previously acquired knowledge or training.

The operator of a secret process has always been presumed to know that he has a perishable article and that the risks are all his own; the patent law itself is a recognition of this.

And, finally, we must not lose sight of the fundamental truth which has governed and always will govern the actions of humanity. In the final working out of the economic law irrespective of what laws are now on or may be put on the statute book, self-interest is the all-controlling factor. Where initiative, foresightedness, energy, prudence and due attention to self-interest will bring their reward, the lack of them will as certainly bring embarrassment and want in time of stress.

The ultimate solution depends upon the employee's ability to make it contrary to the self-interest of the employer to discharge him.

HUGH K. MOORE.

Brown Co., Berlin, N. H.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Feb. 17, 1922.

THE trend of business in January and particularly in the first two months of the year is usually a reliable index to the ensuing year's prospects, and on the whole the outlook is considered favorable. The annual reports and the speeches of the chairmen of the great banking groups have, it is thought, summed up the position with exceptional lucidity and in accordance with informed public opinion. Briefly, strict economy and thrift are to be the watchwords for all, with a definite hope of improving trade and stability, particularly on export account. The reduced bank rate and some relief in the pressure of continental competition, together with easier monetary conditions, have already made themselves felt and stocks in many commodities are appreciably lighter. Buyers in consequence are becoming uneasy and covering their requirements over a longer period instead of continuing the hand-to-mouth policy which served them so well during the recent period of uncertainty and stringency. It is still too early to say anything definite as to the effect of recent legislation, but the safeguarding of industries act has certainly stimulated the fine chemical trade and saved it from complete stagnation. The sulphuric acid and fertilizer trades are reviving, sulphate of ammonia being in demand owing to the peculiar conditions prevailing in America, and basic slag being also in good inquiry. Failures in delivery from continental sources have caused prices to harden in several cases and with a miniature revival in the coal, steel and textile trades, the prospects are distinctly encouraging.

GAS COMPANIES DEFEND THE USE OF WATER GAS

The scare raised in the daily press in connection with the presence of carbon monoxide in coal gas due to the admixture of water gas has roused widespread interest and comment. It so happens that a few cases of carbon monoxide poisoning due to escapes of gas occurred in the provinces and attention was promptly called to the large number of parallel cases which were noted at one time in the United States. The agitation has now practically died down, but not before an order was made under the gas regulation act regulating the amount of carbon monoxide which may be supplied in domestic gas unless the gas supplied has the distinctive odor of coal gas. The chairmen of the two leading gas supply undertakings in London defended the use of water gas, although the South Metropolitan Gas Co. has not so far used it as a diluent.

CALCIUM CARBIDE HELD TO BE AN INORGANIC CHEMICAL

The result of this case was almost a foregone conclusion, but the hearing under the safeguarding of industries act was useful in clearing the ground for other cases. The referee in his decision stated that he would adopt the principle that no article should be included in the dutiable list if there is any reasonable doubt that it should be excluded, and that the burden of proof is on the complainants; that in regard to "fine chemicals" he would adopt the rule: Has it been proved that in the opinion of the bulk of chemists this or that is a fine chemical? But he would accept this only if there was a technical definition. What happened in the carbide case was that an equal number of eminent experts on either side were willing to classify calcium carbide as organic or inorganic, but the balance of evidence from textbooks and official publications inclined to its classification as an inorganic chemical.

CONFLICTING EVIDENCE IN THE CREAM OF TARTAR AND TARTARIC ACID CASE

This case, in which citric acid is also included, will turn on the point whether the term "fine chemical" has a well-understood commercial meaning and if so, what is the accepted view of the trade. The result so far has been a plethora of definitions in the technical press, not one of which has yet been applicable to every instance that can be cited. We have here products which can be obtained in commercial quantities with a high degree of purity both by skilled and by unskilled methods of manufacture according to the locality in which such manufacture is carried on. French firms appear to be manufacturing crude products without skilled supervision and control, while in this country, which draws its raw material from a number of sources, scientific control is essential, especially for the manufacture of B. P. products. The process as carried out in France would, according to one definition, enable the product to be classified as a heavy chemical, whereas in this country tartaric acid would, under the same definition, be a fine chemical. The view of the trade seems to be that, except for B. P. products, the large quantities sold and trade usage will enable the crude products to be imported free of duty, while discriminating against B. P. products.

ALBY CARBIDE CO. GOES INTO LIQUIDATION

This company has been in difficulties for some time, mainly on account of the unfavorable contracts into which it had entered and owing to its failure to pay for its power rent, the plant having closed down. The Tyssefaldene Power Co., in which the Barton group holds a controlling interest, has bought the whole plant, valued at about $1,500,000, for about $7,000, the rights held by the power company rendering it impossible for others to bid at the foreclosure sale. In consequence, Alby shares are now valueless and the company will be wound up. The recent carbide decision lends additional interest to the case, but as regards the future operations of Cumberland Coal, Power & Chemicals, Ltd., in Norway, the position is still very uncertain, as so far the capital required for the development of the Claude process does not appear to have been forthcoming. Mr. Barton was originally closely connected with the Alby Carbide Co.

GENERAL NOTES

The British Dyestuffs Corporation has failed to pay a dividend on its preference shares and although markets are improving, the future does not seem to be very bright. This also applies to the British Cellulose Co., whose shares have fallen still further, partly on account of the decisions in the carbide case. An interesting monograph on synthetic phenol manufacture during the war has been published by the Department of Scientific and Industrial Research, and is worth studying for its chemical engineering interest alone. Further progress is being made in the standardization of chemical plant, both by the British Engineering Standards Association and by the Association of British Chemical Plant Manufacturers, the latter having made a beginning by publishing designs for standard jacketed pans.

American Ceramic Society, Annual Meeting

Report of Twenty-Fourth Annual Meeting, Held at St. Louis—Important Papers Presented Before the Meetings of the Seven Industrial Divisions: Art, Enamels, Glass, Heavy Clay Products, Refractories, Terra Cotta, White Wares

IT was scarcely necessary for Mayor Kiehl of St. Louis to utter formal words of welcome to the members of the American Ceramic Society, gathered at the Hotel Statler for their twenty-fourth annual meeting, Feb. 27 to March 3. The almost continuous rows of brick structures throughout the city evidenced appreciation of what ceramic skill has done to advance human comfort and happiness. Then, too, the sight of the great refractories plants, the fireclay mines even within the city limits and the knowledge that the whole city rested on clay deposits—what more was needed by way of welcome! Nevertheless Mayor Kiehl was there in person to extend a hearty greeting.

Throughout the meeting a state of constant, yet ordered, activity was maintained through the untiring efforts of the local committee. The complete absence of friction in carrying out the schedule indicated careful preparation. The smoker and entertainment on Monday, the informal banquet the following evening and the plant visits on Thursday and Friday were potent factors in maintaining that spirit of fellowship for which the Society is noted.

Through the efforts of the Art Division an exhibition of ceramic wares was held in conjunction with the meeting. The exhibits covered the entire range of ceramic products—from the highly artistic and beautiful work of Mr. and Mrs. Rhead, Prof. Binns, Miss Farren and others to the more commonplace sanitary ware, chemical stoneware, electrical porcelain, refractories, etc.

General Sessions

Forrest K. Pence's presidential address on "Progress and Policy" brought out the necessity for outlining a general policy for the Society in its enlarged field, in order to render the most service possible, both within and outside of the organization. As examples of service needed, Mr. Pence mentioned the publication of a ceramic handbook and monographs on certain industries.

Conditions have changed since the Society was founded and a stage has been reached where the industries are beginning to see the economic reason for cooperative research. The industries must finance this group research, but it is the function of the Society to encourage such work and to provide a publication medium and a forum for discussion.

Reduction of Varieties

E. W. McCullough, manager of the Fabricated Production Department, Chamber of Commerce of the U. S. A., outlined the work which is being done to eliminate excess varieties of commodities. For machine-made products, small variety and large output are essential to low cost. In many lines, our salvation has been and will continue to be mass production, but mass production is not possible if varieties are multiplied to meet the whims of overambitious sales organizations. An example was given of an iron and steel firm which discovered that its catalog was increasing out of all proportion to the profits. Upon studying the 17,000 products listed, it was found that only 614 were profitable.

Prof. C. W. Parmelee proposed a new classification of clays. Prof. E. W. Washburn and Elmer N. Bunting demonstrated and explained their porosimeter for determining porosity by the method of gas expansion. Deformation studies of the silicates and aluminates of the alkali metals were reported by B. A. Rice. Investigation of the systems K_2O-Al_2O_3-SiO_2 and Na_2O-Al_2O_3-SiO_2 indicates that sodium and potassium may be interchanged for their fluxing value.

From X-ray spectra, Prof. E. W. Washburn and Louis Navias conclude that raw chalcedony and raw flint have the structure of quartz, while after calcining the structure of both resembles cristobalite. Both are probably colloidal.

Dr. Kurd H. Endell, professor of ceramic engineering at Charlottenburg, extended an invitation to the members to meet with the newly organized German ceramic society in June.

In a paper on "Reduction of Industrial Wastes," Dwight T. Farnham reviewed the important work done along these lines.

Fuel Oil Systems

Important factors to be considered in installing and operating fuel oil systems were discussed by James D. Lalor. He recommended that storage tanks be placed in concrete pits rather than buried directly in the earth, since a leak in the latter case might cause serious trouble before it was detected.

R. M. Howe showed that the furnace gas pressure has a very decided effect upon heat transmission through furnace walls. A 10½-in. tile was set in the door of a surface combustion furnace and temperatures were measured in this tile 1, 2, 3 and 4 in. back from the hot side. Under a draft of —0.30 in. of water the temperature drop across the 4 in. was from 1,340 to 500 deg. C. With a draft of +0.05 in. the drop was 1,340 to 750 deg. C.; with forced draft (+1.00 in.) from 1,340 to 850 deg. C. Evidently the penetration of hot gases is a factor which must be considered.

Election of Officers

Officers elected were: President, F. H. Riddle; vice-president, Dr. E. Ward Tillotson; secretary, Ross C. Purdy; treasurer, R. K. Hursh.

Mr. Riddle is director of research for the Champion Porcelain Co., Detroit, Mich. This was formerly the Jeffery-Dewitt Co., but is now a subsidiary of the Champion Spark Plug Co. During the war Mr. Riddle was associated with A. V. Bleininger at the Bureau of Standards and worked on the development of special high-temperature porcelains, including spark plugs for airplanes, also on the development of the casting of porcelain glass pots for optical glass manufacture.

It was decided to transfer all editorial work to the secretary's office and to make the secretary editor of the

F. H. RIDDLE
President, American Ceramic Society.

journal for the coming year. Pittsburgh was chosen for the twenty-fifth annual meeting in 1923. The summer meeting this year will be held in Montreal and vicinity.

Refractories Division

Fireclay Deposits

Merely as a matter of record Paul E. Cox presented his paper confirming previous reports on the non-existence of satisfactory fireclay deposits in Iowa. There were some, however, which he thought might serve for cheap brick for the crowns of kilns. Prof. C. W. Parmelee then described in some detail the more important deposits of fireclays in Illinois.

Influence of Grind and Firing Temperature on Properties of Silica Brick

Some very interesting tables showing the influence of grind and of firing temperature on the properties of silica brick were presented by R. M. Howe. The time of grind was 10, 15 and 20 minutes and the firing temperatures from cone 11 to cone 19. The property studied in one set of tables was the modulus of rupture. In the 10-minute grind the modulus of rupture varied from 295 to 531 when the burn varied from cone 11 to 19, the average of 42 determinations being 440. Corresponding figures for the other grinds are 15 minutes, 285-618, average 446; 20 minutes, 330-694, average, 499. Averages of twenty-one determinations on the effect of temperature are:

Cone	11	14–15	15–16	17	18	19
Modulus of rupture	303	368	444	572	533	614

Thus it will be seen that, judged from the averages, the firing temperature has a greater influence on the modulus of rupture than the time of grind.

The specific gravity was found to decrease from 2.50 to 2.30 in going from cone 11 to cone 19, while the grind did not have much effect on this property. Porosity increased slightly with time of grind.

Hydrates of Alumina

Studies of the composition and properties of diaspore, bauxite and gibbsite have led R. M. Howe and R. F. Ferguson to the conclusion that diaspore is the monohydrate of alumina, gibbsite the trihydrate and that bauxite is a mixture of the two. In the discussion which followed I. A. Krusen referred to the plant of the American Bauxite Co. at Bauxite, Ark. Here the bauxite occurs in blankets from 3 to 25 ft. thick and the stripping required varies from 10 to 60 ft. The overburden is removed by steam shovels. Most deposits are less than 10 acres in extent. The ore is crushed to 1-1½ in. in gyratory crushers and transferred to bins which feed ten rotary kilns, formerly fired with natural gas but now using powdered coal. The capacity is 2,500 tons a day, most of it going to the Aluminum Co. of America, although some is shipped to the Norton Co. At one time the General Chemical Co. took a great deal of low-grade ore for the manufacture of alum.

Testing of Silica Brick

Prof. K. Endell described briefly the methods used in Germany for testing silica brick.

An attempt was made by E. N. McGee to develop a relationship between the hot and cold modulus of rupture for silica brick, with the idea that the valuable indications given by the hot modulus might be calculated from the more easily determined cold modulus. Before any definite conclusion can be reached it will be necessary to test other brands and use more samples. The point at which the silica brick is weakest should also be determined.

Ladle Brick

In a paper on ladle brick, D. A. Moulton stated that in this country this variety of brick is made from No. 1 and No. 2 fireclay and contains: SiO_2, 60-67 per cent; Al_2O_3, 20-24 per cent; Fe_2O_3 1-3.5 per cent; CaO less than 0.3 per cent; Na_2O and K_2O, 3.5 per cent. The brick are made either by the stiff mud or dry press process, the latter giving a superior product. The brick will usually withstand eleven or twelve heats. Special testing methods are required, as the tentative and standard methods are not applicable.

In discussion, A. F. Greaves-Walker, chairman of the division, emphasized the importance of ladle brick. They are used not only in the large copper and steel plants, but even in medium-sized foundries, especially where electric furnaces are used. He also referred to the secrecy which has surrounded the manufacture of ladle brick.

Heat Conductivity Data

Data on heat conductivity of the different commercial refractories are somewhat confusing owing to the fact that the conditions of preparation or test are not comparable with industrial conditions. In presenting this subject, Prof. Arthur S. Watts emphasized the difference between heat conductivity as usually measured and heat transfer, which is what is really required for engineering work. The former neglects the skin or surface effect, which has a very appreciable influence on the rate of heat transfer from a point just in contact with

one surface to a similar point on the other side of the refractory.

Prof. Watts found that the literature on the subject was practically limited to the following: Wologdine and Queneau, *Electrochemical & Metallurgical Industry*, September and October, 1909; "The Thermal Conductivity of Refractory Materials," by G. Dougill, H. J. Hodsman and J. W. Cobb, *J. Soc. Chem. Ind.*, vol. 34, p. 465, May 15, 1915; "Thermal Conductivity of Refractory Brick," W. Van Rinsum, *Science Abstracts*, "B," Jan. 30, 1920, p. 18, also *Chemical Abstracts*, vol. 14, p. 1420, May 10, 1920. The scarcity of data and the fact that some of the available data are open to criticism prompted Prof. Watts to make an investigation to determine relative values, at least, under the following conditions:

(*a*) The test specimens are normal samples of commercial ware on which the burning temperature is known.

(*b*) The test specimens are of the same thickness so far as possible. All are exactly as made and burned except the magnesite brick, which was tested in the original thickness and later cut down by grinding off one face, thus reducing it to the same thickness as the others.

(*c*) The test furnace is an electrically heated furnace capable of maintaining an approximately constant temperature for a period of 8 to 10 hours.

(*d*) Each test is continued until a state of practical equilibrium exists. To insure this, the test was continued until the temperature change on either side of the test specimen did not exceed 5 deg. per hour.

(*e*) The conditions of test were maintained constant as regards drafts, the furnace being so located that the exposed face of the test specimen is cooled only by normal radiation.

(*f*) The same insulating arrangement is provided for all specimens. This consists of kieselguhr cleats cut to fit and extending ¾ in. over the edges of the brick, thus preventing radiation of heat along the line of contact between the furnace and the test specimen.

(*g*) Standardized copper-constantan thermocouples are used and the voltage measurements determined by means of a Leeds & Northrup potentiometer.

In order to make the results comparable, temperature gradients were determined by subtracting the temperature of the cold side of the test specimen from that on the hot side and dividing by the diameter of the test specimen expressed in centimeters. Hard steel was chosen as unity, giving the following results:

Specimen	Diameter, Cm.	Temperature Gradient, Deg. C.	Relative Transfer of Heat
Normal fireclay	3.1	174	0.448
High SiO_2 fireclay	3.1	170	0.459
Bauxite	3.1	163	0.478
Silica	3.3	152	0.513
Magnesia	4.0	125	0.624
Magnesia	3.1	135	0.578
Chromium	3.15	108	0.722
Hard steel	3.0	78	1.000

The above values are merely relative and must be so considered. The wisdom of using steel as unity is open to question, since its absorption and emission properties are widely different from those of the refractories. The relative heat conductivity may or may not be proportional to the temperature gradient of the different refractories. If it is proportional, then the relative values of the refractories as heat insulators would be:

Fireclay refractory	1.00
High-silica clay refractory	0.974
Bauxite refractory	0.937
Silica refractory	0.873
Magnesia refractory	0.776
Chromium refractory	0.621

DR. E. WARD TILLOTSON
Vice-President, American Ceramic Society

It was pointed out by the speaker that the mean temperature throughout these determinations was only about 600 deg. C., which is below operating conditions for these refractories, and that consequently the work should be extended to higher temperatures.

In discussion, Mr. Greaves-Walker said that results such as these were of the greatest importance at the present time. With powdered coal, oil and gas, using air under pressure, temperatures of 2,800 to 3,100 deg. C. are becoming quite common. In order to maintain these temperatures with refractories now in use the walls must be made more conductive. Thus reverberatory walls which used to be 24 in. thick have been reduced to 9-12 in. in order to get rid of the heat. It is inefficient so far as heat goes, but the desired reaction is obtained without sacrificing the refractories. The same is true of high-powered boilers when forced much above their normal rating.

Discussion of Questions

Perhaps the most valuable part of this meeting was the discussion of a number of questions which had been asked by members and printed in the program so as to give time for consideration.

The problem of calcining clay was considered from many angles, including the relative merits of rotary kilns, downdraft kilns and other types. A. B. Christopher outlined the method used by the Evens & Howard Firebrick Co. The clay is fed from boxcars on a trestle directly into a shaft kiln having a capacity of three boxcars. The clay must be in chunks and not frozen. The kiln is 28-30 ft. high and 14 ft. diameter, with six fireboxes. To burn 140 to 150 tons of coal to a red heat requires under the most favorable conditions

18 tons of coal, although this may occasionally run up to 50 tons.

Silica, magnesite and chromium brick manufacturers are interested in the use of railroad tunnel kilns. Philip Dressler described a new type of tunnel kiln which has been designed to meet the requirements. Silica brick requires a long time to burn, so that in order to get capacity the cross-section of the kiln must be large. Then, however, it is difficult to control the flow of gas uniformly, as most of it tends to follow the crown. This led to the suggestion of passing the gases across the kiln instead of lengthwise and a kiln has been designed having 12-ft. sections each equipped with regenerators. Two tracks will be used, the cars passing in opposite directions to give efficient heat exchange. Prof. Endell remarked that a kiln using the principle was started 2 months ago in Germany for burning insulators to cone 16.

The possibility of machine-made silica brick also received considerable attention. It was brought out that some time ago the silica brick manufacturers got together in the Refractories Machinery Corporation and in conjunction with Prof. Norton of M.I.T. built and installed two silica brick machines. Only one actually worked and that gave no end of trouble, particularly in getting the brick out of the mold. The machine was finally scrapped. Another is being designed, however, which more nearly reproduces the operations of hand-molding and promises to be more successful.

Dr. F. A. Harvey called attention to the fact that while there were curves showing the thermal expansion and transition points for pure silica, there was none which could be applied directly to green silica brick being burned.

Glass Division

Substitutes for Natural Gas

Under the title "The Passing of King Methane," S. R. Scholes discussed the situation brought about by the rapid diminution in the supply of natural gas, which is conceded to be the ideal fuel for glass manufacture. The question of substitute was taken up, producer gas, byproduct coke-oven gas, and fuel oil being considered.

Mr. Scholes also deplored the lack of sufficient data on design in tank construction, and this point was brought up in the discussion which followed by H. L. Dickson, who pointed out that this condition was quite natural, since it is only recently that technical men have been employed in glass works. Full credit should be given the technical men for perhaps the major portion of the advances in tank construction.

Zirconium Silicate Brick in Small Glass Tank

H. T. Bellamy discussed the use of zirconium silicate brick in the crown of a small glass tank with surface combustion burners, in which a silica crown had eroded and spalled due to frequent shut-downs. Zirconium silicate gave none of these troubles. This is probably the first use in a glass tank of this new material, which, although twice as heavy as silica, and costly, has interesting possibilities.

Officers

Officers for the division were elected as follows: Chairman, Dr. J. C. Hostetter; vice-chairman, A. R. Payne; secretary, A. E. Williams; councilors, Dr. H. W. Hess and J. W. Wright.

Enamels Division

The meeting of the Enamels Division opened with a paper by L. A. Adams describing a brushing and striping machine, which eliminates the use of hand brushing in wiping the edges of stove parts and similar pieces.

W. C. Lindemann discussed the use of the Mott sand table, and J. F. Bardush gave the results of some experimental work on the adaptation of the Meurer apparatus for spraying and applying melted enamel.

Electric Furnaces for Enamels

Studies designed to determine whether the reducing conditions in a carbon resistance furnace would be detrimental to enamel smelted in a furnace of this type were outlined by E. E. Geisinger. The results obtained were satisfactory, although no marked improvement was noted.

Recent installations of electric furnaces in bathtub, kitchen ware, sign and watch dial enameling plants were described by James Carpenter.

Air-Cooled Enamels

Stefan Wiester gave the general results of studies on the use of enamels chilled from the smelter by compressed air instead of being water-quenched. An interesting feature of this work is the appearance of the enamel. Due to the fine division of the glass, it is fluffy and light, and looks like a mass of cotton.

Effect of Fineness of Grind on Opacity of White Enamels

Finding it difficult to obtain uniform opacity in two-coat kitchen ware having one ground coat and one white coat, B. T. Sweely and E. S. Prince investigated the influence of the fineness of grind on opacity and found this factor to be a most important one, since opacity is a refraction phenomenon. It was not found possible to control the fineness by the time of milling, since the latter is influenced by the amount of moisture in the mill charge.

Mr. Sweely also read a paper on "Relation of Composition and Resistance to Thermal Shock," in which he called attention to the fact that during sudden temperature changes the outer coat of an enamel may respond before the change has been transmitted to the inner coat. Increasing the coefficient of expansion of the ground coat was suggested so that ground and cover would expand and contract more nearly at the same rate.

Observations on Fish-Scaling of Ground Coat

Interesting observations on fish-scaling of ground coat enamels were made by B. T. Sweely. Various articles enameled on both sides were treated with an acid so that the enamel was entirely removed from one side. According to the author, this should throw compressive strain into the enamel on the other side. If fish-scaling is due to compressive strains in the enamel due to difference in the coefficients of expansion of the enamel and steel, fish-scaling should result in the cases under observation. This was definitely shown in a number of specimens which had not previously shown fish-scaling, although they had been in stock for a number of months prior to the test. Furthermore, ware coated with an enamel apparently in tension (since crazing occurred) did not show fish-scaling when submitted to the acid treatment. In discussion, it was

brought out that other investigators had produced fish-scaling in pieces coated on only one side upon treatment of the other with acid. It would seem that penetration of the ware by hydrogen or even acid might be as important in this case as the release of compressive strain.

Microscopic Studies of Enamel Reactions

A miscroscopic study of ground coat and cover coat enamel reactions, by E. E. Geisinger, showed the effect of various enamel ingredients on the structure and also the effect of under-firing, over-firing and correct firing. Certain oxides showed evidence of reduction in that there was considerable bubbling in the enamel. In these cases the adherence was good. This apparently explains why cobalt oxide and other oxides are beneficial in ground coats. Mr. Geisinger illustrated his talk with a series of remarkable microphotographs of vertical cross-sections of enamels. In all cases the line of demarcation between the various layers was distinct.

Wet Process Enamels for Cast Iron

R. R. Danielson and H. P. Reinecker reported an extended investigation by the Bureau of Standards on wet process enamels for cast iron. The effect of various refractories as mill additions and the effect of variation in ground and cover coats were given. It was shown that large additions of flint, feldspar or clay to ground coats produced unsatisfactory enamels in that it resulted in poor adherence to the casting. It was found that comparatively large amounts of lead oxide in ground coats of this type wre not detrimental. Excess boric acid caused crawling in both ground coat and cover enamel. Cryolite had a tendency to cause the same trouble in the cover enamel. Large amounts of Na_2O were detrimental in that pin-holing was increased considerably.

Modified Molecular Formula

The present molecular formula used by technical men for glaze and enamel calculations is capable of misinterpretation. J. E. Hansen suggested a modification which should relieve the situation and furnish a better basis for the comparison of enamel formulas. In this modified formula an attempt is made to show the mineralogical form in which the fluorides are introduced.

Composition of Cast Iron for Enameling

M. E. Manson called attention to the fact that the physical condition of cast iron was more important than the chemical composition. Thus cast iron made from Northern pig tends to develop blistering in th enamel, while very satisfactory enameling results can be obtained on cast iron from Southern pig iron.

The committee on research has in mind the collection from cast-iron enamelers of representative samples of iron giving satisfactory and unsatisfactory results in enameling in order to make a systematic study of their physical and chemical properties in relation to enameling. This work will be under the direction of R. R. Danielson of the Bureau of Standards, Washington.

Fish-Scaling

The committee on research and development reported the results of co-operative work in the preparation of steels based upon the conclusions reached in the Bureau of Mines work on fish-scaling. Tests on about 2,000 sheets of steel prepared by the American Sheet & Tinplate Co. and enameled in three kitchenware plants were described. The sheets were cold-rolled to various extents and it was found that the tendency to fish-scale was reduced up to about four passes. Further passing did not prove beneficial. This apparently confirms the conclusions of the Bureau of Standards based upon laboratory work. The final report will be included with the bureau's work in a Technologic Paper on "Causes and Control of Fish-Scaling."

Heat-Resisting Racks

Preliminary laboratory tests on various types of heat-resisting alloys for use in burning racks were discussed by E. P. Poste. Studies on warpage and oxidation of the various alloys as compared with the cast iron and steel now commonly used seem to indicate that some of the alloys may be preferable. However, definite conclusions could not be drawn at this time.

Enamel Division elections gave the following results: B. T. Sweely, chairman; R. R. Danielson was re-elected secretary; councilors, H. F. Staley, R. D. Landrum, W. C. Lindemann, D. F. Riess.

Terra Cotta Division

Fire Cracking

Fire cracking occurs in terra cotta under certain conditions and is characterized by the appearance of sharp, hairline cracks extending into the bodies.

Experiments were made by E. C. Hill on firing large typical pieces made from various clays and grogs and cooling at different rates. The tendency to fire cracking was observed after weathering. The rate of cooling was found to have a much greater effect on the tendency to fire crack than the composition or physical properties of the body. Sandy clays gave more trouble than non-sandy vitrifying clays. The kind of grog is much less important in this respect than the kind of clay.

Shivering of Terra Cotta Glazes

Six terra cotta clays were tested for shivering as a body trouble by John L. Carruthers, using a white mat glaze, at cone 3 starting. One non-shivering clay and one badly shivering clay were experimented with to produce and overcome shivering.

Causes of Shivering. From this work and that of others which has been checked, the causes are:

(1) Presence of finely divided silica in the body from
  (*a*) highly siliceous clays,
  (*b*) finely ground grog of a siliceous nature.
(2) Presence of soluble salts in clay, grog or tempering water.
(3) Longer firing periods.

Elimination of Shivering. The methods suggested were:

(1) Use of a flux such as feldspar to overcome action of fine silica.
(2) Use of coarse grog or sand.
(3) Use of $BaCO_3$ to overcome effects of salts.

Other Division Meetings

Interesting meetings were also held by the Art, Heavy Clay Products and White Wares Divisions, in which matters of importance to the members were discussed, but lack of space precludes a detailed account here.

Contributions to the Study of Ammonia Catalysts—I

The First of an Important Series of Articles From the Fixed Nitrogen Research Laboratory, With Introductory Note by Richard C. Tolman, Director—Description of Apparatus for the Small-Scale Testing of Ammonia Catalysts at Atmospheric Pressure

By A. T. LARSON, W. L. NEWTON and W. HAWKINS

Introductory Note

ONE of the most important lines of investigation of the Fixed Nitrogen Research Laboratory[1] has been a study of the synthesis of ammonia from nitrogen and hydrogen. The marked success achieved during the last few years in Germany in applying this reaction to large-scale nitrogen fixation, together with the important attempts which have been made in this country and in France, Italy and England to utilize the same reaction, has emphasized the need of a broadly conceived study of the entire subject.

The problem of economical large-scale ammonia synthesis is one of the most complex known to chemical industry. It is capable of attack from a great variety of angles, and successful solution is perhaps possible under a wide variety of conditions. Thus the method developed in Germany, largely as a war emergency, is certainly not ideal and may not represent in any way the most satisfactory ultimate solution. The Fixed Nitrogen Research Laboratory has therefore studied, and is studying, the problem of ammonia synthesis from a broad viewpoint.

Among the most important phases of the problem is the development of suitable catalysts for accelerating the combination of nitrogen and hydrogen, and the testing of these catalysts under a wide range of conditions. The laboratory has prepared hundreds of catalysts, has developed testing plants for their study and has investigated their behavior over a wide range of pressure, temperature and other conditions.

After 2 years of intensive work the point has been reached where it is felt that an important service can be rendered to the scientific and industrial world by the publication of a series of papers containing a considerable part of the results obtained. It is by no means felt that the problem has been solved, but it is believed that the results so far obtained may enable the industries interested in nitrogen fixation to hasten their development, and may contribute materially toward the understanding of the complex phenomena of contact catalysis. The facts and theories in the published papers should be understood as representing the present status of the catalyst problem, in so far as the Fixed Nitrogen Research Laboratory is concerned, and not as any final word upon the subject.

In connection with these papers the laboratory wishes to acknowledge the aid of a number of men who have been or still are associated with the work and who have contributed materially to its progress, but whose names do not appear in the published papers. These include Dr. Arthur B. Lamb, former director of the laboratory; Dr. W. C. Bray, former associate director; Dr. R. O. E. Davis of the Bureau of Soils, and Dr. Graham Edgar, consulting chemist. RICHARD C. TOLMAN.

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[1]For a discussion of the history, organization and purposes of this laboratory, see Tolman, this journal (vol. 24, No. 14, April 6, 1921, p. 595). It should be noted that on July 1, 1921, the laboratory was transferred, with personnel and equipment, from the War Department to the Department of Agriculture.

Value of Tests at Atmospheric Pressure

A catalyst suitable for the commercial synthesis of ammonia from nitrogen and hydrogen will undoubtedly be required to operate at high pressures. Therefore, in an investigation of catalyst materials, the final tests must be made at high pressures; certainly unless it can be shown that the behavior of catalysts at high pressures can be rigorously predicted from the results of tests at lower pressures.

Testing at high pressures is, however, a slow, laborious and rather expensive procedure, not well suited for the rapid preliminary study of a large number and variety of catalysts. Testing at atmospheric pressure is relatively simple and rapid and the apparatus for it can be quickly installed from more or less standard laboratory equipment. This paper discusses the general procedure and describes the equipment which has been employed in the Fixed Nitrogen Research Laboratory for testing ammonia catalysts at atmospheric pressure.

Outline of Complete Apparatus and General Procedure

Before discussing individual items in detail it seems advisable to consider briefly the apparatus as a whole, referring to Figs. 1 and 2 for illustration.

Ammonia gas, expanded to atmospheric pressure from liquid ammonia, is passed through an electrically heated

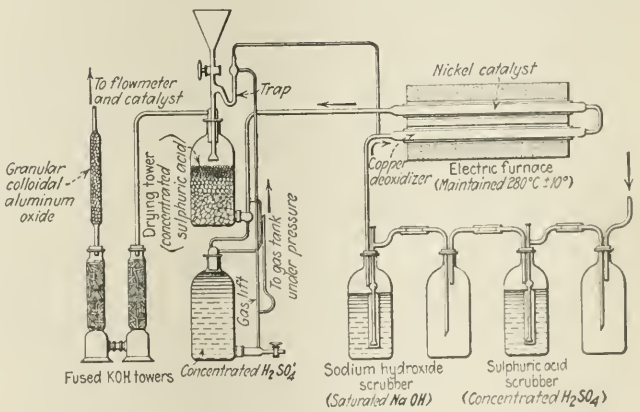


FIG. 1—ARRANGEMENT OF PURIFICATION SYSTEM

"cracker," in which it is decomposed into the 1:3 nitrogen: hydrogen mixture used for testing. This gas is then passed into a gasometer, from which it enters a purifying system (Fig. 1) consisting of a sulphuric acid scrubber to remove undecomposed ammonia; a sodium hydroxide scrubber to remove acid; a deoxidizer of heated copper; a heated nickel catalyst for hydrogenation of carbon monoxide and other substances; a drying tower of concentrated sulphuric acid; two towers of fused KOH;

and a tube of granular colloidal aluminum oxide. The purified gas then passes to a flowmeter and thence to the catalyst chamber proper (Fig. 2), a Pyrex glass tube heated in an ordinary combustion furnace and provided with devices for exact regulation and measurement of temperature. From the catalyst chamber the gas passes into absorption bulbs for analysis. When experiments are to be carried out upon moist gas, there is inserted in the line following the purification train a humidifier, from which the gas enters the catalyst chamber containing a definite amount of water vapor.

In general, the catalyst is introduced into the furnace in the form of metallic oxide and is reduced to metal *in situ* by heating in the same current of pure nitrogen: hydrogen used for testing. This procedure will be discussed more fully in the fourth article of this series.

Sources of Nitrogen: Hydrogen Mixtures for Testing

Commercial compressed nitrogen and hydrogen in cylinders, provided with reducing valves and flowmeters, may, of course, serve as the source of the 1:3 nitrogen: hydrogen mixture used for testing. However, such gases are apt to contain considerable amounts of impurities, and the precise regulation of the composition of the mixture presents an additional complication.

By decomposing ammonia gas by heat, a gas mixture is obtained of definite and invariable composition, containing nitrogen and hydrogen in the ratio desired for testing. Furthermore, by this method a large and readily adjustable supply of the gas mixture is supplied from a small and compact apparatus. This procedure has therefore been adopted for preparing the gases used in the experiments reported in this series of articles.

The Cracker

The construction of the ammonia cracker is shown in detail in Fig. 3. It consists essentially of three concentric cylinders 6, 5 and 3 in. in diameter, and 51, 50 and 63 in. long respectively, made from standard iron pipe and arranged as illustrated. Welded joints are used wherever screw connections are not shown.

The inner cylinder contains the heating element. This consists of 40 ft. of No. .04 nichrome wire first wound in a closed coil on a $\frac{3}{16}$-in. mandrel and then stretched to give the desired length and spacing between adjacent turns of the wire. The coil is drawn through a 36-in. porcelain tube having an outside diameter of $1\frac{1}{4}$ in. and is then wound spirally upon the outside of the tube as indicated. The porcelain tube is fitted with iron guides which serve to hold the nichrome coil in place and also to keep the heating unit centrally disposed within the 3-in. iron cylinder. Porcelain insulators are put around the wire where it passes under the metal guides. The assembled heating unit rests upon an alundum plate. The lead wires are passed through an insulating tube and are attached to the central electrodes of standard $\frac{1}{2}$-in. spark plugs. The lead wires are made sufficiently long so that each can be doubled back on itself. This tends to keep each lead relatively cool at the point where it is attached to the spark plug. A peephole of mica is provided at the top of the inner pipe, through which the heating coil may be observed for temperature regulation. The space between the 3-in. and 5-in. cylinders is packed with steel-wool and the whole apparatus is surrounded by a lagging of asbestos-magnesia. The ammonia gas enters at *A*, passes over the hot steel-wool, then up around the heating coil and finally out at *B* or at *C* as may be desired.

The cracker operates directly on 110-volt a.c. current and consumes $6\frac{1}{2}$ to 7 amperes. It will decompose about 200 liters of ammonia gas per hour, leaving less than 0.01 per cent of ammonia in the cracked gas.

Attention should be called to the following details: (1) Joints are made gas tight at flanges *D* and *E* by the use of asbestos graphite packing. (2) All pipe and fittings indicated are standard, the leads to and from the cracker being made from $\frac{3}{8}$-in. material. (3) The plate shown at the bottom of the 5-in. cylinder is welded on so as to make it gas tight. (4) The decomposer is essentially complete without the 6-in. outer shell. The ammonia gas, however, attacks the iron walls—that is, the 3-in. and 5-in. cylinders—and cracks are apt to develop which might cause considerable leakage of gas. The outer shell—that is, the 6-in. cylinder—serves pri-

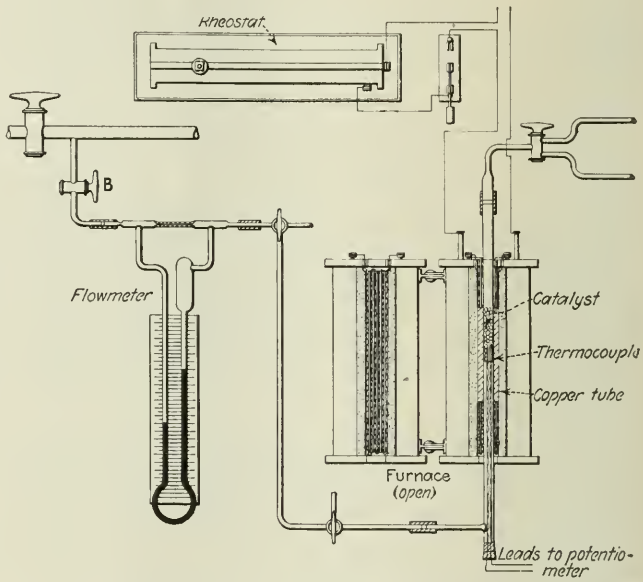


FIG. 2—FLOWMETER AND CATALYST TUBE AND FURNACE

marily to maintain the same pressure on both sides of the 5-in. cylinder. With this arrangement, even though the ammonia does attack the 5-in. cylinder, it does not become deformed, and leakage through this wall is avoided. It will be noted that the cracker may be operated in two different ways. First, the ammonia gas may be introduced at *A* and the decomposed gas drawn off at *B*. By keeping *C* closed the pressure on each side of the 5-in. cylinder remains the same, the pressure on the cracker as a whole being carried by the outside cylinder. Second, by closing the exit at *B* all the gas may be withdrawn at *C*. This has no advantage, however, over the first method suggested and in practice we prefer to withdraw the gas at *B*. At *C* we place a small cock from which we allow a very slow stream, say 5 to 10 c.c. per minute, of gas to escape.

In case the walls of the 3-in. and 5-in. cylinders do break down as a result of the action of the ammonia, this portion of the cracker may be easily removed by loosening the bolts in the flange *E* and withdrawing this portion of the apparatus. A replacement may then be introduced without disturbing the outer shell and the insulating material surrounding it.

Attention should also be called to the initial operation of a newly installed apparatus. The iron walls and piping are coated with oil, which is most conveniently

removed by heating the cracker slowly up to 500 to 600 deg. C. During this time a cylinder of cracked gas is attached at *B* and a slow stream of gas is allowed to escape at *A* and *C*. When the oil fumes have disappeared ammonia may be introduced at *A* and the cracker operated as indicated above.

For several days the efficiency of the cracker will be surprisingly low. After the steel-wool has become sufficiently activated so that the greater portion of the gas is decomposed in contact with its surface, the ammonia in the exit gases will be found to drop to about 0.01 per cent. The nichrome coil is heated to bright redness, the color of which can be observed through the mica window.

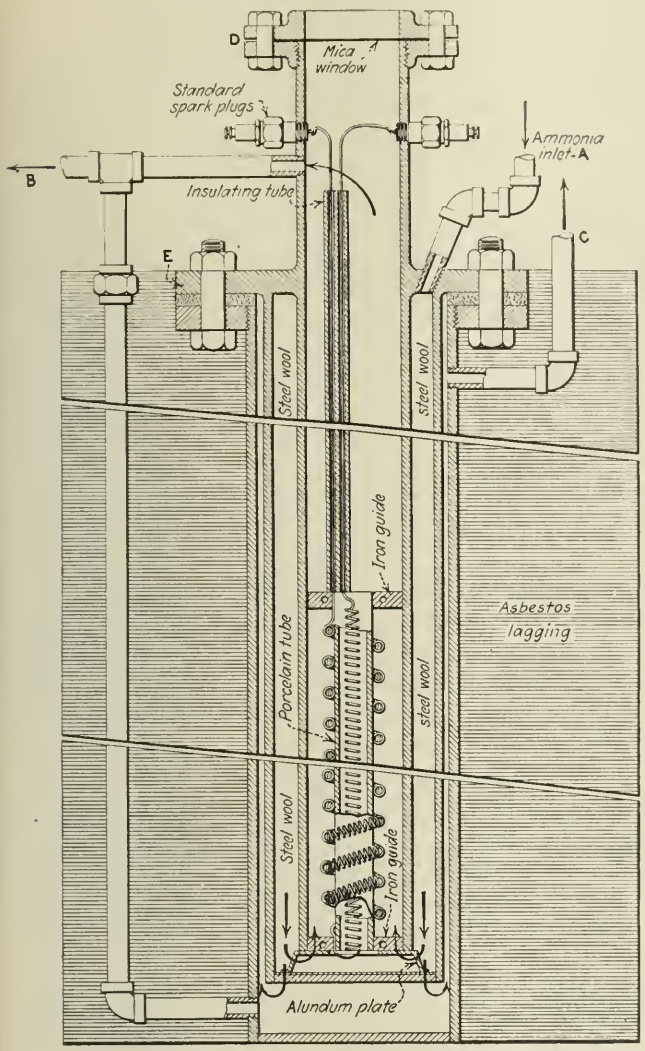


FIG. 3—SECTION THROUGH AMMONIA CRACKER

Purification of the Gas

The purification of the gas mixture is one of the most important factors, perhaps the most important factor, in determining the success of a catalyst-testing apparatus. Like most contact catalysts, the substances which are active in catalyzing the synthesis of ammonia are extremely susceptible to poisons. No intelligent conclusions as to the behavior of a catalyst can be drawn unless the gas used for testing is of the highest degree of purity or else contains definite and known quantities of particular impurities when desired. The poisons most frequently encountered are water vapor, carbon monoxide and acidic constituents. The purification train described below is designed to remove undecomposed ammonia which may have escaped the cracker and also any catalyst poisons which may be present in the cracked gas. What is equally important, it does not introduce impurities into the gas flowing through it, a source of error that is not always sufficiently guarded against.

Details of Purification System

Scrubbers

The individual items of the purifying system (Fig. 1) are described in detail below.

The concentrated sulphuric acid scrubber not only removes any undecomposed ammonia but also serves to absorb any unsaturated hydrocarbons which might be present in the liquid ammonia from which the nitrogen: hydrogen mixture is made. In order to avoid possible reduction of the sulphuric acid, with consequent introduction of sulphur dioxide into the gas, a little potassium dichromate is added to the acid.

The sodium hydroxide scrubber serves to remove acid spray picked up from the sulphuric acid and other acidic impurities possibly present. The solution is kept saturated with sodium hydroxide in order to keep the moisture content of the gas as low as possible.

The Deoxidizer

The gas passes from the alkali scrubber into a tube filled with metallic copper, and is heated to about 280 deg. C., which serves to remove the traces of oxygen which may be present. Whereas a fairly satisfactory copper catalyst for removal of oxygen from nitrogen: hydrogen mixtures may be made by low-temperature reduction of granules of commercial c.p. copper oxide, such a catalyst should be operated above 300 deg. C. for best results. Since in the present apparatus it is desired to heat the copper and nickel catalyst in the same furnace and since the nickel catalyst should not be heated above 300 deg. C. (see discussion following), a special copper catalyst is used. The catalyst is prepared as follows: A 6 to 8 per cent solution of copper nitrate is heated to 40 to 50 deg. C. and slowly added to a 5 to 6 per cent solution of warm sodium hydroxide in slight excess. The mixture is vigorously stirred while precipitation takes place. The precipitate is permitted to settle and the supernatant liquid is siphoned off. After thorough washing by decantation, the precipitate is washed dry on a Buchner funnel and the filter cake broken into 1-in. cubes and dried in a ventilated oven. During the first 12 hours the temperature of the oven is held at 80 to 90 deg. C. The temperature is then raised to 125 to 150 deg. C. and the drying continued for 24 hours. The hard compact granules are then broken up and screened to 4 to 8 mesh, which proves to be a convenient size.

The oxide is now placed in a catalyst tube, as shown in the figure, and is gradually heated to 300 deg. C. in a current of pure, dry nitrogen: hydrogen mixture. This reduced copper oxide is found to be highly pyrophoric, so considerable care must be exercised in keeping it from being exposed to the air. It has been found to work satisfactorily as a deoxidizer at 280 deg. C.

The Nickel Catalyst

From the deoxidizer the gas passes through a tube filled with a nickel catalyst, heated in the same furnace as the copper catalyst. Greenwood and Cowper (Munitions Invention Department. Ammonia Synthesis No.

12) have shown that small amounts of carbon monoxide are completely removed from hydrogen even at high space velocities by passing the gas over a properly prepared nickel catalyst at 250 to 300 deg. C. The carbon monoxide is converted into methane, which is inert toward ammonia catalysts. In addition to carbon monoxide, unsaturated hydrocarbons may be hydrogenated by the nickel. It may be noted that this catalyst would also remove oxygen from the gas (Greenwood and Neville, Munitions Invention Department, Ammonia Synthesis No. 65), but a rapid deterioration of the catalyst results from its exposure to high temperatures, and since this effect may be produced if appreciable quantities of oxygen are present, it was thought safer to precede the nickel by the copper catalyst described above.

The preparation of the nickel catalyst follows Greenwood's specifications. Nonpareil brick, crushed and screened to 4 to 8 mesh, is impregnated with sufficient nickel nitrate solution so that on subsequent ignition and reduction the product contains 10 per cent of metallic nickel. The material is dried at 150 deg. C., is placed in a catalyst tube, and is reduced at as low a temperature as possible in hydrogen or a nitrogen: hydrogen mixture. The catalyst is operated at 280 deg. C. ± 10 deg.

Final Scrubbers and Driers

From the nickel catalyst the gas passes to the sulphuric acid scrubbing tower containing broken glass and beads over which fresh concentrated sulphuric acid is circulated. The acid flow is maintained by a gas lift operated by an auxiliary supply of nitrogen: hydrogen mixture under pressure. The flow is adjusted by a reducing valve and a needle valve. It will be noted (Fig. 1) that the acid from the lift is caught in the trap, from which it trickles into the scrubbing tower. By this means introduction of any acid spray produced by the lift is avoided. The gas used to operate the lift is returned to the main line just ahead of the copper deoxidizer, thus avoiding wastage of gas.

If the acid in the scrubbing tower is kept reasonably fresh, a gas containing less than 0.001 per cent of water may be expected.

The acid scrubber is followed by two towers of fused KOH, which is an excellent drier and also serves to absorb any volatile acidic constituent which might be absorbed by the gas from the concentrated sulphuric acid.

From the KOH towers the gas passes into a tube containing highly porous aluminum oxide, which takes up water very effectively and also serves as a general absorbent, being particularly effective in removing any readily condensable gases.

The preparation of aluminum oxide is similar to that described above for the copper oxide, except that somewhat more dilute solutions are employed, that ammonia is used as precipitating agent, and that the precipitate is washed more thoroughly. The final drying is at 285 to 300 deg. C. The dried granules (6 to 8 mesh) are highly absorptive, and must therefore be kept out of contact with moist air.

Connecting Tubing

The gas issuing from the purification system passes into a copper manifold of $\frac{3}{16}$-in. copper tubing, from which in turn connection is made to twelve catalyst furnaces. A glass manifold, originally employed, was abandoned because of loss of time when breakage occurred. A manifold of standard iron piping was found to contaminate the gas, while a copper manifold has proved thoroughly satisfactory.

It should be noted that rubber tubing is to be avoided whenever possible. For example, 80 cm. of cold-cured tubing lowered the activity of a particular catalyst 95 per cent, and vulcanized tubing produced a similar effect. Considerable improvement is effected by treating the tubing with warm 10 per cent NaOH for several hours and then drying it; but in no case is it safe to use anything more than very short lengths of tubing, such as might be required to join glass tubes together.

Introduction of Moisture and Other Poisons When Desired

Moisture is introduced into the gas, when desired, by a humidifier, consisting essentially of a long horizontal glass tube half filled with water and maintained at a higher temperature than that at which it is desired to saturate the gas. The gas flows over the water in this tube and then passes through a copper coil immersed in water, kept at a temperature corresponding to the vapor pressure of water which it is desired to introduce. By this device saturation of the gas is effected from the supersaturation side rather than the undersaturation side, which gives more uniform results. In practice the glass bulb is usually maintained at room temperature and the copper coil in an ice bath, giving a gas containing 4 mm. of water vapor.

Carbon monoxide, the other poison whose effects have been studied, is introduced into the system by preparing a nitrogen: hydrogen mixture containing 1 per cent CO in a gasometer, introducing this into the line in such quantities as are desired, the operation of the nickel being omitted.

The Catalyst Tube and Furnace

The catalyst, usually 5 c.c. in volume, is contained in a 12- to 14-mm. Pyrex glass tube, about 30 cm. long. It is held in place by a perforated porcelain plate supported on a thermocouple insulator as shown in Fig. 2. A thermocouple junction is placed near the center of the catalyst mass.

A copper tube 6 in. long x $1\frac{1}{4}$ in. external and $\frac{5}{8}$ in. internal diameter slips over the catalyst tube and is supported by stout wires from the top of the furnace. The function of this tube is discussed below. The copper and glass tubes fit into a multiple unit (type 70) furnace with hinged top, connected in series with a rheostat. The furnace is employed in a vertical position, as shown in Fig. 2.

Control the Measurement of Gas Flow

The purified gas from the manifold passes through the cock *B* (Fig. 2), which serves to control the gas flow, and then passes through an ordinary glass flowmeter, from which direct connection is made to the catalyst tube as shown in the figure. The flowmeters are carefully calibrated by water displacement, using a stopwatch, and are known to be accurate within 5 per cent.[2]

Control and Measurement of Temperature

Temperature control in the cracker and in the copper: nickel catalyst furnace, requiring only approximate regulation, is effected by appropriate rheostats and is

[2] A discussion of the details of construction and calibration of these flowmeters is given in *J. Ind. Eng. Chem.*, vol. 11, p. 623 (1919).

measured optically in the case of the cracker and by a thermocouple in the catalyst furnace.

Temperature control and measurement in the catalyst furnace, however, represent a very important problem. In order to be able to draw correct conclusions concerning the behavior of catalysts, it is essential that all parts of the catalyst mass be at the same temperature and that the recorded temperatures be identical with those actually existing.

Uniformity of temperature is not easily obtainable in commercial types of tube furnace. Thus in the furnace employed in this investigation, there was a temperature difference of 10 to 25 deg. C. between top and bottom of the 4 c.c. of catalyst mass. These temperature differences did not vary appreciably with the rate of flow of the gas, showing that they were characteristic of the furnace itself. In order to eliminate these differences it is absolutely essential to smooth out the temperature gradient of the furnace, at least for the distance occupied by the catalyst. The external copper tube, previously described, effects this result most satisfactorily, the high thermal conductivity of the copper serving to distribute the heat in such a way that practical uniformity of temperature is secured throughout the entire catalyst.

A rheostat having fine gradations and connected in series serves to effect a very close adjustment of temperature.

Temperature is measured by means of a chromel-alumel thermocouple with its junction imbedded in the lower layers of the catalyst. The thermocouple wires are insulated by means of a two-holed fireclay protection tube which is supported at its lower end by a rubber stopper. The wires are sealed gas tight in the end of the fireclay tube by means of de Khotinsky cement. Below the rubber stopper the thermocouple wires are attached to copper wires leading to a Leeds & Northrup potentiometer, sufficiently sensitive to permit the estimation of temperature to 1 deg. C. The thermocouples are frequently calibrated by heating them in a vapor bath of boiling sulphur.

Analytical Control

Since the effectiveness of the catalyst is determined by the ratio of ammonia to nitrogen: hydrogen in the outflowing gas, this represents the only necessary analytical determination. At atmospheric pressure the amount of ammonia must always be very small, necessitating the use of a large sample of gas for analysis. In practice, therefore, a Gomberg gas-washing bottle containing standard sulphuric acid is attached to the outlet gas, and the gas current is maintained for a definite time, the flowmeter and stopwatch readings permitting the calculation of total gas volume. The ammonia is then determined by titrating the excess of acid with standard alkali, using methyl red as indicator.

Results

The apparatus described above has been employed in the Fixed Nitrogen Research Laboratory for the testing of a large number of ammonia catalysts and for studying the influence of temperature, rate of flow of gases, catalyst poisons and other factors entering into catalyst behavior. Results of these investigations will appear in the fourth article of this series.

(Part II, which discusses Small-Scale Testing of Ammonia Catalysts at Variable Pressures, will be published in a subsequent issue.)

Cancer From Handling Anthracene Cake in the Dye Industry

The use of anthracene, which is the starting point of the alizarine dye industry, has been shown by W. J. O'Donovan,[1] writing in the *British Journal of Dermatology and Syphilis*, to be capable of producing cancer of the skin among workers handling the crude anthracene cake. Anthracene in the cases reported was delivered to the factory in the form of cake which was unloaded by hand and broken down, exposed to steam, and washed with solvent naphtha mixed with pyridene bases; the product was then distilled with potash and lime, washed with solvent naphtha, and finally sublimed.

The three cases reported were brought to the writer's attention within a period of about 4 months, and in a factory employing only about twenty-five men this was considered by him as "a heavy incidence of a grave industrial disease."

The first case was that of a man 62 years old who had been employed for 5 years in unloading boxes and sacks containing the raw cake. On the back of the right wrist was an ulcer with raised edges which proved to be a scaly and horny-celled carcinoma. The growth which was removed had started as a small wart 6 months previously. His forearms also showed much dilatation of the capillaries and small blood vessels and follicular keratoses, a form of acne. The second case occurred in a man aged 53 who had worked for 30 years in the same factory. A cancer of the same nature had appeared on his right cheek 3 months before and had grown very rapidly. Under treatment by radium it entirely disappeared. The third case was that of a man 59 years of age who had worked in the factory 32 years and who had developed an ulcer on the right wrist 4 years previously. This ulcer had developed rapidly in the preceding 6 months and upon excision was found to be a cancer of the same nature as in the other two cases.

All the men working in this factory who in any way handled the crude anthracene showed a deep staining of the hands and faces. Their hands were stained a deep brown, sometimes almost green, their faces and necks were very swarthy and there were also acne papules on their necks and forearms.

Business in Chile Awaits Lower Nitrate Price

Conditions in Chile, reported to be improving during December, 1921, remained stationary during January and February and are still awaiting a betterment in the nitrate trade of Europe and the United States, says Commercial Attaché McQueen in a cable to the Department of Commerce.

The prices on nitrate which were fixed on Oct. 27, 1921, terminate on June 30, 1922, and lower prices are expected thereafter. The nitrate producers hope to see the reduced prices hasten the marketing of the present stocks in Europe and the United States and a consequent general improvement after the middle of the year. Imports and exports are decreasing, the foreign and domestic demand continuing dull. There has been no appreciable addition to import stocks since October, 1921.

The agreement made between the miners and operators of the coal districts of southern Chile terminated Dec. 31, 1921, following which a walkout and strike was called. This, however, has recently ended in failure for the miners.

[1] *Boston Medical and Surgical Journal*, Dec. 1, 1921, pp. 662, 663. *Journal of Industrial Hygiene*, December, 1921, pp. 187, 188.

Chemical Warfare in Naval Action

This Is the Ghost the Navy Saw in the Bombing of the Alabama and Explains Its Attitude Toward Gas Warfare

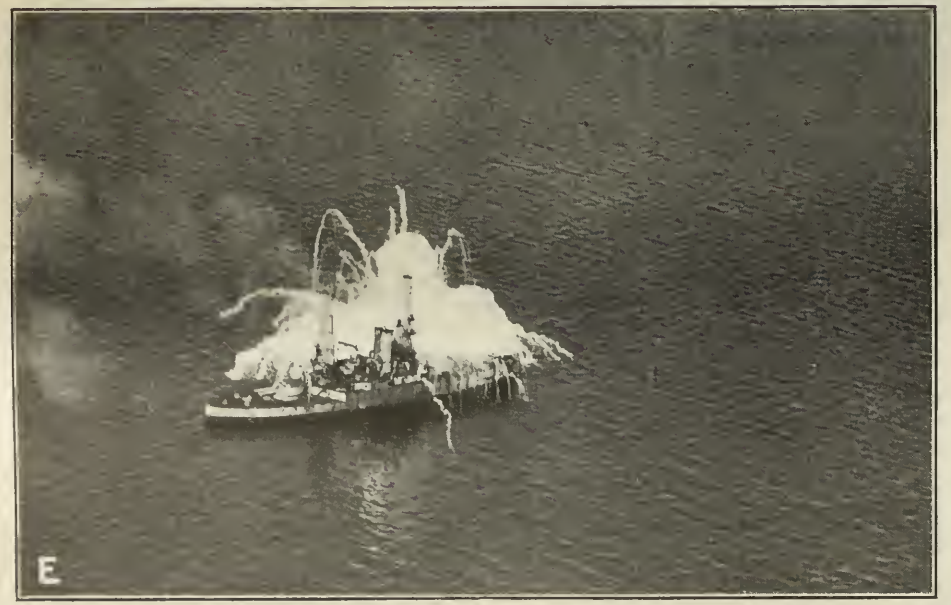
A and *B*—The Alabama in a Smoke Screen

C and *D*—Effect of 25-Lb. Phosphorus Bomb

E and *F*—Direct Hits With Two 25-Lb. Phosphorus Bombs

G—100-Lb. Phosphorus Bomb Hits Crow's Nest

H—Direct Hit of Four 100-Lb. White Phosphorus Bombs



The Froth Flotation of Coal

A Discussion of Research Work on the Recovery of Washery Refuse and Unconsumed Coal in Ashes—The Commercial Utilization of the Froth Concentrate

By OLIVER C. RALSTON[1] and ARTHUR P. WICHMANN[2]

With the exhaustion of the seams of coal which are low in ash content and with the increased cost of coal, problems in the removal of ash have assumed increasing importance. The use of jigs for removing the slate and other impurities from coarse coal has long been standard practice. More recently, ore-concentrating tables have been adapted to the "washing" of the finer sizes of coal in the coal washeries and have saved material that was formerly wasted, because there is a poor market for fine sizes of coal. However, the slime formed in breaking the coal before washing has been entirely discarded, for the reason that it has not been salable even when recovered. Just as was the case in ore-dressing not many years ago, the indications are now that the slime formed in the mill will become sufficiently valuable to save. Also, when the advantages to be gained by the use of clean coal are fully appreciated, it is possible that fine grinding and flotation or other treatment of low-grade coals, formerly considered worthless, will result as it did in the case of finely disseminated ores. While it is not at all certain that such methods will find a commercial field, it was thought well worth while to investigate the applicability of froth flotation to cleaning finely ground coal in order to see just what technical problems would arise and what advantages could be gained.

Since an investigation of the coals of the Pacific Northwest with respect to the possibilities of their improvement by ordinary methods of coal washing was already under way at the Northwest Experiment Station of the Bureau of Mines, in co-operation with the College of Mines of the University of Washington at Seattle, this study of the applicability of froth flotation to the fine sizes of coal was carried out to supplement the coal-washing program.

Products to Which Froth Flotation Might Be Applied

The most obvious product to which froth flotation might be applied is the coal slime produced by crushing coal in washeries and to the finer sizes of coal which cannot be washed very cleanly on coal-washing tables. Huge piles of coal sludges and culm have also accumulated from past washing operations and are available.

Coarse washery refuse often contains considerable interstratified coal which could be liberated by crushing, permitting the coarser material to be recovered by tables and the fine material by flotation.

Mine waste also frequently contains considerable material like the coarse washery waste which might be advantageously crushed and treated for its coal content.

Run-of-mine coal, when too high in ash that is not liberated by crushing to form the ordinary sizes of lump, egg, nut, pea and buckwheat, might even be more finely ground and treated by flotation.

The ash from domestic and industrial furnaces contains considerable unconsumed coal, the average ash of the United States probably containing 20 per cent of combustible matter. Coal-flotation plants might be located near large cities to crush and recover coal from the ash produced in these cities.

Of these possible products which might be treated, two have already received relatively large-scale tests—washery fines and unconsumed coal in ashes.

Review of Previous Work

The idea of using flotation for recovery of coal from fine washery waste is not new. Small laboratory tests on material of this kind were observed by one of the present writers as far back as 1915 in various flotation-testing laboratories of the United States. In one instance the film flotation machines of the Empire Zinc Co., in Canyon City, Col., had been tested for recovery of anthracite from the anthracite culm material known to be so plentiful in Pennsylvania, cleaner concentrate being obtained than by froth flotation. The idea had been passed around in a confidential way among flotation engineers. The first U. S. patent was issued to Raymond F. Bacon, of the Mellon Institute, Pittsburgh, Pa. (U. S. Patent 1,329,493, of Feb. 3, 1920), who assigned it to the Metals Recovery Co. of New York. Bacon described tests with a Callow pneumatic flotation test machine on coal washery waste and on run-of-mine coal crushed to pass a 48-mesh screen and mentioned the fact that lustrous coal in sharp angular fragments was the most easily floated.

Minerals Separation, Ltd., in England, also began patenting features of coal flotation[3] in 1919 and later[4] in that year built at the plant of the Skinningrove Iron Co., in Wales, a test plant to investigate the removal of ash from the coking coal used by that company, a problem which was giving considerable concern. The reports on this work appeared after the present writers had done all of their own work and not only checked their observations but supplemented them to some extent.

In view of this prior publication we shall not attempt to report our own results in detail but shall give them

Published by permission of the Director, U. S. Bureau of Mines.

[1]Assistant Chief Metallurgist, U. S. Bureau of Mines.

[2]Research Fellow, College of Mines, University of Washington, 1919-1920. This paper gives the main results contained in an extensive thesis on the use of froth flotation presented for the degree of Master of Science in 1920 by Mr. Wichmann.

[3]Br. Pat. 154,702, Mellersh-Jackson, Sept. 2, 1919; Br. Pat. 155,875, W. Broadbridge, Aug. 26, 1919; Br. Pat. 159,285, Edser, Rulman and Jones, Nov. 20, 1919; Br. Pat. 165,144, Jones, Bury and Minerals Separation, Ltd., 1920.

[4]Arnold F. Bury and Arthur Bicknell, *Colliery Guardian*, vol. 120, p. 337 (1921). Ernest Bury, W. Broadbridge and A. Hutchinson, *Trans. Inst. Min. Eng.*, vol. 60, pp. 243-253 (February, 1921); also *Colliery Guardian*, vol. 121, pp. 867-868 (1921); also *Chem. Eng. and Min. Rev.*, vol. 13, pp. 388-390 (1921). Anonymous, *Iron and Coal Trades Review*, vol. 102, p. 197 (1921).

only in abstract, reviewing at the same time the work which has been done in Wales.

The material in a coal seam may contain all gradations from pure coal with almost no ash to pure ash. It has been more or less arbitrarily divided into the following types of material: Pure coal, containing up to 5 per cent ash; bony coal, containing from 5 to 15 per cent ash; bone, containing 15 to 50 per cent ash; bituminous shale, containing 50 to 80 per cent ash and pure shale rock or ash with very little bituminous matter.

The Suitability of Various Flotation Oils

In all the various coals tested it has been found that the pure coal is the most easily floated,[5] and the other products follow in order. Since the division between them is merely arbitrary, their behavior in the flotation machine is quite similar and it is almost impossible to distinguish visually one from the other in the froth. The most favorable oil discovered in the work in England was the waste water from the absorption and washing of crude naphthalene in an adjacent byproduct coking plant, whereas our most favorable oil was a mixture of alphanaphthalamine (known to the flotation trade as X-cake) with xylidine in sufficient quantity to keep it in solution. Both of these are practically entirely water solutions of coal-tar products and seem to be adapted best to making the pure coal float first. They are commonly regarded as "frothers" and not very good collectors. When petroleum products or other wood or coal-distillation products such as creosotes, tars or essential wood oils are added, the flotation of the other portions of the coal results.

The British experimenters have said: "If we were asked to state the most striking fact in the application of the process to coal washing, we would refer without hesitation to the facility with which it separates one grade of coal from another merely by the simple control of reagents and without the aid of any form of screening or classification." This observation we are unable to check. Our work has been almost entirely restricted to the bony coals and bone coals of the Pacific Northwest and we have observed a marked tendency of the coal to separate in this manner, but we certainly cannot feel that this is done with any "facility." Had we been working with some of the fine low-ash coals of Wales we might have been able to agree.

If a high extraction of combustible matter is the desideratum rather than low ash concentrate, any of the ordinary flotation oils easily recovers all the pure coal, bony coal and bone together. There is no difficulty whatever in getting coal to enter a flotation froth and in fact we have found our greatest embarrassment in the tendency of all the bituminous matter to float with the clean coal. Pine oil and similar frothers cause trouble of this kind. Quite evidently the best condition for the procurement of a clean coal froth is a relatively poor flotation condition, just as in the differential flotation separation of mixtures of sulphide minerals conditions must be found under which one mineral can barely be floated while the other or others will not float at all.

Skinningrove Iron Co. Tests

This test plant, as well as one built at the Powell-Duffyn Colliery, Aberdare, England, treated the high ash products obtained in the washery where a coking coal was prepared for the ovens. The material liberated a high percentage of low-ash coal by simple crushing to pass a 10-mesh sieve, and this material was treated in Minerals Separation flotation machines, using as a flotation reagent the wash water from the naphthalene recovery section of the byproducts coking plant. The ingoing material contained from 13 to 45 per cent ash and the froth concentrate of cleaned coal contained as low as 3.5 per cent ash—a truly remarkable result when compared to what can be done with the ordinary types of coals available in the United States. A screen analysis of the froth concentrate shows that the material passing a 10-mesh and stopping on a 20-mesh screen contains only 2.7 per cent ash, while the material passing a 200-mesh screen contains 5.9 per cent ash, the tendency being for progressively smaller sizes of the coal in the concentrate to be progressively dirtier. Our own results on higher-ash coals check this.

The froth was thickened in a Dorr tank to 50 per cent solids and then passed over an Oliver continuous filter, yielding a product said to contain about 10 per cent moisture. It was felt that this was too much moisture to be fed economically into the coke ovens and preparations were being made to reduce it further in a drier. Nevertheless this material was easily coked in ordinary byproduct ovens and the low-ash coke afforded a considerable economy, estimated at slightly over 3 shillings per ton of pig iron produced with the coke. The advantages of treating the coking coal by this method in order to make coke for the iron industry are summarized by Bury, Broadbridge and Hutchinson as follows:

Advantages of the Method

(1) Ash reduction. Saving in cost of handling, particularly where the place of the production of material to be coked is some distance from the coke ovens.

(2) Economy in coking. The product is more highly bituminous, yields richer gas, more byproducts and about the same yield of coke.

(3) Superior coke. The coke produced is low in ash and also highly porous but very strong and dense.

(4) Economy in furnace space. More room for iron ore and fuels.

(5) Minimum silica, since ash reduction calls for less lime and hence less coke.

(6) Dense coke means less fines. This avoids loss of coke fines and must be screened out.

(7) Thermal efficiency. Less slag produced to carry out heat.

(8) Maximum thermal efficiency at smelting zone, because coke does not shatter and burn up before it reaches this zone.

A typical test on this Welsh coal containing 10.14 per cent ash gave 87.2 per cent by weight of pure coal concentrate with 3.25 per cent ash, 2.4 per cent second concentrate (bone) with 19.2 per cent ash and 9.5 per cent of residue with 72.1 per cent ash.

This work in England proved to be very valuable and profitable to those entering into it for the reason that it was possible to recover cheaply from the old waste dumps that had accumulated for years a great deal of coal at a time when the nation was suffering from coal shortage caused by strikes and high cost of production.

Recovery of Coal From Ashes

The unconsumed coal in domestic and industrial ashes, mentioned as one of the products to which flotation should be applicable, has been experimented on by

[5]One exception to this has been reported in a private communication from the superintendent of the Rare and Precious Metals Experiment Station at Reno. A bony lignite from western Nevada gave a first concentrate higher in ash than the later products taken from the flotation machine.

Fraser and Yancy[6] at the Urbana experiment station of the Bureau of Mines, where rather large tests were made on the use of coal-washing tables for this work. The ashes were crushed to about $\frac{3}{8}$ to $\frac{1}{4}$ in. before tabling. The washed fuel recovered contained about 25 per cent ash. Such material has been tested qualitatively by the writers, using froth flotation, and the combustible material forms a black froth in sharp distinction to the light-colored ash suspended in the water. However, no quantitative tests have been made. H. B. Hoveland, in his laboratory in Washington, D. C., was one of the first to use froth flotation on such ash, but his results were not available.

Froth Flotation of Pacific Northwest Coals

Representative results of some of our tests on the coals of the Pacific Northwest are briefly abstracted in Table I. They were obtained when we were learning how to float coal and are not nearly as good as might be obtained with better and more closely controlled conditions. Many of them show high-ash froths due to excessive use of the oils which float the bone with the cleaner coal. Very few of them were carried out with the idea of making a high recovery of combustible matter, but rather an attempt was made to produce clean concentrate. Frequently a test was stopped after only a small portion of the coal had been floated.

TABLE I.

Product Treated	Source	Per Cent Ash In Feed	Per Cent Ash In Concentrate	Per Cent Recovery Combustible	Oil Used — Kind	Oil Used — Lb. Per Ton
Sub-bituminous table middling	Mendota, Wash.	47.85	25.66	71.2	Pine oil (steam-distilled)	1.5
Sub-bituminous run-of-mine	Renton, Wash.	28.75	23.75	44.9	Coal tar-pine oil	2.0
Sub-bituminous washery sludge	Renton, Wash.	19.38	10.66	34.6	Coal tar-hardwood oil	3.0
Sub-bituminous fine screenings	Bellingham, Wash.	22.65	13.30	54.1	Hardwood creosote	2.0
Sub-bituminous run-of-mine	Isaquah, Wash.	33.25	22.38	33.6	Kerosene-pine oil	8.0
Sub-bituminous washery sludge	Isaquah, Wash.	29.35	17.10	11.8	Kerosene-pine oil	2.0
Coking bituminous, table middling	Palmer, Wash.	30.01	20.00	76.7	Pine oil	0.5
Coking bituminous, run-of-mine	Carbon Co., Utah	6.00	4.00	61.4	Pine oil	0.7
Coking bituminous, run-of-mine	Ladysmith, B. C.	8.60	4.95	73.7	Pine oil	0.25
Non-coking bituminous, run-of-mine	Roslyn, Wash.	17.80	9.98	56.1	Pine oil	0.6
Non-coking bituminous, run-of-mine	Roslyn, Wash.	24.15	13.43	72.6	Kerosene oil	1.0
Non-coking bituminous, run-of-mine	Carbonado, Wash.	18.65	10.37	60.0	Pine oil	0.8
Coking bituminous, run-of-mine	Carbonado, Wash.	9.50	7.33	52.0	Pine oil	0.8
Semi-anthracite, run-of-mine	Carbonado, Wash.	8.02	4.38	64.2	Pine oil	0.8
Coking bituminous, run-of-mine	Wilkeson, Wash.	14.38	10.73	60.0	Pine oil	0.5
Coke (beehive)	Wilkeson, Wash.	18.50	16.10	66.8	Pine oil	0.4
Coke (beehive)	Fairfax, Wash.	23.65	18.00	60.8	Pine oil	1.0

The work represented in Table I was done in an ordinary Minerals Separation type flotation machine. The opinion was formed that this machine was not well adapted to the froth flotation of coal, as it seemed to require the addition of too much oil to the pulp. Later work in a Ruth machine, which corresponds to a sub-aërated Minerals Separation machine, proved this to be true, as much less oil could be used in the Ruth machine in order to get a satisfactory loaded froth.

TABLE II.

Sample	Per Cent Ash Feed	Per Cent Ash Concentrate
Total	22.65	17.14
Pass 60 mesh, held on 200 mesh	21.57	15.63
Pass 200 mesh	25.20	19.32

The coal seems to absorb the excess of oil from the water so that the frothing properties of the water are soon spoiled. Incidentally the fine coal seems to become overoiled and to form a dirty froth. This is illustrated by a screen analysis made on the feed and the concentrate of one of the tests with Bellingham sub-bituminous coal, which are given in Table II.

[6] Thomas Fraser and H. F. Yancey, *Reports of Investigations*, Bureau of Mines, Serial 2281, September, 1921.

TABLE III.

Coal Treated	Source	Feed Per Cent Ash	First Concentration Weight Per Cent	First Concentration Ash Per Cent	Second Concentration Weight Per Cent	Second Concentration Ash Per Cent	Tailing Weight Per Cent	Tailing Ash Per Cent
Sub-bituminous	Renton, Wash.	19.4	32.0	10.7	35.0	14.0	33.0	33.2
Sub-bituminous	Bellingham, Wash.	22.7	70.0	13.5	15.0	26.9	15.0	57.0
Bituminous	Roslyn, Wash.	17.8	33.0	10.1	49.0	11.4	19.0	51.0
Bituminous	Roslyn, Wash.	17.9	77.0	12.4	19.0	30.1	4.0	73.3
Coking bituminous	Carbonado, Wash.	8.0	61.6	4.4	34.1	9.8	3.4	62.5

Incidentally, the oil mixture used in this test was found to be rather non-selective and too much of a collector. It consisted of 50 per cent hardwood creosote and 50 per cent coal tar creosote used in the proportion of 2 lb. per ton of coal.

A few representative figures showing the way in which a coal tended to divide into several products, the cleanest being floated first, are given in Table III, which deals with two sub-bituminous coals, two non-coking bituminous coals and one coking coal. The first four were quite bony and the last was fairly clean without so much bone.

There seems to be no doubt that many coals can be considerably improved by froth flotation, though the bony coals are quite refractory toward the process. Assuming that there is a demand for it, some clean coal can undoubtedly be extracted from nearly all coals by utilizing the above-mentioned selective tendency to float clean coal first. This being true, the next real problem is the commercial disposal of the finely divided froth concentrate. It must first be dewatered, and this is no easy problem. With the relatively coarse material produced by the Minerals Separation work in England, a satisfactory result seems to have been obtained by using a Dorr thickener followed by an Oliver filter to bring the moisture content down to 10 per cent. However, there are few coals in the United States as clean as the coals experimented with in England and finer grinding than 10 mesh will doubtless be necessary in order to liberate more of the ash. This will give a product which will not settle so readily nor filter so easily. After a filter cake of the consistency of thick mud is discharged from the revolving filter, there is a serious question as to what to do with it.

Disposal of the Concentrate

Various proposals for the disposal of this concentrate are to be considered. One is to dry it out sufficiently to be used for powdered coal combustion appliances. Probably it would have to be ground somewhat further, or at least the lumps would have to be disintegrated,

so a regular coal-pulverizing machine would still be necessary, although it would have a very high capacity.

Another proposal would be to briquet the material and burn it in that form. W. Broadbridge, one of the Minerals Separation engineers, has secured a British patent[7] for this proposal in which he states that it can be briquetted by the use of 7 per cent of pitch or 5 per cent of pitch mixed with some cresol and kerosene. These percentages are calculated on the dry weight of the coal. The binder may be introduced into the froth concentrate in the liquid state or may even be used to produce the flotation and simultaneously provide the binding medium. Our results show that if enough oil to bind the material into briquets is introduced into the flotation pulp it will probably cause the non-selective flotation of all bituminous matter, leaving only the pure ash in the residue. This method could therefore be used to advantage only on coals containing no bony matter.

Still another proposal is to prepare the froth concentrate for the coke oven by dewatering as was done at the Skinningrove Iron Co. plant, except that with finely ground material or even with the 10-mesh material handled in that plant there is still too much moisture in the filter cake. It is probable that a partial drying of the filter cake in a rotary drier would be sufficient. At a certain critical percentage of moisture any mud or finely divided damp material will roll up into little balls when tumbled about in a machine like the rotary kiln drier. These little balls should make good material for feeding to a coke oven, as they would leave enough space between them to provide gas passages for escape of the coke-oven gas and avoid the "vomiting" which sometimes occurs with a closely packed, finely divided charge.

Summary and Conclusions

The work of the writers on a series of coals of the Pacific Northwest, most of them bony, taken in conjunction with the reports of the work of Minerals Separation, Ltd., in England, seems to justify the following conclusions about the applicability of froth flotation to the cleaning of coals:

(1) Due to unexplained difficulties, very finely ground coal slime does not concentrate well by flotation and the process is limited to the treatment of the more granular material. Whereas the finer sizes should give a cleaner concentrate, they actually give a dirtier one.

(2) Coals with a bright luster have been found to concentrate more cleanly than dull coals.

(3) There are indications that cleaner flotation is obtained when the coal is broken into sharp angular fragments than when ground down to rounded pieces.

(4) While in general the coals of higher rank, like the semi-anthracite and the coking coals, are more amenable to flotation, this is not essentially so, as some of the sub-bituminous coals have been successfully floated.

(5) The mode of occurrence of the ash in the coal is most highly important, as it has been found that most of the ash present in bony coal and bone coal cannot be liberated by the finest attainable commercial grinding.

(6) The free clean ash can be left in the flotation tailing and the remainder of the coal can easily be floated away from it.

(7) The cleanest coal is the most easily floated, providing the flotation oil consists of a poor frother with no collector and a sub-aëration or pneumatic flotation machine is used.

(8) Bone coal floats almost as easily as clean coal, but will require the use of a better frothing oil and some collector for complete extraction.

(9) Bituminous shale is somewhat less easily floated than bone coal.

(10) For grading a coal by flotation into clean coal, bone, bituminous shale and free ash, careful control and the use of differential flotation methods is necessary.

(11) Flotation tests on removing the ash from finely ground coke have not shown much success.

[7] Br. Pat. 155,875, Aug. 26, 1919.

Investigations of Iron Blast-Furnace Operation

The blast-furnace research section of the Bureau of Mines, located at Minneapolis, Minn., has carried out plant investigations for 6 years; these are being continued. The conviction has been forced on it, however, that little progress toward the solution of the many important problems involved in furnace operation will, or can, be solved by any method of study of commercial operations on account of the large amount of materials to be handled in these operations and the numerous causes of irregularities. The need of a furnace capable of operating on a small scale and under controllable conditions has been obvious for years. In the last year an experimental stack has been erected and twelve combinations of furnace lines and operating conditions have been tried out. This work is being continued.

The blast furnace works on the countercurrent principle; the ascending gas stream encountering the descending raw materials, with a regenerative transfer of heat. Maximum contact between gas stream and raw materials produces most rapid heat transfer and reduction of the ore. The degree of contact between gas stream and solid charge depends to a very large extent upon the size and shape of the furnace, and the investigation is planned with a view of acquiring data which will enable the engineer to design the furnace more rationally.

Another investigation relates to the effect of physical characteristics of the charge on blast-furnace operation. Probably the greatest cause of the fundamental inefficiency of the blast furnace considered thermally as a furnace is due to the enormous disparity between the sizes of the particles of the solids charged. In a number of cases furnace operators have improved furnace efficiency by sizing the coke charge. There are prospects of being able to continue such work on the sizing, not only of the coke but of the ore.

A laboratory study of the time rate of reduction of iron oxides by carbon monoxide is under way. The reducing gas employed will be 35 per cent CO and 65 per cent N_2. The iron oxide will be obtained from the higher grade Lake Superior shipping ores and the reducing gas will be driven through the ore bed at such rates of speed as obtained in blast-furnace operation—i e., about 25 ft. a second. The rate of the reaction is known to depend primarily upon the gas velocity and the size of the ore particles. To a lesser extent the reaction will depend upon the temperature and the composition of the reducing gas.

Former investigations have been confined to a study of the reactions between iron oxides and carbon oxides, undiluted by nitrogen. The new work will therefore more nearly approximate furnace conditions.

Notes on the Manufacture of High-Speed and Tungsten Steels

Massive Carbides Were Separated From High-Speed Steel, Analyzed, and Found to Approximate the Composition of the Ferrotungsten Used in Their Manufacture—Structural Disposition of These Carbides After Various Heat-Treatments, With or Without Previous Mechanical Work

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IN THE following the writer traces the steps taken in studying segregation in high-speed and tungsten steel. Valuable information is thus developed which may enable the steelmaker to eliminate some of the troubles in manufacturing tungsten steels and to produce a better product.

Ferrotungsten Better Than Metal

In the making of high-speed and tungsten steels tungsten is introduced either as ferrotungsten or as so-called metallic tungsten powder. It seems more logical to use the ferro-alloy; through its use not only will the final product be superior, but also many of the difficulties which are met in the production of tungsten steels can be eliminated.

The temperature of the average crucible furnace is from 2,900 to 3,100 deg. F., that of the electric furnace somewhat higher. The melting point of pure tungsten is about 6,400 deg. F. On the other hand, a ferro containing about 75 per cent tungsten melts in the neighborhood of 3,700 deg. F.; as the iron content increases, the melting point decreases, and the carbon content has a similar though less marked effect.

Due to the very high melting point of even commercial tungsten metal, it is necessary to observe certain precautions in smelting in order to prevent the tungsten metal, which alloys but slowly with the iron, from segregating, particularly in crucible practice. This segregation is sometimes so extensive that a button forms in the shape of a pancake in the bottom of the crucible. This button has always been found to carry a high percentage of tungsten and possesses a melting point higher than that of the steel, with the result that it was not sufficiently fluid to pour from the pot with the rest of the contents. The composition of one such button was C 0.83, Si 0.73, Cr 11.57, W 57.10, and Fe 31.07. The desired composition of the steel being melted was C 0.5 to 0.6, Mn 0.2 to 0.3, Cr 4.0 to 5.0 and W 20.0. In this instance the tungsten metal, as it settled to the bottom of the crucible in the course of the melting process, absorbed some of the ferrochromium of the charge; hence the high percentage of chromium.

This segregation is usually prevented in crucible practice in one of three ways:

First, the tungsten is added shortly before teeming.

Second, tungsten is distributed through the upper part of the charge, so that as the iron melts, the tungsten, on account of its greater specific gravity, passes down through the melt, giving it a chance to be alloyed with the iron by the time it reaches the bottom of the crucible.

Third, an agitation or boiling is produced, either by placing oxides at the bottom of the crucible or introducing oxides during the course of the melt, which tends to hasten the absorption of the tungsten.

The first method is not readily carried out and is considered impracticable by the greater number of steelmakers. The second procedure does not entirely prevent segregation when the tungsten is introduced as metallic powder, on account of its high melting point and slow alloying property. The third method is more widely used, but it is generally accepted that oxides are injurious to fine steel and every effort is bent toward their removal. Their introduction, therefore, would seem to be a step in the wrong direction, for it is very likely that the oxides are not completely removed by the subsequent melting and deoxidizing. Furthermore chromium, one of the essential constituents of high-speed steel, is readily oxidized. When combined with the oxide of iron, it forms one of the most highly refractory and inert combinations, one exceedingly difficult to eliminate when once formed, and when retained produces steel which can be forged with difficulty, and is likely to be brittle and probably crack during hardening.

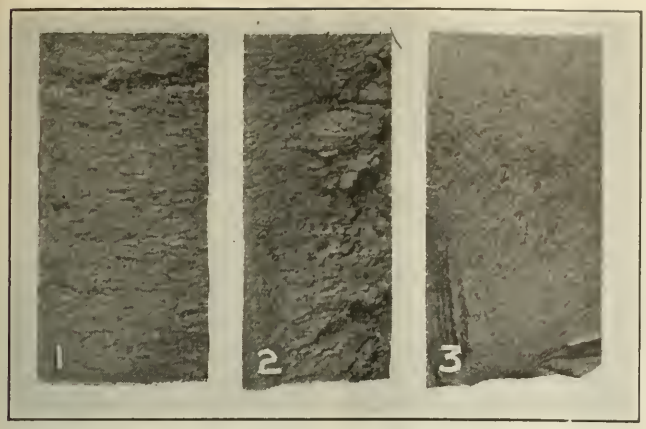
Ferrotungsten, on the other hand, readily alloys with the steel. As noted above, its melting point is much lower than metallic tungsten and likewise its specific gravity. Furthermore the tungsten, iron and carbon in ferrotungsten are already alloyed in somewhat similar chemical combinations and physical constituents to those existing in high-speed steel. The striking similarity which exists between the comoposite carbides found in high-speed steel and ferrotungsten will be apparent from what follows.

C. Mennicke, who compiled a most interesting and complete study of tungsten, in his book "Metallurgie des Wolframs" states that "the use of ferrotungsten in the manufacture of tungsten steels is beyond doubt superior, easier to handle and more effective than metallic tungsten." To this the writer would add that if the ferrotungsten is broken or crushed to the size of rice or of pea, it is in that condition readily handled in the mixing room and produces a cleaner, more homogeneous product, freer from segregation, oxides, slag and such foreign inclosures. In fact, the use of metallic tungsten is based on no logical conclusions, and experience shows a marked tendency toward the use of lower melting and easier combining tungsten alloys until now but few steelmakers have continued the older practice of using metallic tungsten.

Ingotism

Occasionally small sections but more frequently large ones exhibit a dull, fibrous or woody fracture, both in the annealed and hardened state (Figs. 1 and 2), instead of the characteristic fine, porcelanic fracture of normal high-speed steel shown in Fig. 3.

Microscopic examination of sections showing this fibrous condition indicates that it is caused by a eutecti-



FIGS. 1 TO 3—FRACTURES OF HIGH-SPEED STEEL. ABOUT TWICE SIZE.

Fig. 1—Defective steel, hardened. Dull and fibrous fracture.
Fig. 2—Defective steel, annealed. Dull and fibrous fracture.
Fig. 3—Good steel, annealed. Fine, porcelanic fracture.

form segregation of carbides, which forms during the solidification of the molten steel. For convenience this structure will be referred to as "ingotism," from its nature and origin.

When "ingotism" is noted to a very marked degree in high-speed steel it causes the steel to be difficult to anneal, to possess hard and soft spots after annealing, to possess a coarse fibrous fracture in the annealed and hardened condition, to tear and show bright streaks upon machining, to be somewhat "brittle" or short, even in the annealed condition, to develop cracks in hardening which tend to follow the segregated carbides, to lower cutting efficiency, and to interfere slightly with secondary hardening, that characteristic increase in hardness on drawing hardened tools to about 1,000 to 1,100 deg. F.

In the ingot condition segregated carbides assume a "pine" or "fern-leaf" formation, which can often be noted in large-size commercial bars and frequently traced in smaller sizes, depending upon the amount of work that the steel received. Mechanical work and heat break up the segregations, as is shown in the series of microphotographs,[1] Figs. 4 to 7 inclusive. A 15-in. octagon billet was forged (at a temperature of 1,900 to 2,000 deg. F.) into billet, bar and rod, microscopic studies being made at intervals. Fracture of a piece with structure like Fig. 4 was coarse and fibrous. Fig. 7 shows the retention of only a "ghost" of the original ingotism, and in the annealed a hardened condition should show a fine porcelanic fracture.

[1]All sections were etched with 10 per cent HNO_3 in alcohol.

In large ingots, where the segregation is more marked on account of its slower rate of cooling, it requires a reduction of about 90 per cent in section area to break up this structure. Furthermore it was frequently noted in bars made from large ingots (10, 12 or 15 in. octagon) that the outside of such bars are almost completely refined, due to that portion having received a comparatively large amount of hot work, whereas the centers, which received less work, show less refinement.

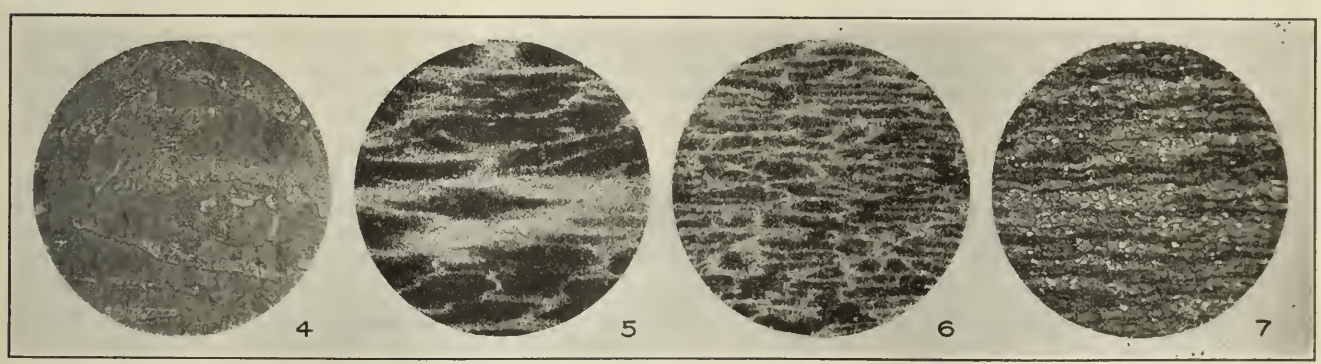
When starting with smaller size ingots, such as 4-in. octagon, the fern-leaf segregation is not as marked, due to more rapid cooling, and is therefore more easily broken up by forging and may be entirely eliminated upon reducing the section to 65 to 75 per cent. Sometimes it may be done with a very small amount of work, depending, however, on whether segregation was suppressed by the casting conditions; high casting temperature and slow cooling favoring "ingotism."

Mechanism of Solidification

As noted by the writer, the origin of these segregations of carbides in high-speed steel with very few exceptions can be traced to eutectiform masses and their position and formation attributed to "ingotism." It is difficult if not commercially impossible to prevent entirely the phenomenon in large ingots used to make the larger sizes of high-speed steel bars, and for this reason large bars do not show as refined a fracture nor as good as a microstructure as smaller sizes of the same chemical composition and heat-treatment.

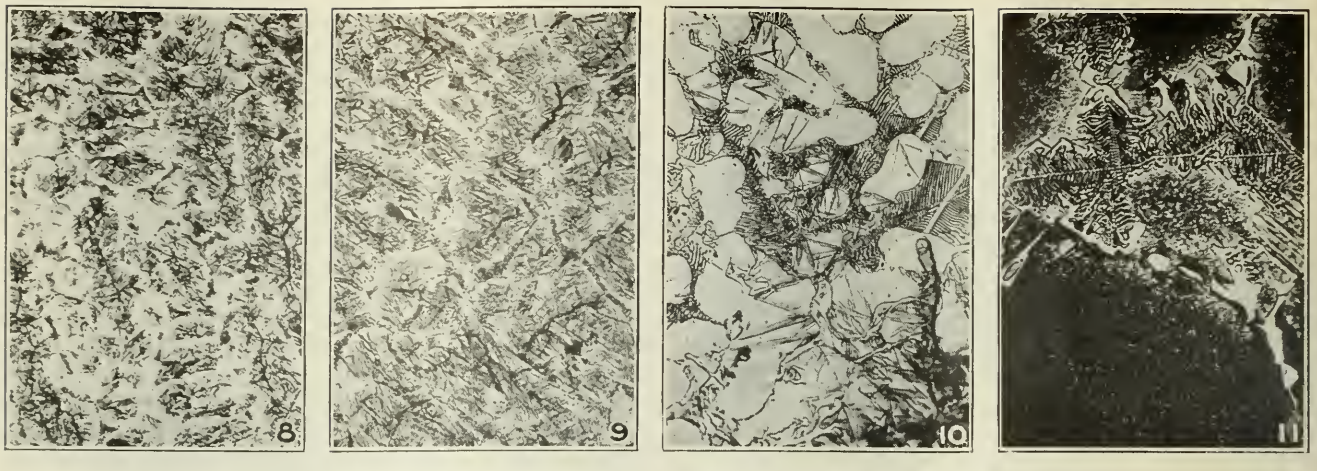
Heating to about 2,200 deg. F. and holding a sufficient length of time to permit an absorption, solution or combination of these carbides, followed by an annealing, reduces the segregation somewhat, bringing about a more uniform condition, although it cannot be entirely eliminated by this method alone, nor by hardening alone from high temperatures.

A study of the casting condition of high-speed steel in ingots of various sizes seems to indicate that this "ingotism" is favored by and is largely dependent upon the casting temperature and rate of cooling. In order to show the effect of various rates of cooling upon "ingotism" formation, a portion of a 100-lb. pot or crucible of molten high-speed steel was poured into cold water, thereby producing very rapid solidification; this will be referred to as condition No. 1. Another portion was teemed into a 4 x 4-in. warm mold, the rate of cooling being less rapid, and this condition will be referred to as No. 2. The crucible, with the remainder of the steel still in a molten condition, was put back into the furnace and the gas turned off, thereby permitting it to cool slowly with the furnace. After it reached a



FIGS. 4 TO 7—SCATTERING OF SEGREGATED CARBIDE BY FORGING. × 165

Fig. 4—Reduction 30 per cent. Fig. 5—Reduction 55 per cent. Fig. 6—Reduction 75 per cent. Fig. 7—Reduction 93 per cent.



FIGS. 8 TO 11—INFLUENCE OF COOLING RATE ON AMOUNT AND DEFINITION OF EUTECTIC. × 275

Fig. 8—Poured into water. Fig. 9—Poured into warm mold. Fig. 10—Quenched from pasty state. Fig. 11—Furnace cooled.

pasty condition (which required about 1 hour) some of the steel was removed and quenched in water; this will be referred to as condition No. 3. The remaining portion was permitted to solidify in the crucible, condition No. 4. It remained in a spongy or mushy state for about 1½ hours.[2]

In the condition of sample No. 1, which was quenched in water from the molten state, one will note in Fig. 8 the comparatively small size of the eutectic as compared with the primary austenitic islands. The writer believes that these islands formed first and were enlarged by the effect of undercooling. This will also be noted in Fig. 9, representing the condition of sample No. 2, but here the effect of undercooling was not as marked, therefore the eutectic is more pronounced. Such "ingotism" as exhibited in these samples is readily broken up by the forging operations.

Fig. 10, which represents the condition after permitting the steel to cool slowly to a pasty state (condition No. 3), shows the characteristic island formation of the primary austenite and the prominence of the eutectic, normally noted in the slow solidification of alloys of this nature. One will note the increase in size of the areas occupied by the eutectic and the decrease of the primary austenite as the steel passes through the rates of cooling represented by conditions 1, 2 and 3. In the latter the eutectic has more freedom to grow its characteristic star- or leaf-like structure.

Fig. 11 represents condition No. 4, when the steel was allowed to solidify in the crucible, it being in a spongy state for about 1½ hours. No undercooling is in evidence, and the relative proportions of eutectic to primary austenite can probably be considered as normal for very slow solidification.[3]

The above experimental tests agree with the numerous commercial tests on ingots of various size and indicate that the rate of solidification plays an important part as to the prominence of "ingotism." In fact, it seems to play the largest part in crucible practice, although the initial casting temperature has a small influence for the following reasons: In order to cast the average high-speed steel successfully, the temperature should not be lower than about 2,800 deg. F., in fact, good steel is seldom poured cooler than 2,850 and various heats will average about 2,900 deg. F. The maximum temperature of large crucible furnaces is approximately 3,100 deg. F., but normally not over 3,000. Therefore the range for commercial casting does not extend much beyond 100 deg. F. and hence the initial casting temperature appears to play only a small part in the formation of "ingotism" in crucible steels. However, in the electric furnace, where higher temperatures are readily obtainable, the initial casting temperatures would have greater influence.

In order to show the effect of heat alone in breaking up this segregated condition, a sample of steel in condition No. 2 (cast in warm mold) and another in condition No. 4 (furnace cooled), as cast, was heated to 2,200 deg. F. and held at that temperature for 24 hours. Before heating, their carbides were in a condition as noted in Fig. 9 and Fig. 11, respectively. Fig. 12 shows the effect of this heating upon the condition represented by sample No. 2, and it will be noted that the eutectiform masses are entirely broken up. Such a degree of "ingotism" would have broken up more readily were this heating accomplished by mechanical work, but this experiment shows the ease of breaking up "ingotism" in the average small ingot. It will also be noted from Fig. 12 that the carbides tend to assume marked crystalline forms, especially those not lying along the border of a grain, but apparently thrown out of solution from the primary austenite. That the eutectiform carbides have great freedom when heated to a temperature such as 2,200 deg. F. can be noted by comparing the change in form from that of the ingot condition shown in Fig. 11 to what may be termed an equilibrium state as shown to the right end of Fig. 13. This figure rep-

FIG. 12—SAMPLE SHOWN IN FIG. 9 AFTER HEATING AT 2,200 DEG. F. FOR 24 HOURS. × 200

[2]In order to appreciate fully the process of solidification of high-speed steel and the formation of these carbide segregations, as well as the causes of these characteristic eutectiform masses, the reader should refer to Dr. Henry M. Howe's work on the "Metallography of Steel and Cast Iron," 1916, pages beginning 135, which describe the solidification of pure and eutectiferous alloys, and page 210 for the effect of "undercooling."

[3]The samples represented by Fig. 11 were etched in 10 per cent nitric acid rather heavily in order to show a marked contrast between the eutectic and primary austenite. It was noted during etching that the primary austenite was readily attacked by this method, and it was used as will be referred to later, in an endeavor to separate the eutectic as a "sponge" from the matrix or austenite.

resents the course which these eutectiform carbides follow upon being broken up by heat alone.

Since the photomicrographs showing these stages were all taken from one sample and assembled into a composite view, it may be noted that heating to a high temperature breaks up these eutectiform carbide masses in several stages.

Some films and masses break up sooner than others, probably depending upon the carbide saturation of the surrounding matrix. The writer believes that the first change from the ingot condition is the formation of a eutectiform mass with thin sheets of carbide and austenite alternating, shown on the left end of Fig. 13. The sheets, or arms or ribs whatever they may be called, next dissociate to form spheroidal masses, as shown near the center of the illustration. These then agglomerate to form carbide masses or islands, shown to the right of Fig. 13. It may furthermore be remarked that higher magnifications reveal small isolated crystallites occurring within the original austenitic crystals, exhibiting plane boundaries and angular edges, similar to those noted above and shown in Fig. 12.

Effect of Overheating

That the eutectiform masses, which are broken up during the combination of heat and mechanical work in commercial manufacture, are of low melting point and are the structures to which the carbides, found in normal high-speed steel, revert upon heating a bar to the point of fusion can be noted from Fig. 14. If a bar of normal high-speed steel, exhibiting the structure shown in Fig. 7, be heated to a temperature just under the fusion point and quenched in oil, the structure at 600 diameters shows fairly large austenitic grains, and in the interstices sizable masses of well-developed and clearly laminated eutectic. The "fern-leaf" carbide formations develop in steps similar to those noted in the breaking up of "ingotism" by heat alone, but vice versa. The carbide masses first appear to form spheroids, which in turn form arms of a eutectiform mass. However, the spheroidal carbides noted in Fig. 14 may have been the arms of a eutectiform mass that broke up during the subsequent slow cooling of the highly heated bar. Fig. 13 and Fig. 14 show striking similarity.

It was mentioned above that if the polished samples

FIG. 14—NORMAL HIGH-SPEED STEEL HEATED TO JUST UNDER FUSION, HELD AT THAT TEMPERATURE FOR SEVERAL HOURS AND COOLED SLOWLY. × 400

of high-speed steel which were permitted to cool slowly with the furnace from the molten state (condition No. 4), the primary austenitic islands or masses were attacked readily during etching in 10 per cent nitric acid, whereas the network of eutectiform carbides were not affected. By the use of this method the following attempt was made to determine the chemical composition of the eutectiform carbides.

Chemical Analysis of Carbides

Small pieces about $\frac{1}{2}$ in. square were ground and polished on one side, similar to preparing a sample for microscopic examination. This polished side was cut off the piece by means of a thin-friction carborundum wheel, giving a disk about $\frac{1}{16}$ in. thick. This disk was placed in a clamp with the polished side facing in. The opposite side was then ground and polished, reducing the thickness to about $\frac{1}{32}$ in. The disk was then weighed

FIG. 13—COMPOSITE VIEW OF SAMPLE SHOWN IN FIG. 11 AFTER HEATING AT 2,200 DEG. F. FOR 24 HOURS. × 350

and suspended by means of a platinum wire in a beaker containing 10 per cent nitric acid. After a period of about 240 hours all reaction appeared to end; it was dried, weighed and placed in fresh acid until no further reaction was noted and no loss of weight detected, after which it was analyzed. Results are shown in Table I.

The chemical composition of the original steel is as follows: C 1.34 per cent, Mn 0.34, P 0.020, Si 0.59, Cr 3.14, W 15.88, V 0.83.

It will be noted that the carbon content, 1.34 per cent, is much higher than is usually found in commercial high-speed steel. This was not made intentionally, but was due to the absorbtion of additional carbon from the crucible during the soaking and slow cooling.[4] Therefore the chemical composition obtained by the separation of the eutectiform carbides by the above-mentioned

TABLE I—INSOLUBLE CARBIDES FROM HIGH-SPEED STEEL

Sample No	Wt. Disk, G.	Loss Wt., G.	Wt. Carbide Residue	Per Cent Loss Wt.	Per Cent C in Residue	Per Cent W in Residue	Per Cent V in Residue	Per Cent Cr in Residue
1	3.3778	2.5818	0.7960	76.4	3.49	52.9	....	....
2	1.7895	1.3987	0.3908	78.2	3.15	60.0	....	....
3	Destroyed							
4	0.7965	0.6169	0.1796	77.4	3.07	57.9	....	....
5	0.6961	0.5386	0.1575	77.4	3.18	58.9	....	....
6	Destroyed							
7	0.6544	0.5092	0.1452	77.8	3.79	58.5	....	....
8	1.7563	1.3535	0.4028	77.1	2.95	57.4	....	....
9	3.2844	2.5474	0.7370	77.4	....	....	1.52	3.31

method may not be of exactly the same composition as those usually found in high-speed steel containing about 0.50 to 0.70 per cent carbon. However, the analyses may give some idea of the aproximate composition of these carbides and probably their real composition, if the elements tungsten and chromium form definite combination with carbon.

It will be noted that, although the weights of the polished disks show quite a wide variation, nevertheless the percentage of loss in weights is nearly constant, indicating that the extraction of the matrix from the sponge of carbides was practically uniform.

Table II shows the calculated composition (using the values given in Table I) of the primary austenite, or

TABLE II—SOLUBLE METAL FROM HIGH-SPEED STEEL

	Calculated composition of primary austenite or the areas that went into solution				Chemical analysis of solutions after removing carbides		
Sample No.	C	W	Cr	V	W	Cr	V
1	0.68	4.46	....	....	4.15	....	....
2	0.83	3.54	....	....	3.29	....	....
4	0.83	3.67	....	....	....	....	....
5	0.80	3.36	....	....	....	....	....
7	0.64	3.73	....	....	....	....	....
8	0.87	3.52	....	....	3.42	....	....
9	....	....	3.10	0.63	....	3.03	0.74
Av.	0.775	3.71	....	....	Av. 3.62	....	....

the masses that went into solution, together with results of chemical determinations of the tungsten, chromium and vanadium contents of the solutions. A comparatively close agreement exists between the calculated values and the results of actual determination.

Only one residue or separated eutectiform mass was used for chromium and vanadium determinations. However, by using the data on hand and obtaining the iron content by difference, the approximate chemical formula of these eutectiform carbides is: $VCr_2W_{10}Fe_{22}C_9$, which figures C 3.10 per cent, W 55.90, Cr 3.31, V 1.52, Fe 36.17.

[4] That such absorption took place is evident from the fact that samples 1 and 2, that were quenched in water and teemed into a mold, respectively, show only 0.87 per cent carbon, which, too, is slightly high.

Summary

1. The composition of the eutectiform carbides examined may be represented by the formula $VCr_2W_{10}Fe_{22}C_9$ and has the following chemical composition: Carbon 3.10 per cent, tungsten 55.90, chromium 3.31, vanadium 1.52, iron 36.17, and excepting for the chromium and vanadium content is the approximate composition of ferrotungsten. The composition of the primary austenite of the specimens examined appears to be: Carbon 0.77, chromium 3.10, vanadium 0.63, tungsten 3.71.

2. These eutectiform carbides are essential factors in imparting high-speed properties.

3. When present in eutectiform mass, these eutectiform carbides produce in high-speed steel a coarse, fibrous, woody fracture in the annealed, natural or hardened states.

4. The condition mentioned in item 3 causes the steel to be difficult to anneal, to possess hard and soft spots after annealing, to tear and show bright streaks on machining, to be brittle or short even in the annealed condition, to develop cracks in hardening and to lower the cutting efficiency.

5. The condition mentioned in item 3 is favored by high casting temperature and slow cooling, hence the advisability of using ferrotungsten with its lower melting point and easy solution in the melting mass of the charge, which form of tungsten favors lower temperatures, more rapid melting and quicker cooling.

6. The condition mentioned in item 3 can be broken up best by the combination of heat and sufficient mechanical work. It cannot be entirely removed by heat alone, nor eliminated by hardening and annealing.

Pittsburgh, Pa.

Scotch Producers Combine to Push Esparto Paper

An important combine recently organized in the Scottish paper-making industry is reported in the March 6 issue of *Commerce Reports*. The new organization is to be made up of the esparto paper mills of Scotland, including eight or ten mills. There is no intention to disturb the existing organizations, the mills to continue their own individuality and their own directing board. The propaganda and the advancing of the business throughout the world generally will be handled by the board, with the assistance of the present distributing houses, which are for the most part favorably disposed. It is hoped to develop a very big business in America.

The sole idea underlying the action of the promoters of the new combine is to extend the demand for the use of esparto paper so as to enable it to be more cheaply produced. Esparto grass, which is gathered in large quantities in Africa and to a smaller extent in Spain, is said to constitute one of the best of paper-making materials, especially for those qualities of paper used in printing papers, books and magazines, as well as the qualities used in lithographic printing and art work. It is claimed that its great peculiarity is that it will not stretch, is opaque, and light in weight. It is also stated that the only place in the world where this class of paper is made is in the British Isles, chiefly in Scotland.

Shaloilogy and Oil-Shale Nomenclature

A Consideration of Some of the Inconsistencies in Present Oil-Shale Terminology—As an Aid to the Definite Expression of Ideas in This Industry the Following Are Suggested: Petrologen; Petrolo-Shales; Oil-Shale; Petroil; Shalene; Shaloilogy

By J. B. JENSON

OUR American shales and the production of oil therefrom is at present being discussed in written articles by many writers of varying experience and capacity. Some of these are recording more or less valuable results of experimental and research work, some of which is new and some already well-known facts; others are merely rehashing old and well-worn data gleaned from the records of Scotch operations and U. S. Geological Survey Bulletins.

Those of the former class are endeavoring in an honest way to contribute their quota toward the pioneering of the coming shale-oil industry, an industry which cannot help but become sooner or later one of the largest and most important within the boundary of the United States. Owing to the fact that it is in its infancy in this country and its literature somewhat limited, and owing to the further fact that it has developed without elaboration from a sort of cut-and-try method to its highest scientific development in Scotland, the nomenclature of the industry is small and some of the terms adopted are not only unscientific, but are either meaningless or convey a meaning not intended. As the industry develops, new terms will of course eventually find their way into our shale-oil lexicon, but inasmuch as important data are already being recorded and will continue to be recorded as the scientific development of the industry progresses, it is important that meaningless terms be either eliminated or substituted as early as possible by scientific terms of correct meaning, in order that the nomenclature and development of the industry may be proportionately advanced and also that present-day articles of importance may contain terms which shall not soon become obsolete to the detriment of such articles.

Bituminous Shale, Pyrobitumen and Kerogen

The term "bituminous shales" is one in common usage and quite correctly so, although the oil-making material in the shale cannot properly be termed "bitumen." [1]

The term "pyrobitumen" has been applied to that substance in oil-yielding shales which is not soluble in carbon bisulphide but which when subjected to heat will become transformed into oil.

A somewhat more popular term, "kerogen," was very properly suggested by Prof. Crumb Brown many years ago and has been used in Europe quite universally ever since, to denote "the carbonaceous matter" in Scotland's shales that gives rise to crude oil in distillation.[2]

At the time of its adoption the principal important product from Scotch shales was kerosene, and it is only natural that the term "kerogen," or "source of kerosene," should suggest itself to Prof. Brown. At the present stage of the world's development, however, kerosene as an oil product becomes of only minor importance and its source of little interest to us, while the matter to which the term is applied is of great interest and is very much more than the source of kerosene. It is the source of petroleum, the mother of kerosene and all the varied petroleum products and byproducts. If Prof. Brown had in mind to base the term on "kero" as wax, intending it to express "the source of wax or paraffine," it becomes perhaps even less appropriate. The term does not fully suggest to the mind or cover the matter referred to; it is not broad enough or deep enough and can scarcely be considered to be a satisfactory scientific and definite term, particularly when applied to our American shales, wherein the source of petroleum in its embryo condition and broadest sense is referred to.

Furthermore, our Eastern and our Western American shales, but not our Central Devonian shales, are geologically younger than the Scotch shales and their oil-making material has not reached that degree of decomposition that has been reached in the Scotch shales, giving us therefore in these not only a much different product but one compelling us also to do, in our retorts for these shales, what nature has partly done for the Scotch shales *in situ*. This to a certain extent accounts for "fluxing" and other troubles in the retorting of some of our high-grade massive shales of Utah and Colorado, and even though the term were applicable to Scotch shales, it does not follow that it is applicable to American shales.

"Oil-Shale" a Misnomer

The term "oil-shale," which suggests to the mind a shale containing oil, much as saturated sands do, is freely used not only to designate shales which do not contain oil except in mere traces but which do contain the carbonaceous material capable of producing oil, but also to designate such shales as do contain oil and from which it may be extracted, but which do not contain the material from which oil may be produced or manufactured.

We are rapidly approaching the stage of development wherein it becomes necessary to designate which class of shale is being referred to—the oil-producing shale,

[1] Bitumen. "The substances which furnish oil or tar when subjected to dry distillation." ("Shale Oils and Tars," Scheithauer, p. 19.)

"A generic term applied to native substances of variable colors, hardness and volatility, composed of hydrocarbon substances free from oxygenated bodies; sometimes associated with mineral matter, the non-mineral constituents being fusible and largely soluble in carbon disulphide. Examples: petroleum, native asphalts, native mineral waxes and asphaltites." ("Asphalts and Allied Substances," Abraham, p. 21.)

"A naturally occurring hydrocarbon complex, often associated with a mineral matrix, insoluble in water, but largely soluble in carbon disulphide, benzol, etc. Its color and hardness are variable." ("American Petroleum Industry," vol. 2, p. 853).

[2] "Shales of the Lothians," p. 143.

the oil-containing shale, or some of the intermediary shales between these.

By way of illustration: The black "warty" shale of the upper horizon in the Utah, Wyoming and Colorado fields yields only a trace of oil through solvents, but is capable of producing more than 70 gal. per ton by destructive distillation. There is no evidence of oil to the touch and none of the true petroleum odor, but on freshly breaking, the shale gives an odor peculiar to certain hydrocarbons. It contains virtually no oil, but is rich in oil-making materials.

The diatomaceous and other shales of California and similar fields contain a high percentage of oil but little or none of the oil-making material. They are oily to the touch and give forth a strong petroleum odor. Practically all of the oil in them may be extracted by solvents.

We have in the Uinta Basin an almost white or cream-colored shale which produces, through the agency of solvents, 7½ gal. of fine-grade paraffine oil; by destructive distillation 21½ gal. It therefore contains both oil-making material and free oil or possibly bitumen and in the proportion of about two to one. It is a hard, compact, dry, fine-grained shale having somewhat the appearance of a white limestone, will not soil the whitest silk handkerchief and gives absolutely no suggestion of oil, yet when ignited it burns freely and forms a ring of oil on the shale surrounding the flame, something which is not usual in other shales.

As the industry develops and the shale products come into competition with underground petroleum products, it will become necessary to designate which particular product is wanted—for instance, whether "shale gasoline" or "petroleum gasoline," if motor fuel is wanted. Terms designating this may also be used to very good advantage at this time in our research work.

Retorting vs. Carbonization of Shales

Occasionally someone speaks of the distillation of oil from shale as the "carbonizing of shale." Is it truly carbonizing shale?—i.e., "converting animal and vegetable matter into a residue of carbon by action of fire or corrosive agents."[3]

Or is it "converting to carbon by the action of fire or an acid or by any other means,"[4] such as we do in carbonizing or converting coal to coke and in connection with which industry the term seems to have originated? We are not interested in converting the oil-making material of shale to carbon or coke, but into crude oil, capable of being successfully and commercially refined into marketable products. That is done by proper distillation in a suitable retort, "a vessel in which substances are subjected to distillation or decomposition by heat,"[5] either intermittently or continuously.

Shale differs from coal in having a larger proportion of hydrogen in its composition and in not leaving coke on distillation. When heated in an air-tight retort, the hydrogen unites with the carbon so as to carry it away as gas and the residue left is not coke or carbon but ash, with a very small portion of carbon—in fact, is simply a spent shale.[6]

It would seem then that the appropriate term for this operation is not "carbonizing," but either retorting, "the act of distilling or decomposing the oil-making materials," or eduction, "the act of drawing out" the oil-making material as gases, from either oil-producing or oil-bearing shales.

Pyrolysis vs. Destructive Distillation

Another term which is not only cumbersome and unwieldy but in general quite distasteful is that of destructive distillation, a term which creates with the layman an undesirable impression, as was shown by a rural, bewhiskered "old timer" who, after listening to a paper read at one of our shale conventions, arose and said, "If you chemists and engineers would quit your 'destructive' distillation and do a little 'constructive' distillation, we would soon begin to get somewhere." Dr. W. A. Hamor, of the Mellon Institute, however, has very splendidly substituted "pyrolysis" for this term, and the new word is rapidly being adopted and already becoming quite extensively used by our chemists and engineers.

New Terms Suggested

To overcome some of the objections referred to and to express myself more definitely I adopted, 3 or 4 years ago, some terms of my own which I have used continuously ever since, particularly in my geological reports. They have been serving their purpose well and I thought little of them until recently I was favored by a visit from one of our active petroleum geologists who had observed these terms and who expressed himself as highly impressed with their importance. To quote his own words: "They are expressive and impressive. They are terms which grow on one, and continue to revolve through the mind for days after hearing them. Give them to the public and let geologists and chemists also have their use. We are just entering a nationally important industry and much is being done and much written on the subject. We need these and need them now."

From the thoughts developed by this conversation and with a desire to see not only the supremacy of American engineering and American chemistry maintained, but also, with the development of the industry, the simultaneous development of a concise, accurate and scientific American shale nomenclature, I have been prompted to present and discuss these matters. Therefore I submit, for the consideration and discussion of our American petroleum geologists and chemists, the terms which I am using and which apparently not only overcome the objections mentioned but also convey to the recipient a correct idea of what is intended.

In considering the adaptability of these terms, the first question which naturally arises is: Is the crude oil, produced by distillation of shale, a petroleum or sufficiently near such that it may come into the petroleum class? It is true that as at present produced it contains, on the average, a higher percentage of unsaturates than does most underground petroleum, but the unsaturates of petroleum from different fields also vary as widely as do some of the shale petroleums when compared with some underground petroleums.

We find also that the unsaturates of a single shale vary as widely when retorted by different methods as do those of some underground petroleum and some shale petroleum. Is it not likely, therefore, that as we shall more nearly approach the method of nature in the production of oil in our retorts, we shall more nearly

[3] "Webster's Unabridged Dictionary."
[4] "Winston's Simplified Dictionary."
[5] "Webster's Unabridged Dictionary."
[6] "Shales of the Lothians," p. 160.

approach also and eventually perhaps duplicate the oil-well products?

Notwithstanding the existence of several theories as to the origin of petroleum, I believe it is quite generally conceded by our best petroleum geologists that the major portion of our underground petroleum is the result of underground distillation of oil-making materials similar to those of our exposed shales, if indeed they be not lower lying petroliferous shales of a similar nature. Even though we might accept the inorganic theory as the source of underground petroleum, might it not also apply to the source of the oil-making material in our shales? On fractionation and subsequent treatment, we find the shale oil yields practically the same products as the underground petroleum, the slight variation probably being due in part to the short time used by us in their production from the shale as compared with that employed by nature. It would seem therefore, in the adoption of our first term—the term indicating the oil-making material—that we are fully warranted in selecting one which carries with it a suggestion of petroleum.

Petrologen

From the fact that the hydrogen and carbon, or oil-making material as contained in the shales, is the source of petroleum, I have taken from the word petroleum the first syllables "petrol" and have added the suffix "ogen," or source, to form the word "petrologen," indicating the source of petroleum, or that material which, through pyrolysis or destructive distillation, produces crude petroleum.

There are, as we know, a number of theories as to the origin of petrologen. The most important of these are the organic and sedimentary[7] and the inorganic[8] theories. Although it has not been positively established, it is reasonably certain that petrologen consists of plants, vegetable fiber, spores, algæ, etc., with smaller portions of animal matter, which were deposited at the bottom of lagoons and quiescent inland lakes, together with clays and ooze and which have been subjected under pressure, in the absence of atmospheric agents, to maceration and microbic action and have finally become a minutely disseminated but integral part of the shale strata, and which were apparently laid down during periods in Devonian, Carboniferous and early Tertiary times. The main constituents of our petrolo-shales are petrologen, iron pyrites and clay.

Petrolo-Shales

To those shales which are still in their primary, unaltered condition containing petrologen but not petroleum, and therefore are yet only a source of petroleum, I apply the term "petrolo-shales." This applies in general to the shales of Colorado, Utah, Wyoming, New Brunswick, the Devonian shales of Kentucky, etc.

Oil-Shales

To those which were originally petrolo-shales, but which, through later earth heat, have given up their petrologen and then through absorption have taken up the resultant petroleum and are now saturated or true oil-shales and to those shales which were originally not petrolo-shales, but which through capillary attraction or otherwise have taken up migratory oils and therefore also contain oil, I retain the term "oil-shales."

Petroil

Inasmuch as shale oil and underground petroleum resemble each other closely in source and characteristics and will shortly be converted into competitive products, it is desirable and highly important that we have for shale oil a term which not only suggests similarity and relationship to underground petroleum but which also maintains a marked distinction between the two products.

I have endeavored to accomplish this by the adoption of the Latin "petro" (rock) as in petroleum, and the substitution of our own word "oil" for the Latin term "oleum," obtaining thereby the very simple term "petroil," which has both the distinguishing feature and the correct meaning, "rock-oil." I am aware that this word is somewhat similar to the European term "petrol" but with the accent in one case on the first syllable and in the other on the last syllable, together with the very wide distinction between the application of the two words, this, it seems, should not be an important objection and the similarity is no greater than is the case in many other instances.

Shalene

To distinguish the product from "petroil" which corresponds to the gasoline fraction from petroleum, I add to the word "shale" the letters "ne" to form the word "shalene."

Shaloilogy

To indicate the science relating to the oil-making materials, oil-bearing and oil-producing shales, rocks, etc., as well as the products derived therefrom, their extraction or production, I combine the word shale, after having dropped the final "e," with the letters "oi" from oil and add the combining term "logy" to form the word "shaloilogy."

Summary

The concise terms thus developed may be summarized and defined as follows:

Petro'ogen.—A bituminous substance contained in petrolo-shales, coal, peat and other materials, which when subjected to pyrolysis in the absence of air produces a crude form of petroleum termed petroil; a sedimentary yellowish gray or brownish substance, being the remains of innumerable minute accretions and accumulations of vegetable fiber, algæ, spores, etc., frequently with small proportions of marine animal remains, originally deposited under water on the bottom of lakes and lagoons in Devonian, Carboniferous and Tertiary times and subjected to pressure, maceration and microbic action free from atmospheric conditions and being preserved, compressed into and becoming an integral part of the clay strata forming our present-day petrolo-shales.

Petrolo-Shales.—When pure, a fine-grained, gritless, argillaceous, sedimentary, underwater deposit, ranging in thickness from a fraction of an inch to many feet, containing petrologen and disseminated iron pyrites usually of microscopical fineness; that class of bituminous shale which is still in its primary unaltered, unretorted, unmetamorphosed condition and therefore contains petrologen but not petroleum or petroil, but

[7] "The New Oil-Shales Industry of the Western Slope," by the author, p. 2.
[8] "Kerosene Oil-Shales," by Karne, p. 64.

which when subjected to pyrolysis in a closed retort or otherwise in the absence of air is capable of yielding petroil. Impurities are lime and quartz, with petrologen decreasing proportionately as these impurities increase.

Oil-Shale.—An argillaceous or diatomaceous, porous, laminated or massive sedimentary or other mineral accumulation containing, through absorption or capillary attraction, petroleum, bitumen or other residual petroleum, resulting either from formerly contained petrologen or migratory petroleum and from which petroil may be extracted through the agency of solvents or by simple distillation but not requiring pyrolysis.

Petroil.—A term used in contradistinction to the term "petroleum" as applied to free-flowing underground petroleum obtained naturally from oil wells, and designating a crude petroleum obtained through the pyrolysis of petrologen, pyrobitumen or oil-making matter contained in petrolo-shales, peat, coal, etc., and capable of being fractionated and refined into products quite similar to those of petroleum. The product obtained through digestion by solvents, distillation or pyrolysis of the oil, bitumen or other oil-yielding materials in such substances as oil-shales, oil-sands, etc.

Shalene.—That fraction distilled from petroil which corresponds to the "gasoline" or "motor spirit" fraction distilled from underground petroleum.

Shaloilogy.—The science which treats of the nature and formation of the crude materials found in nature, such as petrolo-shales, oil-shales, oil-sands, peat and other bituminous matter or materials, from which petroil may be either extracted or produced through the agency of solvents, distillation or pyrolysis. The science which treats of the digestion treatment by solvents, distilling or retorting of bituminous or petroliferous materials in the production of petroil and all its varied products and byproducts.

Salt Lake City, Utah.

The Oil Industry in Russia Under Bolshevik Régime

All available data indicate that the exploitation of the Baku region as a whole has not nearly reached its full scope of development, according to an article appearing in *Commerce Reports* of Jan. 9, 1922. Only the upper horizons have thus far been worked, while the richer deposits contained in the lower strata are yet to be tapped.

The production of oil in Russia is distributed very unevenly among the principal regions of Baku and Grozny in the Caucasus and the secondary areas in the Emba region of the Urals—Turkestan, Maikop, Vosnesenk and Tsheleken. The four principal fields of the Baku region—Balakhna, Sabunchi, Romany and B. B. Eybat—cover an area of 2,978 acres. The newer fields of Surahany, Benagady, Atashka, Holy Island, etc., cover a far more extensive area, not so far fully delimited by geological surveys.

The total production of the Baku region in the last pre-war year (1913) amounted to 7,532,000 tons, or an average of about 628,000 tons per month. Its productivity for the three pre-Bolshevik years were: 1914, 6,840,300 tons; 1915, 7,267,700 tons; 1916, 7,691,900 tons.

For the period March to July, 1918—i.e., for the period of the first Bolshevik occupancy of the region—the production averaged 279,000 tons, as against the monthly average of 440,000 tons for the first 2 months of the same year.

During August and the first half of September the Baku region was controlled by a new government—namely, the "Dictatorship of the Central Committee of the Caspian Naval Fleet." Under the "dictatorship" the output was, in August, 181,000 tons, and from Sept. 1 to 15, 92,000 tons. After Sept. 15 production stopped completely and the properties were ransacked and burned, a large number of the workmen being killed. On Oct. 10 the oil industry was denationalized by the Azerbajan Government, which occupied the Baku region with the aid of the Turks, and the properties were restored to their former owners. The owners proceeded with the task of rehabilitating the industry. They managed to get up a production of 150,000 to 160,000 tons per month for October, November and December, 1918, and an average of 300,000 tons per month for the year 1919. This average was maintained up to April 27, 1920, when Baku was occupied, for the second time, by Bolshevik forces, and on May 28 the oil industry was again nationalized. At that time the oil industry of Baku had about recuperated, after 20 months of continuous private exploitation, from the violent perturbations of 1917-18. From that point (May 28, 1920), however, production declined steadily, the average monthly production for the first 10 months of 1921 being 205,200 tons.

There are 7,000 men employed in the fields, and for the first half of 1921 this force was augmented by 4,000 Red Army laborers. In 1916 the monthly productivity per employee, exclusive of distilleries, averaged 234 tons, which compares with 80 tons at the present time. The drilling average in 1916 was about 105 ft. per month per employee, as against 28 ft. at present. The same ratio obtains in the case of the distilleries and refineries.

The grand totals of the output of oil for the first 6 months of 1921 covering all the oil fields of European Russia, as compared with the figures for 1915 and 1920, are shown in the following table:

Month	1915 Tons	1920 Tons	1921 Tons
January	797,000	340,000	277,000
February	716,000	306,000	289,000
March	797,000	347,000	335,000
April	765,000	305,000	339,000
May	805,000	305,000	373,000
June	761,000	397,000	363,000

Cadmium Production for 1921

Figures obtained from producers by the United States Geological Survey show that the total production of metallic cadmium in 1921 was 65,101 lb., a decrease of 64,182 lb., or about 50 per cent, as compared with the production in 1920. On the other hand, the production of cadmium sulphide in 1921 amounted to 65,446 lb., an increase of 33,313 lb., or more than 100 per cent, over the production in 1920.

The value of the metallic cadmium produced was $63,799 and that of the cadmium sulphide was $71,336, making a total value of $135,135, as compared with $188,535 in 1920, a loss of 28 per cent. The average selling price of metallic cadmium in 1921 was .98c. a pound, as against $1.17 in 1920, and that of cadmium sulphide was $1.09 a pound, as against an average price of $1.16 in 1920.

A noteworthy development of the year was the extension of the use of cadmium electroplating for preventing rust.

A Neglected Electromagnetic Force

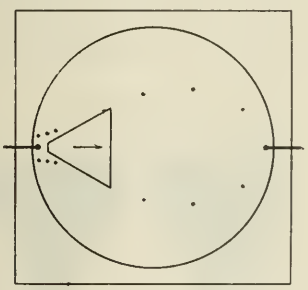
By Carl Hering

In your issue of January, 1913, p. 48, Dr. E. F. Northrup described a curious and interesting phenomenon: a kite-shaped piece of copper (well amalgamated) was floated on a trough of mercury so that its small end pointed toward one end of the trough, and its round or large end pointed toward the other end; it was found that when a very large direct current was passed through the mercury, the copper piece moved lengthwise to the trough, large end foremost; its direction of motion was independent of the direction of the current. The explanation offered by him was that the pinch effect (the radial contraction of the conductor) was greater at the smaller than at the larger end; copper having a very much better conductivity than mercury, the current was shunted largely through the copper.

In the opinion of the writer the true or primary cause of the motion is a different one, and as such new and peculiar forces may perhaps sometimes be made good use of in electric furnaces, a search for their origin and properties may be of interest, so that they may be correctly and intelligently applied.

Results of Experiments

Believing that this force was not primarily due to the pinch effect, whose force is perpendicular to the direction of the current and could therefore produce a longitudinal force only by hydraulic action, the writer floated a thick, kite-shaped piece of copper on a large circular bath of mercury about as shown in the adjoining diagram, the current being passed through the bath between the two terminals shown.



When a large direct current was used from storage batteries the copper piece made a decided but very short momentary movement toward the other pole the instant when the current was started, but the motion soon ceased; it was a mere "kick." The pinch effect was apparently very small, though if it had been the cause the motion should have continued and should not have been merely an impulse or kick.

The writer's proposed explanation is that because the magnetic flux encircling the main path of the current near the small end was more dense than that around the main path at the large end (as indicated very crudely by the dots which are supposed to represent the cross-sections of the center lines of unit lines of force) the well-known lateral repulsion of like lines of force (therefore longitudinal with the path of the current) was greater at the small end than at the large one; it is as though these lines of force acted like two compressed helical springs under unequal compression. The tendency of the mercury conductor to stretch or lengthen itself is therefore greater at one end than at the other, hence the short movement until a balance is reached.

If this is correct, an alternating current which would give a continuous rapid succession of such impulses should produce a continuous motion. When tried, it was found to do so, the piece moving very decidedly and with an apparently constant velocity across the bath to the other pole; reversing its position, it moved in the reverse direction. A counter e.m.f. must have been generated during this motion. The surface of the mercury did not show the agitation which a pinch effect would have caused, and the cross-section of the mercury was rather large for causing any marked pinch effect. The experiments were merely preliminary and somewhat crude, though apparently quite decisive. It is admitted that the pinch effect, if quite great and in a long narrow trough, would add to this force by a secondary hydraulic action, and that it would then produce continuous motion with direct current also; but the writer has shown in numerous other experiments that the same longitudinal force produced apparently by this repulsion of like lines of force acts also on solid conductors, in which of course hydraulic action cannot exist. A short piece of a well-amalgamated chain of copper links laid loosely on the mercury in a trough longer than the chain stretches itself straight when current was passed through the trough; if this motion had been due to the pinch effect at the two end links, it ought to have contracted the chain.

This Force Neglected by Physicists

This longitudinal electromagnetic force has been neglected by physicists, presumably because it happens to be zero in what appears to have been the fundamental case on which our present mathematical treatment of such forces was based, and it was thereby lost sight of.

There are two, and apparently there are only two, well-known magnetic forces which can properly be called the primary ones, at least until it can be shown that one is the resultant of the other; these are the contraction of a line of force and the mutual repulsion of like lines. A general mathematical formula should have contained both, as cases might arise like the above, and others which the writer could cite, in which these longitudinal forces do not add up to zero, or act if given the freedom to do so. Development in this field has, in the past, been checked by the fact that this longitudinal force had unfortunately been outlawed by physicists; we know that this force does exist, though in the more usual cases (but apparently not in all) it drops out because two equal and opposite forces balance each other, or because the necessary freedom of motion does not exist.

A really complete mathematical treatment ought to contain three fundamental or primary factors, instead of only one, as these forces act in space of three dimensions and the resultant in space is in the most general case dependent on all three; in most cases one or two drop out, but there seem to be some in which they do not. Referring to the flux encircling a conductor, these three directions of forces are: The usual one which is radial to the conductor, the longitudinal one (repulsion of like lines) and the tangential one (force on a unit pole).

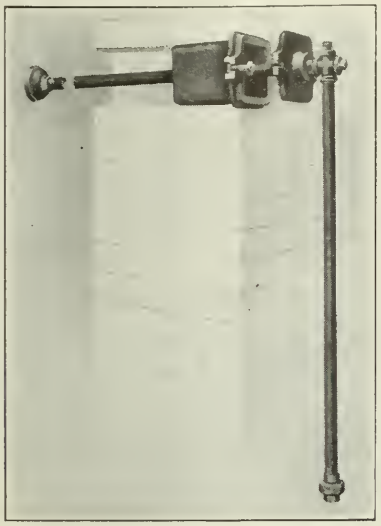
Such a complete treatment would then apply when *any* one or two are zero, for some of which cases the usual system fails.

The writer could cite experiments in which each one of these three forces is the only one, in the particular experiment, to produce the motion, the two others being inactive. There are indications that the ether acts something like a liquid with respect to these forces.

Flue Gas Filter for CO_2 Equipment

The main essential for the satisfactory operation of recording carbon dioxide equipment is cleanliness of the flue gas sample. In order to eliminate the deposition of soot in the sampling lines and the recording apparatus, the Uehling Instrument Co. has developed a filter which may be placed on the inlet end of the gas sampling line inserted in the flue or last pass of the boiler. The filter consists of a heavy but highly porous disk of refractory material which is held in a cup-shaped casting by means of a bolt.

Formerly the gas was withdrawn through an open-ended pipe and the filtering was accomplished with cot-



UEHLING FILTER FOR FLUE GASES

ton waste, this necessitating more or less frequent blowing out of the gas line and renewal of the filtering material. With the new arrangement, the soot builds up on the "Pyroporous" filter and does not appear to enter the pores to any extent—in fact some of these filters have been in service for months without having been blown out or replaced and without offering appreciably increased resistance to the gas flow.

It is not yet known what life may be expected of these filters, but present indications are that they will last for several years without attention. They are, however, inexpensive and are easily replaced. To facilitate inspection and replacement the manufacturer has also developed a frame to be inserted in the brickwork and a holder for the sampling pipe. In the illustration the holder is shown detached from the frame. It is quickly fastened in place by two bolts. By loosening the nuts on these bolts and by unscrewing the union shown at the bottom of the section of sampling line the filter may be withdrawn through the frame. The frame is the width of two bricks, hence it is a simple matter to insert it in the setting without cutting a large hole in the brickwork. When the sampling line is to be inserted through a metal casing, as with a horizontal tubular boiler, the frame is omitted and the holder is bolted directly to the metal casing of the boiler.

The filter may be used for any type of recording or testing instrument where clean gas is desired, and the frames and holders may be adapted for the installation of pyrometers, draft gages and for providing convenient openings in the furnace for test and observation purposes.

Synopsis of Recent Chemical & Metallurgical Literature

Properties of Single Crystals of Aluminum.—H. C. H. Carpenter and Miss C. F. Elam have described[1] experiments on "Crystal Growth and Recrystallization in Metals," where they demonstrated that crystals in a commercial aluminum sheet would not grow or be absorbed upon annealing if not previously overstrained. A certain amount of overstrain caused a few crystals to grow by boundary migration; a larger deformation caused recrystallization starting from a multitude of centers at former grain boundaries.

Working recently[2] with very pure cold-rolled aluminum sheet (Al 99.6 per cent, Si 0.19 per cent, Fe 0.14 per cent), test-pieces measuring 4 in. x 1 in. x $\frac{1}{8}$ in. were converted into a single crystal thus: Recrystallizing by annealing 6 hours at 550 deg. C.; stretching 1.6 per cent on 3 in. by loading at 2.4 tons per sq.in.; then heating in a furnace whose initial temperature was 450 deg. C., and raising it 20 deg. per day up to 550 deg. C., and subsequently heating 1 hour at 600 deg. C. to effect the absorption of persistent small surface crystals.

Prof. William Bragg examined some of those large crystals by his X-ray method, and confirmed not only Hull's conclusion that they are built up on a face-centered cubic lattice, but the metallographist's assumption that etching is a reliable method of distinguishing crystals in a metal. However, these crystals may be placed at any angle to the line of load, consequently the tensile properties will vary widely. Still each specimen exhibited the wedge-shaped fracture predicted by Jeffries and Archer.[3] The authors recognize five types of fractures, as shown in Table I.

A word descriptive of type 5 may be included. These produced twins in various numbers. Slip-bands change direction at these twin boundaries, and recrystallization commences here, but they are invisible in a repolished and

FIGS. 1 TO 4—TEST-BARS OF ONE CRYSTAL. FRACTURES OF VARIOUS TYPES

etched section except under oblique illumination. Some twins looked like large fibers (Fig. 4). Others showed merely a narrow straight dark line on the test-piece; they often occurred at the edges. Fig. 5 shows the plan and

[1] *J. Inst. Metals*, vol. 24, p. 83 (1920), No. 2. Summarized in CHEM. & MET. ENG., vol. 24, p. 224 (Feb. 2, 1921).

[2] *Proc. Roy. Soc.*, Series A, vol. 100, No. A701; p. 329 (Dec. 1, 1921.)

[3] CHEM. & MET. ENG., vol. 24, p. 1058 (June 13, 1921).

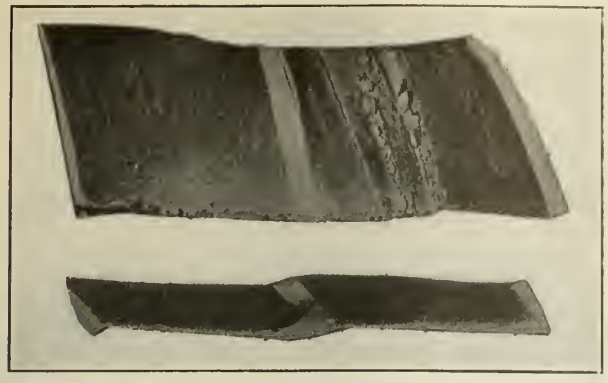


FIG. 5—SIDE VIEW AND CROSS-SECTION OF A TEST-BAR WHICH TWINNED LENGTHWISE

cross-section of one crystal which turned at the edges in opposite directions and at the center, all on parallel planes.

Many test-pieces were pulled which consisted of two abutting crystals. In no case did fracture occur at the junction; in fact, mutual support was clearly in evidence to a depth of ¼ in., leaving the boundary as a pronounced ridge.[4] If crystals existed side by side, one frequently broke before the other, and on reassembly a gap of ¼ in. was often noticed.

Round bars, 0.56 and 0.8 in. diameter, consisting of a single crystal, always flattened in one dimension as much as 45 per cent, leaving the other substantially unchanged. Fracture always occurred in a curious way; both pieces were cupped, forming a groove on reassembly.

Single crystals are remarkably malleable, remaining quite ductile after cold reduction of 93 per cent with no annealing, a property far in excess to the normal sheet. Brinell depressions made in single crystals were almost square, with rounded corners.

Carpenter and Elam conclude their paper with a brief discussion of the cause of grain growth. They have been of the opinion that mechanical deformation supplied the energy required, and heat supplied only the necessary mobility. Amorphous metal produced during deformation cannot be a store of recrystallizing energy, since maximum deformation does not correspond to maximum crystallizing power. Such questions will await the investigation of the actual changes in the space lattices of large crystals when subjected to plastic deformation, a research which is under way in collaboration with Sir William Bragg.

TABLE 1—CHARACTERISTICS OF SINGLE CRYSTALS OF ALUMINUM

Type	No. of Specimens	Characteristics	Fracture	Figure	Strength Long Tons Per Sq.In.	Elongation, Per Cent
1	7	Slips reduce breadth only	Severe necking	1*	2.9 to 3.9	57 to 67
2	7	Slips reduce thickness only	Straight knife edge	2	2.8 to 3.3	47 to 73
3	15	Slips reduce both dimensions. Cross-section becomes rhomboidal	No neck	..	2.9 to 4.08	34 to 86
4	8	Like type 3, but necks	Local neck	3	3.1 to 3.8	53 to 79
5	5	Develops mechanical twins	Various	4	3.0 to 3.8	55 to 67
Normal	5	Sheet as received, but reheated 6 hr. at 550 deg. C. About 150 crystals to the linear inch	Slight neck	..	4.5 to 4.7	36 to 38

*Some of the specimens were lightly ruled in squares before testing.

Importance of Time in Heat-Treatment of Chromium Steel.—Notwithstanding the general understanding that temperature control is essential to correct heat-treatment, direct attention is seldom given to the no less important factor of time, Prof. C. A. Edwards pointed out at a recent meeting of the British Institute of Metals in Birmingham.[1] For instance, ordinary carbon steel, suitable for files, if quenched in water will be glass hard, but if a slightly longer time be allowed for cooling between 800 and 400 deg. C. it will be very soft. Hence the impossibility of deep hardening massive pieces of such steel—it is impossible to quench the underlying metal at a sufficient rate—and the use of alloyings elements such as Ni, Cr, W or Mn, which act on hardness in the same direction as rapid cooling. However, many special steels are no less sensitive to the time at heat than high-carbon steel. For instance, a steel containing 0.33 per cent C, 3.1 per cent Ni, and 1.6 Cr, will exhibit markedly different cooling curves and different strength and hardness as it is cooled even at the same rate from varying temperatures between 814 and 874 deg. C. Again, chromium steels are sensitive or not depending upon whether the ratio between chromium and carbon exceeds 10 to 1. If there is more than enough chromium to satisfy the carbon as Cr_2C_2, then the steels no longer act as plain carbon steels, and the initial temperature of quenching ceases to have influence on their critical cooling velocities. A sample of 0.4 C. steel having 12 per cent chromium requires a cooling rate of more than 60 minutes to permit the transformation to progress. High-carbon, high-chromium steels (like 1.2 per cent C, 10 per cent Cr) will exhibit increasing hardness as the quenching temperature rises to 1,000 deg. C., but decreasing hardness when quenched higher. Thus its Brinnell hardness is about the same when annealed and when quenched from 1,200 deg. C. This is somewhat misleading, however, for, like high-manganese steels, they cannot be machined. Also "tempering" at 600 deg. C. or higher greatly increases the hardness.

[4]It is somewhat surprising that the normal specimens have such moderate strength in comparison with that of crystals 2,000,000 times as big, in view of the undoubted aid given by adjacent crystals.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Artificial Silk.—Brilliant threads of viscose silk are obtained if the freshly precipitated gelatinous threads spun in a sulphuric or other acid bath are wound up on spools, etc., in a solution of ammonium chloride or sulphate. The ammonium salt bath is maintained neutral or of the desired degree of acidity by the addition of aqueous ammonia or acid. The viscose may be in the fresh or ripened condition, and it is preferred to employ concentrated solutions. (Br. Pat. 171,776. Technochemia Akt. Ges., Glarus, Switzerland. Jan. 11, 1922.)

Sodium Cyanide.—Sodium cyanide is produced by the action of nitrogen on a mixture of sodium carbonate and carbon, the latter being preferably in large excess. To prevent the destruction of the cyanide through contact with the other reaction products, the furnace is provided with a pervious hearth through which the reaction products are withdrawn, while the furnace space is filled, for the most part, with reducing gases which are burned in the upper part of the furnace. The furnace hearth may consist of hollow iron plates stood on edge, through which water or cold gases are passed to cool the reaction products. If necessary, the water or other cooling medium may be injected into the reaction products to produce ammonia and soda, the latter being returned to the furnace. (Br. Pat. 172,027; not yet accepted. H. Mehner, Berlin. Jan. 18, 1922.)

Decolorizing Liquids.—Sugar solutions and other liquids are decolorized by the use of an adsorbent and a reducing agent in conjunction. The reducing agent may be applied first, or some adsorbent may be applied first and filtered off and the reducing agent may be applied, followed by more adsorbent, or the adsorbent may be allowed to remain in

[1]Reported in the *Iron and Coal Trades Review*, Jan. 27, 1922, p. 121.

contact with the material while the reducing agent is applied. Examples are given of the treatment of sugar solution with bone charcoal and sodium hydrosulphite. Sulphur dioxide may also be employed. (Br. Pat. 172,272; not yet accepted. J. F. Straatman, Holland. Jan. 25, 1922.)

Soaps and Fatty Acids.—A process for deodorizing liquid soaps containing water or converting fatty acids with several double bonds into homologs of oleic acid consists in forcing the substance under pressure through a pipe heated to about 250 deg. C. The heating may take place in two stages, in which case the second portion of the pipe may be heated up to 300 deg. C., and further quantities of alkali may be added by means of a separate pipe before the second stage is reached. A suitable pressure is 70 atmospheres. (Br. Pat. 172,250. Henkel et Cie., Dusseldorf. Jan. 25, 1922.)

Book Reviews

THE CHEMICAL AND METALLOGRAPHIC EXAMINATION OF IRON, STEEL AND BRASS. By *Wm. T. Hall* and *Robert S. Williams*. New York: McGraw-Hill Book Co., Inc. 502 pp., 183 illustrations. Price $5.

About two-thirds of this volume is taken up with methods of chemical analysis, and the remaining third with metallography. The former portion is the more valuable. Various methods for the analysis of all possible constituents of iron and steel are not only given in detail as to procedure, but are also explained in principle or theory, and the different methods for the determination of a given element are compared and criticized in an interesting way. Quoting from the introduction, the book "is written more from the point of view of the educator than from that of the busy analyst," and not "for the chemical laborer so much as for the man who wants to know and to understand methods of chemical analysis." Judged from this point of view, the book is certainly a success as applied to iron and steel, and few adverse criticisms of that portion can be made. A serious omission is that of any method for the determination of alumina or of total non-metallic inclusions in steel. The table of oxygen contents of various steels on page 257 would be much more interesting to a metallurgist if more data had been given on the history of the samples during manufacture. But it is plain throughout the book that it is written by, and intended for, chemists, rather than metallurgists.

The chapter on electrometric methods is excellent, with its brief explanation of electrical terms and electrolytic theory. One of the best points about the book is the stress laid throughout upon the importance of proper sampling in order that an analysis may be of value. This certainly cannot be emphasized too much, to those who use as well as those who make chemical analyses, and the troubles arising from segregation and other non-uniformity of materials are well brought out by the authors.

The non-ferrous chapter is brief and rather peculiarly arranged, and evidently was considered of secondary importance. Methods for the determination of copper, tin, zinc, lead, phosphorus, nickel, arsenic, antimony, etc., are given, but there is no mention of the rapid method for deposition of copper by means of a solenoid for rotating the solution as advised by Frary, instead of by use of a rotating anode. Neither is any method given for the determination of sulphur in bronze. A glaring error is the wrong definition of manganese bronze on page 307. Theoretically perhaps this term *should* denote a "copper-tin alloy to which manganese has been added," but practically what is now called manganese bronze is an impure copper-zinc alloy, and it would seem that a book of this kind should recognize facts as they are, even though it might be necessary to explain that the name as commonly used is illogical and should eventually be discontinued. In this as in several other places in the book it appears that the authors are just a trifle out of touch with the practical applications of metallurgy, so that their ventures into this realm are not always wholly successful.

Part II, or the final third of the book, dealing with metallography, is plainly written from a chemist's viewpoint, and does not go into the subject very deeply. The method of preparing specimens is outlined, with some useful notes on the microscope and photography, but the usual textbook fallacy in regard to the necessity for color-sensitive plates in non-ferrous work is repeated. In certain instances such plates may be an advantage, but those instances occur just as often with iron and steel as with copper alloys, and the vast majority of work with all kinds of metal can be recorded with perfect satisfaction on ordinary process plates, provided some intelligence is used in printing as well as negative-making.

Excellent discussions are given of the iron-carbon diagram, metallographic constituents, and segregation. It is unfortunate, however, that segregated spots are stated to include oxides, for this is extremely doubtful and certainly not demonstrable by the microscope, which shows them only in *decarbonized* areas. Macroscopic methods of investigation are described, including the making of sulphur prints, but the latter process, while correct in principle, is not given in a specially practical manner, and would appear to have been described by some one who had not made very many of these prints successfully.

A chapter on the general study of steel with the microscope indicates some of the ways in which this work might be useful to the chemist, or as supplementing the chemist's report, and two very good chapters follow on the structural features of cast iron. Sampling is discussed in detail in another chapter, and magnetic and X-ray testing are briefly described. It is hard to see why they should be given under "Sampling," however.

The final chapter, on non-ferrous metallography, is good on the whole, though rather brief on all phases of this subject except the brasses. A few rather serious errors and omissions occur, however, in this chapter, and a revision of certain parts would be decidedly beneficial. The discussion of beta brass and Muntz metal on page 455 does not agree very well with that on page 467, and the careful reader who might be attempting his first study of the subject from these pages could scarcely fail to be confused by them. The trouble is that it is not explained on page 455 that true equilibrium as represented by the copper-zinc diagram is probably never attained in this alloy under practical conditions, so that both pure beta and alpha plus beta structures are often found in the commercial alloy, whether quenched or cooled slowly. The conditions here are quite different from those met with in bronze, as described on page 456, where it is difficult to retain beta below the transformation temperature. The important delta constituent of bronze is not discussed at all, though its occurrence and distribution are among the most important points to be determined in metallographic work on this alloy. The statement that copper alloys may contain copper oxide is erroneous, as this oxide is found only in the pure metal, and all ordinary alloying elements promptly reduce it, becoming oxidized themselves instead. The bad effect of oxide on conductivity is also a fallacy, as it has less effect in this way than almost any other impurity in copper except lead.

Thus in general it may be said that the chemical part of this book is an excellent and interesting guide to the thoughtful analyst, while the metallographic part is not quite so good. Of course it could not be expected that in a book two-thirds devoted to chemistry the subject of metallography would be thoroughly covered, but on the other hand it is disappointing to note so many errors that might have been avoided by a little more care.

Steel-works chemists using this book could scarcely fail to find it a help in their analytical work, and if they wished to take up metallographic investigations, as the authors very sensibly advise, they would undoubtedly get a fair start from it along this line. But it would not be long before they would find problems in manipulation to be solved by personal experience, and other problems on which the help of a more advanced text would be required. To the worker in non-ferrous metals exclusively the book is not to be recommended, as there are other books available that cover this branch of the subject more completely.

GEORGE F. COMSTOCK.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Muscle Shoals Developments Lag in House and Crowded Out by Treaty Interest in Senate

Some time is expected to elapse before any important step is taken by Congress in the pending negotiations involving the Muscle Shoals project. The Senate, in the throes of the treaty fight and about to take up tariff legislation, is having difficulty finding the time to give consideration to so intricate a matter as the disposal of the plants and waterpower at Muscle Shoals. The Senate Committee on Agriculture will probably not be able to visit the plant until the latter part of March. Fifty Senators have indicated their desire to investigate the plant.

Several efforts have been made in the House to bring its hearings to a close. The ramifications of the proposal, however, have made it impossible to carry those plans through, with the result that the record is assuming formidable length. No proposition before the Military Affairs Committee of the House has enough strength to make it advisable to press the proposition for an early vote in committee. The friends of the Ford offer believe that delay will work in their favor in that the desires of the public will be manifested anew when the results of the hearing are summed up. They believe this will bring into their ranks two or three members of the committee who still are non-committal. On the other hand, the opponents of the Ford offer think they will gain by any delay. As a result there is no great pressure for a prompt report on the matter. Chairman Kahn of the House Military Committee has introduced a resolution in the House authorizing that committee to visit the plant for investigation.

Senator Culberson of Texas has announced that he favors the sale or lease of the plant to Henry Ford.

During a Senate debate on the subject, Senator Norris of Nebraska, chairman of the Agricultural Committee, which is considering the various lease offers, said he was drafting a bill which he will introduce in the Senate providing for government operation of the plant. While he has not made up his mind as to the value of the various offers for lease, he said the Senate should seriously consider the possibility of government operation in view of the large expenditure heretofore made on the plant by the government. He favors independence from foreign fertilizer materials and from the fertilizer trust alleged to exist in the United States.

Senator Heflin of Alabama favors acceptance of the Ford lease offer. Senator McNary of Oregon said serious consideration should be given to all lease offers, and expressed a desire to know if the Alabama plant could compete with the Niagara Falls nitrate plant. Senator Smith said there should be no quibbling over the various offers, but the matter should be decided in the light of benefit to agriculture. Senator McNary said Ford's offer should not be accepted until every offer had been studied. Senator McKellar of Tennessee favored the Ford offer and referred to the phosphate available in the South.

Appropriation Announced for Bureau of Chemistry

The House Committee on Appropriations, in reporting the bill carrying funds for the Department of Agriculture for next year, provides $1,267,631 for the Bureau of Chemistry, which is $32,620 less than appropriations for the current year and $7,080 less than the estimates.

Swedish Fertilizer Workers Strike

Socialdemokraten reports that the workers at the Stockholm phosphate mills have struck. This means that workers at all the fertilizer works in Sweden, totaling 1,200 hands, are striking.

McGraw-Hill Company Purchases "Mining and Scientific Press"

The McGraw-Hill Co., Inc., publisher of CHEMICAL & METALLURGICAL ENGINEERING, has purchased the *Mining and Scientific Press* of San Francisco and on April 1 will consolidate it with the *Engineering and Mining Journal* under the name of *Engineering and Mining Journal-Press*. These two publications are the leading magazines of the metal mining industry, the *Journal* having been established in 1866 and the *Press* in 1860. J. E. Spurr, editor of the *Journal*, will be editor of the combined weekly, while T. A. Rickard, editor of the *Press*, will be contributing editor, keeping his residence in San Francisco and representing, in particular, the coast and Western viewpoints. The combined publication will be issued in New York.

Secretary of Interior Urges Government Aid in Development of Western Potash Fields

Development of potash deposits on public lands in the West under more liberal leasing laws or under a government revolving fund is recommended by Secretary of Interior Fall. He believes that potash deposits exist in sufficient quantities in the Western country to "relieve us of the monopoly existing at present under the control of Germany, which furnishes to our people practically all the potash which we use in America." He recommends that Congress either liberalize the law so that private capital may be attracted to the development of the fields or provide a revolving fund to be used by some government department in prospecting for mineral deposits. The result of such prospecting would enable operation under the second provision of the leasing law and permit the government to sell or lease lands in the potash and phosphate fields upon bonus and royalty and surface rental basis.

The House Committee on Appropriations, in reporting the bill carrying funds for the Department of Agriculture for next year, recommends $70,000 for the Bureau of Soils for exploration and investigation of methods of obtaining potash, nitrates, etc.

To Investigate Foreign Chemical Markets

Director Klein of the Bureau of Foreign and Domestic Commerce recently requested of the House Appropriations Committee funds for investigations of chemicals. He said the chemical industry was considerably stimulated in this country during the war, especially in the manufacture of heavy industrial chemicals, and the bureau desired to study the possible markets in new industries in Latin America for chemicals.

In the manufacture of soap, for example, there is a considerable market to be found for caustic soda and other commodities where a market did not exist before the war. The bureau is anxious to find markets and see that American chemicals are placed there. He said there would be a demand for these chemicals for new industrial activity in Latin America.

British Imports of German Dyestuffs

In reply to a question in the House of Commons, Hildon Young stated that the total weight of dyestuffs received by Great Britain from Germany by way of reparation up to Dec. 31 last was 4,070 tons, of which approximately £570,000, or £140 per ton, was credited to Germany. Two thousand four hundred tons had been sold for approximately £228 a ton, which represented the values ruling at the date of the sale.

Chemical Industry in the Tropics Subject at New York Section, A.C.S., Meeting

The spicy tang of the Oriental tropics pervaded Rumford Hall at the meeting of the New York Section of the American Chemical Society on March 10, when two interesting papers, illustrated with attractive stereopticon slides, were presented on the place of the chemical industry in the tropics. R. F. Bacon of New York spoke on "The Tropics as a Source of Chemical Raw Materials." Dr. Bacon spent 5 years in the Eastern tropics and is familiar with the present applications and the undeveloped possibilities of tropical products. He pointed out that the field of the industrial chemist is in working up processes for making the tropical natural products more transportable and more available for consumption in the temperate countries. He described the industry built up around the coconut palm, including the drying of the copra, the collection of the sap and the extraction of the oil. The wonderfully rapid growth of vegetation suggests the development of tropical woods and grasses for paper manufacture. The prolific yield of tropical soil suggests the cultivation of casaba as a logical source of starch. The speaker predicted a steady increase in the amount of oils that will be imported from the tropics, due to the flexibility afforded consumers by newly developed hydrogenation processes. He also voiced the opinion that some of the effort now directed toward the perfection of synthetic methods might be more profitably turned to the development of the tropical sources of the natural products. The slides included photographs of the cultivation and harvesting of essential oil-bearing plants, rubber, cloves, etc., and the extraction of perfumes and oils from the plants in native distilleries.

"A Unique Alcohol Industry and a New Source of Sucrose" was the subject of the paper presented by H. D. Gibbs of E. I. du Pont de Nemours & Co. Dr. Gibbs discussed the occurrence and extraction of sugar in different varieties of palm trees and described the sugar industry that has been developed in the Phillipines using this source of supply. The nipa, coconut, sugar and fish-tail palms are the best sources of sugar among the palms, but the nipa is the only one commercially important in the Philippines. It grows in swampy land along the rivers. The sap is obtained by cutting the flower stalk and hanging a small bamboo joint under it. It is necessary to cut a slice from the end twice each day to maintain a steady flow of sap. The average yield is about 43 liters per season per plant, the plants maintaining this production without decrease for as long as 50 years. The yield can be doubled by scientific cultivation and harvesting methods. The nipa palm is the source of 90 per cent of the alcohol produced in the Philippines, and at its price of 2 cents a liter is probably the cheapest raw material known. It is not suitable for sugar manufacture, however, since it is contaminated with yeasts. The sap contains about 15 per cent sucrose. Among the slides shown were photographs of the native distilleries and nipa palm plantations. Several very interesting photographs of different varieties of palm trees taken with infra-red light rays were shown.

New Bulletin on Carbon Monoxide Poisoning

Carbon monoxide poisoning is discussed by Dr. Alice Hamilton of the Bureau of Labor Statistics in Bulletin 291 of that bureau. This publication gives a full technical discussion of the symptoms and causes of both acute and chronic poisoning and points out many industrial sources of carbon monoxide gas where danger to operatives is met. Not only safety engineers of corporations, but also those generally responsible for plant conditions will find much of value in this publication. It can be obtained direct from the Bureau of Labor Statistics, Washington, D. C.

Industrial Chemical Exhibit at Union College

An exhibition covering products and processes of practically all industrial applications of chemistry will be given in the Butterfield chemistry building by the Union College Chemical Society of Schenectady. The exhibition will be opened April 6 and will continue for a three-day period.

Third Week of Dye Investigation Brings No Substantiation of Monopoly Charges

No one of the accusations which have been made against the domestic organic chemical industries has been substantiated. At the time of this writing, the hearing before the Senate sub-committee is in its third week. The charges that have been made are numerous. In nearly every case they go back to some previous public record, but the proof which the original accusation lacked is still wanting. No consumer of dyes has come forward to testify that there is a monopoly or that efforts are afoot to consummate a monopoly. No small producer of dye materials has been brought forward to testify as to efforts to gobble him up.

There is abundant evidence that the instigators of the investigation are likely to suffer more as a result of its disclosures than are those whom they accuse. It is quite apparent that the representatives of the organic chemical industries have made a very favorable impression on Senator Shortridge, the chairman of the sub-committee conducting the probe.

Francis P. Garvan, president of the Chemical Foundation, was able in the course of his extended testimony to explain away many of the fanciful accumulations of accusations which had been brought against the industry. He feels, in the light of the information which he has given the committee, that the tissue of charges brought by Senator King have been discounted. Senator Moses of New Hampshire, who long has been active in laying much wrong-doing at the door of the domestic dye-manufacturing industry, has contributed nothing to disclose these iniquities. He has attended none of the hearings and as this is written is away from Washington.

Chemical Industries Profit by Opportunity to Present Viewpoint

The representatives of the chemical industries in attendance at the hearings are more than satisfied with the way things are working out. They point out that this is the first time the chemical manufacturers have had an opportunity to present their side of the case. Such defense as they have been able to make before Congress has been as an incident to the tariff hearings. The very nature of those hearings was such as to preclude any thorough defense such as now is possible before the Shortridge committee.

From a textile source somes the opinion that the whole investigation really has had its inspiration in the dye industry and that the hearing was timed carefully so as to enable the dye people to obtain wide discussion of their arguments for an embargo at the time the Finance Committee is whipping the tariff bill into final shape. If such were the case, it would necessarily imply collusion with Senator Thomas, Senator King and Senator Moses, who have been consistently working for more than 2 years to secure the investigation. In chemical circles it is pointed out that at least some of the accusers of the dye interests suddenly lost their enthusiasm when the Senate adopted Senator Frelinghuysen's amendment broadening the scope of the investigation so as to include an investigation of the practices of dye importers.

When the investigation reaches the point where the activities of the importers are to be considered, a sensational disclosure is said to be in prospect.

Garvan Concludes Testimony in Defence of Chemical Foundation

Mr. Garvan concludes his extensive testimony in defense of the dye manufacturers and the Chemical Foundation, declaring that he had given a complete answer to all the charges made by Senator King. He expressed willingness to answer any questions that may be asked by Senators King and Moses, who will be invited to cross-examine him. In the course of his testimony, Mr. Garvan expressed the belief that the decision of the sub-committee to place all witnesses under oath drove to cover those who have been conducting a whispering campaign to prevent the development of the American dye industry. Witnesses hostile to

development of the American industry, if required under oath to give the source of information contained in their statements, would show by their answers that their information originated with supporters of the German chemical cartel, he declared.

The Chemical Foundation, far from being the powerful, wealthy organization alleged by its enemies, has expended all of its income and part of its capital in the public interest, to educate American public opinion to the necessity of developing the science of chemistry, stated the witness.

Says Tariff Cannot Protect Dye Industry as Embargo Can

Senator Sterling brought up the question of tariff by inquiring why a high tariff could not protect the American dye industry as well as an embargo.

"No tariff can be high enough because no price is too high for Germany to pay to destroy the American industry," responded Mr. Garvan, and continuing, he declared that Germany is willing to pay any price, even to the extent of giving away its dyes plus a bonus for using them, in order to destroy the American industry. The embargo, he explained, makes it possible to keep out foreign dyes which are manufactured here satisfactorily, whereas Germany would crash through any tariff wall regardless of expense. "She wants to regain commercial domination. She wants to regain military control of the world," he concluded dramatically.

In answer to Senator Sterling's inquiry as to how reasonable American prices are, the witness replied that competition among American producers during the time they have been protected by government control of imports has brought prices down to the proper limits to the consumer.

Jeffcott Defends Institute and Ridicules Monopoly Charges

Declaring that "intensive, bitter, cut-throat competition" exists today in the American dye industry instead of the monopoly charged by Senators Moses and King, R. C. Jeffcott, president of the American Dyes Institute, challenged and denied most of the charges made by King. Mr. Jeffcott is president of the Calco Chemical Co. and is the first dye manufacturer to be heard by the committee.

In defending the American Dyes Institute against the charges that it is the center of a dye monopoly in the United States and that it has expended money for insidious propaganda and improper lobbying in connection with legislation for the complete protection of the dye industry, Mr. Jeffcott went into some detail as to the individual members of the Institute and the various expenditures. The charge that the large dye manufacturers meet to arrange and agree as to prices, through the Institute, was emphatically denied by Mr. Jeffcott.

Contrasting the alleged monopoly with the condition which he claims actually exists, Mr. Jeffcott declared the manufacturers appear to be so suspicious of one another that they not only refuse to give statistics concerning their business but will not work together to the extent called for by the present situation. He also stated that prices of American dyes are down to pre-war levels and some products are being sold under cost of production because of competition.

Under cross-examination by Senator Shortridge, Mr. Jeffcott was asked what is necessary to protect the American industry.

"First of all," he replied, "we should have a selective embargo for 5 years, then for the ensuing 5 years protection under the highest possible tariff rates, after that the same degree of protection as is accorded to other American industry against foreign competition would be ample. The only way to make protection effective is to make it certain. We have had no feeling of security, no assurance as to how long we will have an embargo. We feel that misunderstanding on the part of Congress is solely responsible for failure to give the industry proper protection."

Mr. Jeffcott said that time is an important element in developing the American industry, as before the war there was practically no such industry. The development of the American dye industry will bring American science to the aid of industry, he predicted, with benefits of incalculable value resulting.

Textile Interests Not Opposed to Tariff

Textile interests opposed to adequate protection of the American dye industry constitute only a minority of the American textile industry, according to the testimony of Morris R. Poucher of E. I. du Pont de Nemours & Co. and chairman of the legislative committee of the American Dyes Institute. Mr. Poucher presented a summary of the activities of the legislative committee of the American Dyes Institute and also made a statement concerning the activities of importers of German dyes to prevent development of the American industry and denying certain of the testimony of Senator King of Utah before the sub-committee.

"In the final analysis there is but one question," he said, "and that is, do we want this industry in the United States, or do we not? America will answer 'Yes' and the German dye monopoly will answer 'No' and that is the sum total of the whole controversy."

Open Price Section Not Successful

Harry E. Danner, treasurer of the American Dyes Institute, described in detail the work and purposes of the open price section, which was formally abandoned in June, 1920. Mr. Danner said that when this section was organized, in 1918, only five of the sixteen companies then members of the Institute participated in the section, and that no more than twelve Institute members at the most ever participated in it.

In reply to questions from Senator Sterling, Mr. Danner said the American Dyes Institute was originally organized to have an open price section, but that the latter failed, probably because the dye industry was new and its members did not like the idea of giving information about their business. No penalty was enforced, he said, against members not participating, as membership was voluntary. The difference between those participating and those not, he said, was that those who made reports received the information exchanged, while non-participating members did not.

Textile Manufacturer Not Satisfied With Investigation

A letter severely criticizing the conduct of the sub-committee of the Senate Judiciary Committee in charge of the dye hearing was left with the sub-committee by George Deming, a Philadelphia lawyer. The letter complained, in effect, that the sub-committee has permitted representatives of the American dye industry to appear voluntarily, give their testimony and depart without adequate testimony. Senator Shortridge, through one of the stenographers at the hearing, made an unsuccessful attempt to locate Mr. Daming as soon as he ascertained the contents of the letter, which bore the typewritten signature of "John Nash McCullaugh, industrial manager, National Association of Hosiery and Underwear Manufacturers."

Senator Shortridge then publicly replied to the allegations in the letter and later announced that Mr. Deming will be invited to appear before the sub-committee, in order that he and any clients he represents may have full opportunity to present any evidence they believe of value to the inquiry now going on.

Forty Tons of Sulphur Per Day Limit Set on Smelter Stacks

In the suit of the State of Georgia against the Ducktown Sulphur, Copper & Iron Co., which seeks to restrain damages to crops by reason of discharge of sulphur gases, a stipulation has been filed in the Supreme Court by both parties under which the company agrees not to permit the escape into the air of sulphur dioxide gases which have a sulphur content of more than 40 tons a day, and to furnish the state a report as to the tonnage of ore smelted and acid made. The agreement also calls for a board of arbitration of one representative each of the state and the company to supervise operations and to ascertain damages caused to citizens by the gases.

Distributing Agencies at Fault in Fleischmann Alcohol Case

All permits for the sale of alcohol at branch plants of the Fleischmann Co., Inc., were withdrawn following an exhaustive hearing of the most important alcohol case that has come before the Bureau of Internal Revenue. The Commissioner of Internal Revenue declined to cancel the permits of the Fleischmann Co. to distill alcohol at its yeast plants at Langdon, D. C., and Peekskill, N. Y. The formal decision of the Commissioner states that the agents of the Fleischmann Co., Inc., at Philadelphia, Pa., Brooklyn, N. Y., and Bridgeport, Conn., diverted to unlawful purposes the alcohol produced by the company, and forwarded to them for distribution. There is no evidence to show that the unlawful diversion of alcohol by the agents of the Fleischmann Co., Inc., was known to the company or its officers or that such officers connived or conspired with their agents in such unlawful diversion, but it is established that the officers were negligent in the inspection of the agencies and did not use due care in supervising them.

The records kept at the distilleries of the Fleischmann Co., Inc., were found to be proper and correct and in accordance with the law.

As a result of the Fleischmann case a Treasury decision has been issued amending Sec. 58 of Article IX of Regulations 60, so as to set forth clearly the responsibility of manufacturers of alcohol who distribute their product through agencies. The new regulations place upon the manufacturer the responsibility for the conduct of a distributing agency in conformity with the law. Title to liquor in the hands of an agent remains with the manufacturer until title is transferred to a purchaser having a permit to purchase. The manufacturer must accept the risks of the business done through an agent. The agent must forward daily to the manufacturer for examination a complete report showing the details of all transactions of the agent. Each transaction must invariably be reported not later than the business day following the sale.

Industrial Developments of the Week

Paper.—The S. Y. Beach Paper Co., Seymour, Conn., is arranging for the early resumption of operations at its local mills, which have been closed down for about a year. The machinery will be overhauled and improved at once.

Ceramic.—The National Fireproofing Co., Pittsburgh, Pa., is maintaining active production at its different plants. During the month of February the company booked about twice the volume of busines as in the same month of last year.

The New Castle Brick Co., New Castle, Pa., will soon resume production at its plant. Repairs and improvements will be made to the equipment at once.

Oil.—Nine oil refineries in the El Dorado district, near Monroe, La., will resume full-time production during the next fortnight, increasing production to a basis of 25,000 bbl. per day, with employment of 3,500 men.

Rubber.—The Goodyear Tire & Rubber Co., Akron, Ohio, has increased operations at its plant at Los Angeles, Cal., to a production basis of 25,000 tires a day.

Paint.—The Prince Metallic Paint Manufacturing Co. has placed its plants at Bowmanstown and Lehigh Gap, Pa., on a full-capacity basis.

Iron and Steel.—The Carnegie Steel Co. is increasing operations at its Mingo Junction plant in the Steubenville, Ohio, district, which has been running on a 75 per cent basis.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., a subsidiary of the United States Steel Corp., has blown in its Alice blast furnace at the local works. Production in all departments has reached practically a 100 per cent basis, making the first complete steel plant to reach this point during the past 24 months.

The Carbon Iron & Steel Co., Parryville, Pa., is completing repairs and overhauling of equipment at its mill, preparatory to early resumption of operations.

The Cambria Steel Co. has resumed production at its open-hearth furnaces at the Johnstown, Pa., works. The company has sixteen furnaces in operation at its Franklin plant and is planning to resume manufacture at its Bessemer mills before March 25.

The Inland Steel Co., Chicago, Ill., has increased production at its East Chicago, Ind., works, adding about 1,000 men to the working force. The manufacture of steel rails has been resumed and a number of departments are operating on a 75 per cent basis, as compared with a 60 per cent schedule a few weeks ago.

The United Alloy Steel Co., Canton, Ohio, is now operating ten furnaces at its local plant and the majority of the mills are in service.

Coke.—The Century Coke Co., Brownsville, Pa., has resumed operations at part of its ovens. Other units will be placed in service at an early date.

The H. C. Frick Coke Co. has fired 700 additional ovens at its plant at Scottdale, Pa., and will place other ovens in service at an early date.

During the week of March 1, 270 additional merchant ovens in the Connellsville, Pa., section were fired.

Leather.—The Graton & Knight Co., Worcester, Mass., has increased operations at its local tanning and leather plant on a basis of 50 hours per week, giving employment to about 900 men. The factory has been working on a part-time schedule for some weeks past.

Eberle Tanning Co., Westfield, Pa., is operating under a capacity schedule at its plant for the tanning of buffalo sole leather.

The Craddock-Terry Co., Lynchburg, Va., has adopted a full-capacity schedule at its new central upper leather cutting plant, recently completed. A factory unit for the production of welts is being equipped and will be placed in service on a full manufacturing basis before the close of March.

Metals.—The New Jersey Zinc Co. is making ready to place its spiegel furnaces in operation at its Palmerton, Pa., works.

The Inspiration Copper Co., Globe, Ariz., has resumed the production of concentrates at its plant. Four sections of the plant are now in operation after a shut-down of about 9 months.

The Utah Copper Co., Salt Lake City, Utah, is arranging for the early resumption of operations at its plant.

The United Verde Extension Mining Co., Jerome, Ariz., has commenced operations at one of its reverberatory furnaces at its copper plant at Clemenceau.

The Silver King Coalition Co., Park City, Utah, is planning for the immediate operation of a new 450-ton mill now being completed. Timing-up will commence about the middle of March.

Changes in Specifications for Lubricating Oils

Certain changes in specifications for lubricating oils of various grades, which were advocated by refiners on the Pacific coast, were agreed upon at the first meeting of the recently formed Interdepartmental Petroleum Specifications Committee, held in the offices of the Bureau of Mines in Washington, D. C., Feb. 27. The changes have been submitted to the Federal Specifications Board, and it is hoped to incorporate them in the technical paper containing revised specifications for petroleum products, to be published shortly by the Bureau of Mines. The committee postponed the discussion of proposed changes in specifications for transformer oil, aviation gasoline, kerosenes and signal oil. It was decided to appoint a sub-committee on greases.

The personnel of the new committee is the same as that of the former Technical Committee of Standardization of Petroleum Specifications. The new committee, however, reports directly to the Federal Specifications Board. The revision of Bulletin 5 of the old committee, which was made last fall, has had the approval of the Federal Specifications Board, and will shortly be published in the form of two technical papers of the Bureau of Mines. Of these, Technical Paper 298 will relate to methods of testing petroleum products, and Technical Paper 305 to specifications.

British Alkali Company Reduces Wages

Notice of a reduction in the wages and holidays of chemical workers has been posted by the United Alkali Co., according to a dispatch from London. The 12½ per cent war bonus on time work and 7½ per cent on piece work are withdrawn in three stages—on March 2, April 6 and May 4. The bonus is being paid to operators, laborers and other workers. Directors of the company state that its withdrawal is justified in view of the continued depression in the volume of demand for the company's products, constantly falling prices and the decreased cost of living.

Cost of Analyses in State Laboratory

The State Department of Chemistry, Harrisburg, Pa., has compiled figures showing that the state agricultural chemists analyzed feeding stuffs, fertilizers, oils, paints and animal viscera during the past year at an average cost of $4.76 per sample. A total of 2,876 samples of such materials were analyzed in 1921. The cost per sample includes all overhead charges, as rent, light, etc., at the Harrisburg laboratories, and in comparison with the work of the department at the prevailing cost, J. W. Kellogg, chief chemist, makes a comparison with the average charge of a commercial chemist at about $20 a sample.

Personal

General Avery D. Andrews has been elected president of the Shell-Union Oil Co., San Francisco, Cal., comprising the recent merger of the Royal Dutch Shell interests and the Union Oil Co. of Delaware.

L. J. Buck has severed his connection with the National Carbon Co., a subsidiary of the Union Carbide & Carbon Corporation, and has become United States sales representative of the British America Nickel Corporation, Ltd., Ottawa, with office in the Canadian Pacific Building, New York City.

William M. Corse, general manager of the Monel Metal Products Corporation, will take active charge of the division of research extension of the National Research Council on April 1, succeeding Harrison E. Howe, now editor of the *Journal of Industrial and Engineering Chemistry*. In addition to his work for the National Research Council Mr. Corse will devote a part of his time to private consulting work.

Joseph B. Elam has been appointed secretary of the Louisiana branch of the Texas-Louisiana division of the Mid-Continent Oil and Gas Association, with headquarters at Shreveport, La.

Harmon P. Fisher has been appointed engineer with the research division of the American Petroleum Institute. He was formerly in charge of operations at the United States Government helium plant No. 3 at Petrolia, Tex., and previously was connected with the Gellert Engineering Co., Research Corporation and the Westinghouse Electric & Manufacturing Co.

W. S. Frisbie recently resigned his position as chief of the Bureau of Food, Drugs and Oil, State Department of Agriculture of Nebraska, to accept an appointment as chemist in charge of the office of co-operation, Bureau of Chemistry, Washington, D. C.

H. Stuart Hotchkiss, president of the General Rubber Co. and the United States Rubber Plantations, Inc., subsidiaries of the United States Rubber Co., New York, has been elected vice-president of the parent company in charge of overseas operations.

Clayton L. Jenks has opened an office at 2 Rector St., New York, for the practice of patent and trade-mark law. He will give special attention to chemical and mechanical inventions. Mr. Jenks was for 6 years assistant examiner in the U. S. Patent Office, organized and conducted a patent department for the Eastman Kodak Co. at Rochester, N. Y., and 5 years ago established a similar system for the Norton Co., Worcester, Mass., of which he will retain charge.

H. A. Megraw has resigned as engineer for the Kennedy-VanSaun Manufacturing & Engineering Corporation of New York to become vice-president and treasurer of the Crown Oil & Wax Co. of Baltimore, Md.

Graham L. Montgomery, mechanical engineer, joined the editorial staff of Chem. & Met. on March 1. He will devote his attention primarily to mechanical phases of the chemical and allied industries and to methods of handling materials.

J. W. Newton, assistant superintendent of the Magnolia Oil Refinery, Beaumont, Tex., gave a lecture to the engineering students of the Agricultural and Mechanical College, College Station, Tex., recently, on the subject of "Refining Petroleum." The lecture was given under the auspices of the Mid-Continent Oil and Gas Association, and was the fourth of the series.

E. G. Rippel has withdrawn from the Buffalo Foundry & Machine Co. and will take an extended rest before engaging in business again. He organized the Buffalo Foundry Co. over 21 years ago and has been largely instrumental in building up the company to its present position. He was largely responsible for the extensive company exhibits at the National Exposition of Chemical Industries and for the large advertising campaigns that characterized the company's publicity plans. Mr. Rippel is succeeded as sales manager by C. W. Pearson, assistant treasurer of the Buffalo Foundry & Machine Co. Mr. Rippel's future plans will be announced later.

L. I. Shaw has resumed his duties as assistant chief chemist of the Bureau of Mines at its Washington office. For several months Mr. Shaw has been on duty at the ceramic station of the bureau at Columbus, Ohio.

Dr. Edwin E. Slosson addressed the recent meeting arranged by the chemical committee of the Chamber of Commerce and by the American Chemical Society, at Rochester, N. Y., on "Relation of Chemistry to a Civic Community."

Charles Syer, Norfolk, Va., has been appointed manager of the new sugar refinery of the American Sugar Refining Co. at Baltimore, Md., and will take up his duties at once.

S. W. Willson of the Graham Paper Co., St. Louis, Mo., has been appointed a technical adviser of the Bureau of Standards, during the work which the bureau is doing in connection with the standardization and simplification of paper and paper products. Mr. Willson was chief of the pulp and paper division of the War Industries Board during the war.

Obituary

Captain Horace G. H. Tarr, a familiar figure in the waterworks field for the past 50 years, died at his home in Philadelphia, March 2, aged 78 years. At the time of his death he was manager of R. D. Wood & Co., manufacturers of waterworks machinery, Philadelphia, Pa. At the close of the Civil War, through which he served with the Tenth Connecticut Volunteers, Captain Tarr entered the employ of the Brooklyn (N. Y.) Water Department as an inspector of cast-iron pipe. A few years later, as receiver, he operated the Tom Gaylord plant at Newport, Ky. Later he joined the Worthington Pump Co. as salesman. From 1900 until his death he was with R. D. Wood & Co. designing, selling and supervising the erection of waterworks machinery.

John J. Vorhees, president of the Vorhees Rubber Manufacturing Co., Jersey City, N. J., died at his home in that city, Feb. 26, at the age of 75 years. He was connected with the New Jersey Car Spring & Rubber Co. for 28 years, and then organized the company of which he was head.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Petroleum Refining in 1921

On Jan. 1, 1922, there were 303 refineries operating in the United States with a total indicated daily capacity of 1,736,725 bbl., according to the compilation of H. J. Lowe, petroleum economist of the Bureau of Mines. These figures are to be compared with 328 refineries having a daily capacity indicated at 1,714,395 bbl. on Jan. 1, 1921. Operations at the latter date were on the basis of 84 per cent of capacity and on Jan. 1, 1922, at 80 per cent.

The Geological Survey has estimated the production of crude oil in the United States for 1921 at 469,639,000 bbl. and the consumption of domestic and imported petroleum at 525,407,000 bbl. During 1921 the refineries of the United States distilled 75,325,670 bbl. of Mexican crude oil; 2,745,-015 bbl. of Mexican tops and 160,557 bbl. of Mexican crude naphtha. The run of Mexican crude exceeded that of 1920 by 19 per cent.

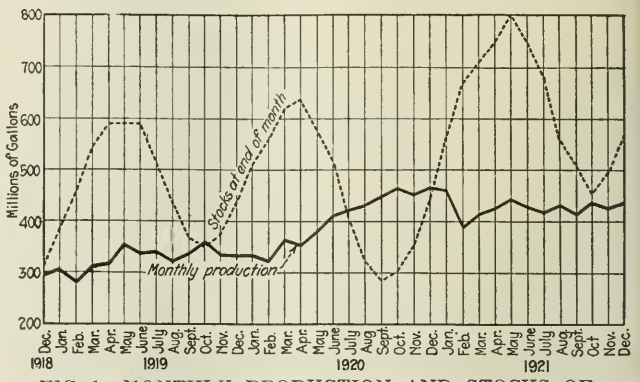


FIG 1—MONTHLY PRODUCTION AND STOCKS OF GASOLINE, 1918-1922.

TABLE I—OUTPUT BY MONTHS OF THE PETROLEUM REFINERIES IN THE UNITED STATES FOR 1921

	Run to the Stills: Crude Oil (Bbl.)	Run to the Stills: Other Oils (Bbl.)	Gasoline (Gal.)	Kerosene (Gal.)	Gas and Fuel (Gal.)	Lubricating (Gal.)	Wax (Lb.)	Coke (Tons)	Asphalt (Tons)	Miscellaneous (Gal.)	Losses (Gal.)
January	39,637,382	4,206,576	460,432,439	205,374,611	836,684,040	85,908,641	45,659,668	57,961	80,672	145,846,215	1,664,203
February	34,588,096	2,942,666	388,188,252	163,081,918	732,542,415	72,432,219	40,384,408	55,029	74,508	120,075,769	1,440,377
March	35,509,115	2,788,737	419,795,390	169,247,-94	758,334,681	73,003,304	37,719,575	45,475	84,774	85,849,195	1,575,538
April	37,594,220	2,363,193	426,215,200	156,156,565	813,144,202	76,456,958	39,200,197	51,386	86,120	96,017,271	1,699,652
May	36,990,478	2,823,694	448,567,873	145,225,023	817,367,590	70,000,194	31,441,634	49,891	102,327	84,823,852	1,573,090
June	36,940,821	2,740,131	430,344,393	141,637,081	826,355,262	63,088,609	29,860,281	43,567	109,565	100,049,466	1,546,123
July	36,040,797	2,649,364	419,641,815	138,724,132	807,428,397	65,893,228	25,070,736	43,496	111,523	83,999,461	1,610,271
August	36,044,910	2,705,120	431,577,895	143,652,290	784,450,485	66,473,473	28,498,408	42,602	112,943	92,463,702	1,596,083
September	35,613,933	2,999,042	416,913,000	154,017,299	788,408,124	69,053,367	33,054,167	44,863	107,420	83,050,575	1,638,549
October	37,968,496	3,727,357	440,955,518	182,453,598	833,775,254	75,971,377	38,264,778	52,368	153,118	93,656,968	1,796,781
November	37,211,534	2,956,469	431,886,845	175,240,466	799,256,607	77,005,042	41,574,253	54,338	103,834	86,524,716	1,722,052
December	39,222,875	3,590,216	439,031,398	170,315,279	865.769.078	82,572,662	43,159,109	63,489	87,732	130,075,973	1,694,798
Total	443,362,657	36,492,565	5,153,549,318	1,945,126,156	9,663,816,135	877,859,074	433,887,214	604,465	1,214,536	1,202,433,163	19,557,517

Gasoline Production

The following figures on the production and consumption of gasoline are of interest in showing its increasing importance:

THE INCOME AND OUTGO OF GASOLINE, 1918–1921

Income	1921	1920	1919	1918
Stocks, Jan. 1	462,381,837	446,793,431	297,326,983	412,256,833
Production	5,153,549,318	4,882,546,649	3,957,857,097	3,570,312,963
Imports	37,816,004	46,066,110	8,520,169	12,899,350
Total	5,653,747,159	5,375,406,190	4.263,704,249	3,995,469,146
Outgo				
Exports	524,279,031	635,247,487	365,883,011	556,422,334
Shipments to Insular Possessions	27,368,017	21,348,911	16,217,081	12,209,957
Domestic consumption	4,516,012,979	4,256,427,955	3,434,810,726	3,129,509,872
Stocks, Dec. 31	586,087,132	462,381,837	446,793,431	297,326,983
Total	5,653,747,159	5,375,406.190	4,263,704,249	3,995,469,146

The monthly production during this period as well as the stocks on hand at the end of the month are shown graphically in Fig. 1. Maximum rate of production was reached in October and December of 1920, although the total output for the year was at its maximum in 1921.

Other petroleum products produced by American refineries in 1921 are presented in Table I. The column headed "Miscellaneous" includes the following materials and quantities:

	Gal.		Gal.
Binder	18,527,055	Pitch	129,800
Flux	27,353,495	Residue	5,786
Medicinal oils	761,008	Slops	757,125
Paint products	266,220	Tailings	180,624
Petrolatum	7,250,636	Tar	3,374,166
Road oil	125,820,652	Tops	122,267,027
Roofers' wax	66,166	Unfinished	227,446,245
Sludge products	34,672,612	Wash out	25,280
Acid oil	2,271,513	Wax tailings	3,687,074
Distillates	627,570,679		
		Total	1,202,433,163

Stocks of Gasoline

Stocks of gasoline held in storage by American refineries reached 800,495,787 gal. in May, 1921. These are said to be the largest gasoline stocks ever recorded in this country. On Dec. 31, 1921, gasoline in storage had decreased to 586,-087,132 gal., which is but little more than 10 per cent of the output for the year. Storage at the end of 1920 was 123,705,000 gal. less than that reported for the last of 1921. The domestic consumption of gasoline for 1921, however, exceeded 1920 by 260,000,000 gal. and 1919 by 1,081,000,000 gal.

The exports and shipments for 1921 amounted to a daily average of 1,511,000 gal. This figure is 283,000 gal. less than the daily average for 1921, but 463,000 gal. in excess of the corresponding figure reported for 1919.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.13
Last week	157.46
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

Market developments of the past week have had practically no effect on the index number, which is but one-third of a point lower than last week. The slightly increased prices for ammonium sulphate, barium chloride, caustic soda and citric acid were more than offset by the lower quotations for soda ash and crude cottonseed and linseed oils.

The Causes of Business Failures

The following figures, compiled from reports of Dun's and Bradstreet's and presented in Babson's barometer letter, afford an interesting, quantitative comparison of the different causes of business failures in 1913, 1918, 1920 and 1921:

Cause	1913 Per Cent	1918 Per Cent	1920 Per Cent	1921 Per Cent
Incompetence	18 4	26.9	13.3	22.2
Inexperience	2 0	4.7	3.3	2 9
Lack of capital	24 9	30.8	26.6	21.9
Unwise credits	16 0	1.8	3.7	3.9
Failures of others	11 4	3.3	0.8	1.8
Extravagance	0.6	0.6	0.3	0.3
Neglect	0 7	0.9	0.5	0.4
Competition	0.9	0.8	0.3	0.3
Specific conditions	14.0	19.8	45.5	42.1
Speculation	2.7	1.2	1.9	1.1
Fraud	8.4	9.2	3.8	3.1
Total	100 0	100.0	100.0	100 0
Number of failures	15,296	9,657	8,672	19,779

Business Failures in January

The largest number of business failures for any month since January, 1915, was reported in January, 1922. As we have previously averred, business mortalities are not necessarily to be regarded as an unfavorable index of future business. Rather they are the result of circumstances which have already passed and in the long run business gains by the elimination of those concerns which cannot compete successfully with the new industrial situation.

Business failures in the chemical and allied industries during January of 1920, 1921 and 1922 are compared with the 1912-13 average in the following table. It will be noted that these industries account for only a relatively small proportion of the total number of failures.

BUSINESS FAILURES IN CHEMICAL AND ALLIED INDUSTRIES

	Number of Failures in January of				Liabilities in Thousands of Dollars			
Industry	1922	1921	1920	Ave. '12-'13	1922	1921	1920	Ave. '12-'13
Chemicals and Drugs:								
Manufacturers	9	13	3	4	376	392	18	111
Dealers	64	40	10	50	715	380	66	222
Paints and oils:								
Manufacturers	1	2	..	3	83	40	...	37
Dealers	2	6	..	2	40	150	...	16
Glass and ceramics:								
Manufacturers	10	9	3	11	282	114	80	237
Total for all industries	2,723	1,895	569	1,824	73,796	52,137	7,240	20,878

Du Pont Earnings Greatly Reduced in 1921

The annual report of E. I. du Pont de Nemours & Co. for 1921 shows a net income of $5,762,417 after inventory adjustment and taxes. When dividends on the debenture stocks were deducted, this is equivalent to $2.35 per share on its outstanding common stock. This is to be compared with a net income of $14,563,232, or $16.96 a share on the common stock in 1920.

President Irenee du Pont, in his letter to the stockholders, stated that in his opinion the lower volume of business was directly attributable to the liquidation of inventories. "Of raw materials used in products sold during the first 8 months of 1921," said Mr. Dupont, "approximately one-half came out of the storehouses and one-half was purchased. This means that those who sold to the du Pont company suffered a reduction of 50 per cent in volume of materials needed by this company for its already reduced operations.

"It seems reasonable to suppose that marked reduction in buying has resulted in intense competition to sell and that this has been a large factor in the reduction of prices.

"The most lamentable result of liquidation of inventories has been the discontinuance of employment while inventories were being consumed. Your company has been obliged to discontinue the services of two-thirds of its wage earners and half of its salaried employees."

Corn Products Reports Smaller Income

The Corn Products Refining Co., during the year ended Dec. 31, 1921, earned a net income, after deduction of charges and federal taxes, of $6,326,358, equivalent, after subtracting preferred dividends, to $9.21 a share on the outstanding common stock. This compares with a net income of $12,469,626, or $21.53 a share, earned in 1920.

New York Market

NEW YORK, March 13, 1922.

The resale market during the past week did not show any signs of increased activity, but large producers have reported a good inquiry for material at the works. Caustic soda was decidedly stronger, as well as the prussiates, barium products, nitrite of soda, sal ammoniac and nitrate of soda. Imported sodium nitrite is very scarce at present and the market is apparently prepared for another sharp advance. The demand for caustic soda for March shipment has kept the market for that commodity in a very firm position. Arsenic, sulphide of soda, oxalic and citric acids have maintained their former levels and leading factors reported moderate inquiries. Caustic potash, cyanide of soda and soda ash were a trifle easier under increased importations and domestic competition.

The Commodity Markets

Barium Chloride.—Recent strength reported in the chemical was in evidence at the close of the week and it is doubtful if better than $62 per ton on spot could be done. The demand remains very good with imported offerings greatly diminished.

Bicarbonate of Soda.—Large producers have shaded regular quotations in a few instances and sales were recorded down to $1.80 per 100 lb. for barrels, f.o.b. works. Kegs were offered at 2¼c. per lb. The demand is only moderate.

Bichromate of Soda.—Dealers report small quantity business at 7¾c. per lb. Producers ask 7½c. per lb. for large lots on contract. Some of the leading tanneries have been buying recently and a still better demand is predicted.

Bleaching Powder.—Large drums are offered at 1¾c. per lb. f.o.b. works, while the imported is quoted at $1.90 per 100 lb. ex-dock. Competition still remains keen between importers and domestic producers. The demand is somewhat irregular.

Caustic Potash.—Sellers are generally quoting the 88-92 per cent at 5¾c. per lb. Some resale lots could still be bought at $5.65 per 100 lb. The demand has not shown any increased activity during the week. Shipment prices are quoted at $5.75@$6.50 per 100 lb.

Caustic Soda.—Dealers report limited offerings of March shipments for export and the market is higher at $3.65 per 100 lb. There have been some short interests in the market and this has tended to advance prices. Leading producers are of the opinion that remaining March shipments will work to a much higher level. April shipments were offered at $3.50@$3.60 per 100 lb. by dealers. Producers' quotations at the works were unchanged at $2.50 @$2.57½ per 100 lb., basis 60 per cent, for carload lots.

Citric Acid.—Prices have shown an advancing tendency, although business has been only of ordinary dimensions. Restricted production abroad has limited offerings considerably on spot and sellers were quoting 45c. per lb., duty paid.

Chlorate of Soda.—Dealers quote the imported at 6½c. per lb. Large producers are holding prices on the basis of 7c. per lb., f.o.b. works. The demand is only moderate.

Nitrite of Soda.—Higher prices are recorded for imported and domestic material and it is doubtful if better than 8½c. per lb. could be done. Producers quote this price for nearby shipments. The inquiry continues very active with supplies limited.

Oxalic Acid.—Producers report sales on the former basis of 12c. per lb. and report the demand moderately active for regular quantities. Some business has gone through on spot at 13c. per lb.

Prussiate of Potash.—Offerings of this material are not liberal and the market is holding steady at 25½@26c. per lb. on spot. The demand is fairly active from the consuming industries. Red prussiate continues nominal, with March shipments from abroad quoted at 75c. per lb.

Coal-Tar Products

Inquiries during the past week have only shown a slight improvement and have tended to place the market in an

irregular condition. Its general tone, however, appears to be toward a gradual expansion in the volume of business. Coal-tar crudes have been brought to rock bottom figures and this has caused a better demand from the consuming industry. Demand for benzene, cresylic acid, toluene and other crude products is steady and the market is being firmly sustained. There have been some recent export orders for alpha-napthylamine. The available supply of this material appears to be quite limited and very little was obtainable in the open market. Small lots of dimethyl-aniline were in good demand. Offerings of para-toluidine appeared slightly firmer. Aniline oil is showing a better tone with a moderate improvement from consuming channels. Producers report a lower market for H acid.

Benzene.—There has been no let-up from the firm position of this crude. The demand continues active both on domestic and foreign account and producers report a heavily sold condition. Resale lots are very scarce and the market is nominally quoted at 35c. per gal. for the 90 per cent grade.

Naphthalene.—Sales of flakes are reported by makers at 6½c. per lb. Balls are moving quietly through first-hand channels at 8c. per lb., while odd lots have been sold a fraction under this figure. Crushed material is quoted at 6@6½c. per lb. The demand should be better at this season of the year.

The Chicago Market

CHICAGO, March 9, 1922.

No noteworthy changes occurred in the industrial chemical market during the past 2 weeks. Factors in this field report a fair volume of small orders and a good inquiry for prices. Competition is still very keen and a large request will usually bring out prices lower than the schedule. However, this tendency to cut is becoming less marked, especially on material of foreign origin where the replacement cost is considerably higher than the present spot market.

General Chemicals

The alkali market is unchanged as to price and the consuming demand remains light. Solid *caustic soda* is quoted at $3.75 per 100 lb. and the ground at $4.50, both prices being for ton lots with the material delivered to the consumer's plant. *Caustic potash* is exhibiting signs of strength and 6½c. per lb. was the rock bottom for ordinary lots to be delivered from spot stocks. *Soda ash* is moving in a routine way and is available at $2.30 per 100 lb. for material in cooperage.

Potash alum is rather scarce and whatever spot material is available is being quoted at 6c. per lb. for lumps and 7c. for powdered. *White arsenic* is still firm and is quoted somewhat higher at 8½@9c. per lb. *Blue vitriol* is in fair request with $5.90 per 100 lb. the inside for small or medium quantities. *Copperas* is also in good demand and is quoted at $1.75 per lb., single barrel lots. *Carbon bisulphide* is slightly easier and 6¾c. could probably be done on a fair-sized lot. *Carbon tetrachloride* is quiet and spot supplies could be had at 10½c. per lb., large drums extra. *Formaldehyde* is moving fairly well and at the present price of 10c. per lb. should be an attractive proposition. Competition has forced refiners of c.p. *glycerine* to lower their prices, the new schedule being 16c. per lb., bulk basis.

Bichromates are unchanged as to price although the movement is restricted to very small lots. *Potassium bichromate* is quoted at 11¾c. per lb., single cask lots, and sodium at 9@9½c., depending on the quantity and seller. *Red prussiate of potash* is still off of the spot market and as far as could be determined none is near by. *Yellow prussiate of potash* is very firm and is moving well at 27@28c. per lb. *Sodium fluoride* is attracting a little attention and is unchanged at 11c. per lb. for small or medium-sized lots.

Commercial *furfural*, reported for the first time in our letter of March 1, is still quoted at 50c. per lb. for quantities in excess of 100 lb. Rumors that imported furfural was available in the Eastern markets have not yet been confirmed.

The Iron and Steel Market

PITTSBURGH, March 10, 1922.

Production of steel ingots, which is an accurate and prompt reflection of the volume of steel demand when buying is for prompt shipment, has been practically stationary since the end of January, at a rate of about 29,000,000 tons per annum. During January and February there was a remarkably rapid increase. The American Iron and Steel Institute's reports of monthly production of thirty steel companies indicate that the annual rate at which the whole industry operated was as follows: In November, 23,300,000 tons; December, 19,750,000 tons; January, 22,750,000; February, 26,850,000 tons. These are approximations, with a probable error of less than half a million tons. The rate at the end of December was probably under 17,000,000 tons, while the rate in the past fortnight has been about 29,000,000 tons, an increase of 70 per cent or more.

The future would be discovered if the exact cause or causes of this increase in 2 months could be ascertained. "General conditions" or "underlying conditions" will not explain it, though it will explain a part. Liquidation of stocks will not explain it, for such liquidation was practically completed by Oct. 1, and a 23,000,000-ton rate of ingot production followed, for 2 months. The season of the year will not fully explain it, unless one is prepared to believe that when spring has actually arrived production will be much larger still. If all the buying has been of a strictly hand-to-mouth character, by far the heaviest demand is still to come.

Steel prices may furnish part of the explanation, particularly as we have an incident that may be illuminating. A few days ago the Jones & Laughlin Steel Co., one of the large independents, advanced its price on bars, shapes and plates to 1.50c. The market has been quotable at 1.35@1.50c. Previous to this withdrawal from the market, for that of course is what the action amounts to, the company is understood to have accumulated enough orders to carry it with its present operating rate for about 60 days. Perhaps the very low prices, well below what were expected to develop, influenced buyers to provide for the future to a certain extent.

The total demand has been practically constant in the past fortnight, as indicated by the steel ingot production rate. The only conspicuous absentee from the steel market has been the agricultural implement trade, and it has lately been buying a little steel to piece out its stocks preparatory to resumption of manufacturing in a modest way.

Sheet prices continue to be firmly held at 3c. for black and 4c. for galvanized, the rigid continuance of these prices for more than 3 months being the phenomenon of the steel market. Wire nails appear steady at the recent decline to $2.40, but there are rumors of less having been done. There is much talk of shading in standard steel pipe, but it is a fact that much business is done at substantially the regular prices. Tin plate is steady at $4.75 per base box, concessions on moderately large lots being usually 10 or 15 cents.

Pig Iron and Coke

On the whole the pig-iron markets are steady if not actually stiffening. Prices are reported a trifle better at Birmingham, Chicago and Philadelphia, while the local market is unchanged at $19@$19.50 for bessemer, $17.75@$18 for basic and $18.75@$19 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

Lake Superior iron ore is likely to come down at least $1 a ton for the 1922 season. Shippers consider it practically certain that the rail rate from the Mesabi range to upper lake dock will be reduced from $1 to 75c. before the opening of navigation. The vessel rate will doubtless come down somewhat. It was 94c. last season, 14c. being paid by vessel to lower lake dock, leaving 80c. net. As prices are f.o.b. Lake Erie dock, these declines will affect the market price of ore, the ore shippers themselves standing some reduction at mine.

Connellsville coke has been holding its recent 50-cent advance, spot and prompt being $3.25@$3.50 for furnace and $4.25@$4.75 for foundry.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0 40 – $0 42
Acetone	lb.	$0 11½ – $0 12	12½ – 12½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	11 – 11½	11½ – 12
Boric, powder	lb.	11½ – 11¾	11¾ – 12½
Citric	lb.	—	45 – 46
Hydrochloric	100 lb.	1 15 – 1 25	1 30 – 1 75
Hydrofluoric, 52 per cent	lb.	11 – 11½	11 – 12
Lactic, 44 per cent tech	lb.	09½ – 10	10¼ – 12
Lactic, 22 per cent tech	lb.	04 – 04½	04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg	lb.	06¼ – 06½	06¾ – 07
Nitric, 42 deg	lb.	06¾ – 07	07¼ – 07½
Oxalic, crystals	lb.	12 – 12½	13 – 14
Phosphoric, 50 per cent solution	lb.	08 – 08½	08¾ – 09½
Picric	lb.	20 – 25	27 – 35
Pyrogallic, resublimed	lb.	—	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	—
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	—
Sulphuric, 66 deg., tank cars	ton	16 00 – 16 50	—
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	—	60 – 75
Tannic (tech.)	lb.	40 – 45	46 – 50
Tartaric, imported crystals	lb.	—	25 – 26
Tartaric acid, imported, powdered	lb.	—	26 – 29
Tartaric acid, domestic	lb.	—	— 30
Tungstic, per lb. of WO	lb.	—	1 00 – 1 10
Alcohol, ethyl	gal.	—	4 75 – 5 50
Alcohol, methyl (see methanol)		—	—
Alcohol, denatured, 188 proof No. 1	gal.	—	34 – 36
Alcohol, denatured, 188 proof No. 5	gal.	—	34 – 36
Alum, ammonia, lump	lb.	03½ – 03¾	04 – 04¼
Alum, potash, lump	lb.	03½ – 03½	03¾ – 05
Alum, chrome lump	lb.	07½ – 08	08¼ – 08½
Aluminum sulphate, commercial	100 lb.	1 65 – 1 85	1 90 – 2 40
Aluminum sulphate, iron free	lb.	02½ – 02¾	03 – 03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ – 07¾	08 – 08¼
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30 – 30½	31 – 33
Ammonium carbonate, powder	lb.	07 – 07½	08 – 09
Ammonium nitrate	lb.	06½ – 07	07¼ – 07¾
Amylacetate tech	gal.	—	2 00 – 2 40
Arsenic, white, powdered	lb.	07¼ – 07½	07½ – 08
Arsenic, red, powdered	lb.	12 – 12¼	12½ – 13
Barium chloride	ton	62 00 – 64 00	65 00 – 70 00
Barium dioxide (peroxide)	lb.	20 – 21	21¼ – 22
Barium nitrate	lb.	06½ – 07	07½ – 08½
Barium sulphate (precip.) (blanc fixe)	lb.	03¾ – 04	04¼ – 04½
Blanc fixe, dry	lb.	04 – 04½	—
Blanc fixe, pulp	ton	45 00 – 55 00	—
Bleaching powder	100 lb.	1 75 – 2 00	2 05 – 3.00
Blue vitriol (see copper sulphate)		—	—
Borax	lb.	05¼ – 05¾	06 – 06¾
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	20 – 21	21½ – 26
Calcium acetate	100 lbs.	1 75 – 2 00	—
Calcium carbide	lb.	04½ – 04¾	05 – 05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	01¾ – 02	02¼ – 02½
Calcium peroxide	lb.	—	1 40 – 1 50
Calcium phosphate, tribasic	lb.	—	15 – 16
Camphor	lb.	—	90 – 92
Carbon bisulphide	lb.	06 – 06½	06¾ – 07½
Carbon tetrachloride, drums	lb.	10½ – 10¾	11 – 12
Carbonyl chloride, (phosgene)	lb.	—	60 – 75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chalk, precip.—domestic, light	lb.	04½ – 04½	—
Chalk, precip.—domestic, heavy	lb.	03½ – 03¾	—
Chalk, precip.—imported, light	lb.	04½ – 05	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	06 – 06½	06¾ – 07
Chloroform	lb.	—	37 – 40
Cobalt oxide	lb.	—	2 00 – 2 10
Copperas	ton	15 00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	19 – 20	20½ – 21
Copper cyanide	lb.	—	58 – 60
Copper sulphate, crystals	100 lb.	5.55 – 5 65	5 70 – 6 25
Cream of tartar	lb.	—	23½ – 25
Epsom salt (see magnesium sulphate)		—	—
Ethyl acetate com. 85%	gal.	—	60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	—	93 – 1 00
Formaldehyde, 40 per cent	lb.	09 – 9½	09¾ – 10½
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	—
Fullers earth—imported powdered—net	ton	30 00 – 32.00	—
Fusel oil, ref	gal.	—	2 50 – 3 00
Fusel oil, crude	gal.	—	1 40 – 1 75
Glauber's salt (see sodium sulphate)		—	—
Glycerine, c. p. drums extra	lb.	—	16 – 17
Iodine, resublimed	lb.	—	4 05 – 4 15
Iron oxide, red	lb.	—	12 – 18
Lead acetate	lb.	—	09 – 11½
Lead arsenate, powd	lb.	15 – 15½	15¾ – 16½
Lead nitrate	lb.	—	15 – 20
Litharge	lb.	07½ – 07¾	08 – 08½
Magnesium carbonate, technical	lb.	06 – 06½	06¾ – 08
Magnesium sulphate, U. S. P.	100 lb.	2.65 – 2.70	2 75 – 3 00
Magnesium sulphate, technical	100 lb.	—	1 60 – 1 80
Methanol, 95%	gal.	—	57 – 58
Methanol, 97%	gal.	—	59 – 60
Nickel salt, double	lb.	—	11 – 11½
Nickel salt, single	lb.	—	11 – 11½
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	—	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	10⅜ – 10¼	10½ – 10¾
Potassium bromide, granular	lb.	—	.15 – .20
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04 – .04½	.04¼ – .05½
Potassium chlorate, crystals	lb.	.05¾ – .06	06¼ – .08
Potassium cyanide	lb.	—	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5 65 – 5 75	5.80 – 6.50
Potassium iodide	lb.	—	3.10 – 3.15
Potassium nitrate	lb.	.07⅞ – .07½	.08 – .09
Potassium permanganate	lb.	.13 – .14	.14½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	25½ – .26	.26¼ – 26½
Rochelle salts (see sodium potas tartrate)		—	—
Salammoniac, white, granular	lb.	.07 – .07¼	.07½ – .08
Salammoniac, gray, granular	lb.	.07 – 07¼	.07½ – .08
Salsoda	100 lb.	1.60 – 1.70	1 75 – 2 00
Salt cake (bulk)	ton	17.00 – 20.00	—
Soda ash, light	100 lb.	1.75 – 1.90	1.95 – 2 50
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04¼ – .04½	.04½ – 05
Sodium bicarbonate	100 lb.	2.10 – 2.15	2.20 – 2.50
Sodium bichromate	lb.	.07¼ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04½ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¼
Sodium chloride	long ton	12 00 – 13 00	—
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10¼ – .11
Sodium hydroxide (caustic soda)	100 lb.	3.65 – 3.70	3.75 – 4.25
Sodium hyposulphite	lb.	.03¼ – .03½	.03½ – .04
Sodium nitrite	lb.	.08½ – .08¾	09 – .09¼
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03 – .04	.04½ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	—	.18 – .21
Sodium prussiate, yellow	lb.	.18¼ – .18½	.18¾ – .19
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.50 – 2.60	2.65 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.15 – 1.25	1.30 – 1.90
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ – .04½	.04½ – .05
Sodium sulphite, crystals	lb.	.03½ – .03¾	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 – 20.00	—
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	—	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	—	2.00 – 2.75
Talc—imported	ton	30 00 – 40 00	—
Talc—domestic powdered	ton	18 00 – 25 00	—
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	—	.39 – .40
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran	lb.	.07½ – .08	.08¼ – .08¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.27 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97-99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.10 — 1.15
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.32 — .35
Dinitrophenol	lb.	.35 — .38
Dinitrotoluene	lb.	.22 — 24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — 80
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	.11½—	15
Pyridine	gal	1 75 —	2.75
Resorcinol, technical	lb.	1.25 —	1.30
Resorcinol, pure	lb.	1.80 —	1.95
Salicylic acid, tech., in bbls	lb.	.20 —	.21
Salicylic acid, U. S. P	lb.	.22 —	.23
Salol	lb.	.80 —	.82
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.25 —	.27
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	30 —	....

Waxes

Prices remain same as March 8th report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.25 —	5.30
Rosin E-I	280 lb.	5.35 —	5.40
Rosin K-N	280 lb.	6.00 —	6.75
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.88½ —	.....
Wood turpentine, steam dist	gal.	.85 —	.....
Wood turpentine, dest. dist	gal.	.70 —	.80
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.38 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla	gal.		35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium Sulphate, Bulk and F.A.S., 100 lb....$3.00-$3.15

Nitrate of Soda, 100 lb..... 2.80- 2.85

All other prices remain quotably unchanged.

Crude Rubber

Para—Upriver fine	lb.	$0.17½—	.17½
Upriver coarse	lb.	.13 —	.13½
Upriver caucho ball	lb.	.13 —	.13¼
Plantation—First latex crepe	lb.	.14¾—	.15
Ribbed smoked sheets	lb.	.15 —	.15¼
Brown crepe, thin, clean	lb.	.13 —	....
Amber crepe No. 1	lb.	.15 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10 —	$0.10¼
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls	lb.	.14 —	.14¼
Cocoanut oil, Ceylon grade, in bbls	lb.	.09¼ —	.09½
Coconut oil, Cochin grade, in bbls	lb.	.09¾ —	.10
Corn oil, crude, in bbls	lb.	.11¼ —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	.10 —	.10⅝
Cottonseed oil, summer yellow	lb.	.11¾ —	.12
Cottonseed oil, winter yellow	lb.	.13¼ —	.13½
Linseed oil, raw, car lots (domestic)	gal.	.84 —	.85
Linseed oil, raw, tank cars (domestic)	gal.	.80 —	.81
Linseed oil, in 5-bbl lots (domestic)	gal.	.87 —	.89
Olive oil, denatured	gal.	1.15 —	1.20
Palm, Lagos	lb.	.08½ —	.08½
Palm, Niger	lb.	.06½ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls	lb.	.13 —	.13¼
Rapeseed oil, refined in bbls	gal.	.86 —	.87
Rapeseed oil, blown, in bbls	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09½ —	....

FISH

Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. mills	net ton	17.00 —	23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00 —	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24 00
Barytes, crude f.o.b. mines	net ton	6.00 —	7.00
Casein	lb.	.10½ —	12
Shellac, orange fine	lb.	.78 —	.78½
Shellac, orange superfine	lb.	.80 —	.81
Shellac, A. C. garnet	lb.	.63 —	.64
Shellac, T. N	lb.	.76 —	.77

All other prices remain unchanged.

Refractories

Prices same as previous report.

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb	.11½—	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	59.00 —	60.00
Ferromanganese, 78-82% Mn, English and German c. i.f. Atlantic seaport	gross ton	58.00 —	62.50
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25 —	.....
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.37 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	.....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.55 —	3.75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19 00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	4.00 —	4.25
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24½—	.25
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.45 —	.45
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport.	unit	27.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.00 —	2.25
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.00 —	2.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½—	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.90
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29 00
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.40
Zinc, spot, New York	5.10
Zinc, spot, E. St. Louis	4.65

OTHER METALS

Silver (commercial)	oz.	$0.64¼
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	50.00

Finished metals, old metals and structural material quotations remain unchanged.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

ALTON—The Russell Clay Mfg. Co., Baltimore, Md., recently organized under Delaware laws, has acquired property at Alton, near Birmingham, for the operation of a new plant for the manufacture of vitrified paving brick and other burned clay products. It is planned to begin operations early in April, developing a capacity of about 50,000 bricks per day. The company is headed by L. S. Russell. Floyd B. Powell, Equitable Bldg., Baltimore, is manager.

CHOCTAW POINT—The Republic Creosoting Co. is planning for the rebuilding of the portion of its plant recently damaged by fire with loss estimated at about $12,000.

Arkansas

WALNUT RIDGE—The Industrial Bureau of the local Chamber of Commerce is perfecting plans for the establishment of a leather-tanning plant.

FORT SMITH—The Choctaw Brick & Gas Co., Kennedy Bldg., has acquired property at Mansfield, Ark., for the establishment of a plant for the manufacture of brick, tile and other burned clay products. Allen Kennedy is secretary.

California

RICHMOND—The Galena Signal Oil Co., Franklin, Pa., has acquired property at Richmond, comprising about 4 acres of land, near the works of the Standard Oil Co., for the erection of a new oil-refining plant, estimated to cost about $500,000. Construction will be commenced at an early date. Charles A. Miller, superintendent of the Franklin refinery, will be in charge of erection.

VERNON—The Pacific Petroleum Products Co. is planning for the rebuilding of the portion of its plant destroyed by fire, Feb. 16, with loss estimated at about $25,000.

LOS ANGELES—The Los Angeles Gas & Electric Co., 645 South Hill St., has had plans prepared for the erection of a 1-story compressor plant, 77 x 150 ft., on Center St., near Jackson St., to cost about $60,000, including machinery.

SAN FRANCISCO—The Los Angeles Soap Co., Los Angeles, has plans under way for the erection of a new 3-story and basement soap manufacturing plant, 100 x 160 ft., at 2nd and Brannan Sts., San Francisco, to cost about $150,000, including machinery. W. H. Crim, 425 Kearny St., San Francisco, is architect.

ALTURAS—The Stockton Match Co., Stockton, Cal., has acquired property at Alturas, as a site for the erection of a new plant. Plans will be prepared at an early date.

Delaware

WILMINGTON—The National Fibre & Insulation Co. has closed negotiations for the purchase of the plant and business of the American Vulcanized Fibre Co., Wilmington, Del., with branch factory at Newark, Del. The purchasing company will continue the operation of its present plant and headquarters at Yorklyn, Del., and will use the acquired plants as branches. General expansion in operation is planned. J. Warren Miller is president of the National company.

Florida

HIALEAH—The Hialeah Producing & Refining Co., 25 Second Ave., Miami, Fla., is planning for the erection of a new oil refinery at Hialeah, ner Miami, to cost about $200,000. It will be equipped for an initial output of approximately 1,000 bbl. per day. E. D. Noe is president.

Georgia

AUGUSTA—The Dunbar Brick Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about $20,000. H. H. Stafford is head.

Idaho

KELLOGG—The Bunker Hill & Sullivan Mining Co. will build a new electrolytic zinc plant addition to its local plant, estimated to cost about $1,000,000, including machinery. It is expected to require about 24 months to complete the mill.

Illinois

MATTESON—The Mid-West Box Co., 111 West Washington St., Chicago, Ill., has preliminary plans under way for the erection of a new chemical plant at Matteson, to be 3-story, 60 x 140 ft., estimated to cost about $300,000, including equipment. K. I. Herman, company address, is in charge. Harvey C. Miller, 112 West Adams St., Chicago, is architect.

CHICAGO—Ludwig & Ludwig, 1611 North Lincoln St., are planning for the erection of a 2-story addition, 25 x 65 ft., to their leather tannery, estimated to cost about $25,000. Axel V. Teisen, 4804 North Kedzie Ave., is architect.

Indiana

COLUMBUS—With the dismissal of the receiver for the Indiana Oil Refining Co. and the return of the property to the company, plans are being arranged for the completion of its new oil-refining plant on property to the south of the city limits. The work is estimated to cost about $75,000. It is expected to have the refinery ready for service in about 60 days. Louis J. Scheidt is president.

FAIRMOUNT—The Fairmount Paper Products Co. will soon begin the erection of a new plant on Adams St., for the manufacture of paper specialties of various kinds. Harry Dwyer, Marion, Ind., is president and general manager.

VALPARAISO—The Chesterton China Co. is completing the erection of a new plant and plans to begin service in a portion of the works at an early date. Two of five kilns have been completed. It is expected to have the entire plant ready for capacity production early in the summer, giving employment to about 500 persons.

Iowa

FIGART—The Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh, Pa., has preliminary plans under consideration for the construction of a new plant at Figart, for the manufacture of firebrick and other refractories.

Kansas

COFFEYVILLE—The Sinclair Refining Co., 111 West Washington St., Chicago, Ill., will proceed at once with the erection of its new local oil refinery, upon which work was temporarily discontinued recently owing to labor difficulties. The company has arranged an appropriation of $3,000,000 for work on the refinery and affiliated structures during the present year.

Kentucky

LOUISVILLE—The Peaslee-Gaulbert Co., 15th and High Sts., manufacturer of paints, varnishes, etc., is planning for the erection of a plant addition to cost about $100,000, including equipment.

Louisiana

LAFAYETTE—The Benners Salt Co. has been reorganized under the name of the Lafayette Salt Co., with increase in capital to $500,000. The company plans for expansion at its plant at Anse La Butte, La., and will install equipment for increased production. J. J. Kean is manager.

Maine

BRIDGTON—The Simes Leather Co. has acquired the local tanning plant of A. G. Walton & Co., which has been closed for about 5 years. The new owner will remodel and improve the tannery, and plans to commence production at an early date. The former capacity will be increased.

Maryland

BALTIMORE—The Rennous-Kleinle Division of the Pittsburgh Plate Glass Co., 3221 Frederick Ave., is planning for the erection of a 4-story addition to its plant, 75 x 205 ft., to be equipped primarily for the manufacture of plate glass.

BALTIMORE—The Aromo Mfg. Co., 308 South Hanover St., recently organized with a capital of $100,000, is arranging for the establishment of a new plant for the manufacture of chemicals and affiliated products. Bids for equipment will be asked at an early date, including chemical machinery, mixing equipment, filtration apparatus, etc. Morris Bernstein is president, and Arthur W. Smith, vice-president and manager.

Michigan

PONTIAC—The Corodium Sand Brick Co., recently organized, has plans under way for the erection of a new plant on local property, and will break ground at an early date.

PORT HURON—The New Egyptian Portland Cement Co. has work under way on the remodeling and improving of the local shops of the Grand Trunk Railway Co., for a new cement mill, and will commence the installation of machinery at an early date. The property was acquired recently. Headquarters of the company are at 1213 Ford Bldg., Detroit. John Gillespie is president.

Missouri

MONETT—The Hammond Dehydration Co., J. H. Elpass, manager, will postpone for a number of months the erection of its proposed new plant, estimated to cost about $50,000. Heckenlively & Mark, 642 Landers Bldg., Springfield, Mo., are architects.

New Jersey

BUTLER—The Bloomingdale Rubber Co. will make a number of improvements in its local plant for the manufacture of rubber specialties, and will remove the reclaimed rubber department to its works at Chester, N. J. The local plant will be enlarged and employment given to about 50 additional persons.

SAYREVILLE—Fire Feb. 25 destroyed a portion of the plant of the Sayre & Fisher Co., manufacturer of brick and other burned clay products, with loss estimated at about $40,000.

TRENTON—The Henry R. Fell Co., East Carroll St., manufacturer of concrete roofing tile, will install additional equipment for increased production. J. Henry Fell is head.

New York

BROOKLYN—Fire Feb. 23 destroyed a portion of the plant of the Williamsburg Chemical Co., 230-2 Morgan Ave. An official estimate of loss has not been made.

BROOKLYN—J. M. Huber, 602 62nd St., manufacturer of colors, etc., has awarded a contract to Smith & Leo, 103 Park Ave., New York, for the erection of a 2-story addition, 36 x 52 ft., at the corner of 62nd St. and 6th Ave.

Pennsylvania

ELIZABETHTOWN—The Farmers' Fertilizer Works, William Schneitman, head, will soon commence the erection of a new plant building, 1-story, 90 x 140 ft.

PHILADELPHIA—The Wittman Moriarty Co., 4th and Vine Sts., manufacturer of leather products, has acquired property at Westmoreland and B Sts., as a site for the construction of a new plant, 75 x 105 ft., estimated cost $75,000. The tract totals 240 x 350 ft., for future expansion, and was secured for a consideration of about $30,000.

Tennessee

MEMPHIS—The National Waterproofing Co. is planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at about $175,000.

Texas

EASTLAND—Butler Bros. have acquired property on the J. L. Johnson tract, near the city limits, as a site for the immediate erection of a new gasoline absorption plant, with capacity of about 12,000 gal. per day. It will cost about $300,000. This will be the first of a series of plants to be established by the company, with complete cost estimated at $1,500,000.

Washington

SPOKANE—The Standard Stoneware Co., Spokane, Wash., is planning for the erection of a new pottery for the manufacture of earthenware and stoneware products, to cost about $25,000. Charles Stormes is head.

Capital Increases, etc.

THE FILER FIBRE CO., Filer City, Mich., manufacturer of fiber products, has filed notice of increase in capital from $450,000 to $1,000,000.

THE SCOTT TILE CO., Paris, Tex., manufacturer of ceramic tile, has filed notice of increase in capital from $15,000 to $35,000.

THE ATOMIZED PRODUCTS CO., Evansville, Ind., has filed notice of increase in capital from $200,000 to $500,000.

THE SLAYMAKER ELECTRIC WELDING CO., Detroit, Mich., has filed notice of increase in capital from $28,000 to $50,000.

THE OXFORD PAPER CO., Rumford, Me., has arranged for a bond issue of $5,000,000, the proceeds to be used for general operations. The company has completed negotiations for the purchase of the Rumford Falls Power Co. James A. Harris is general manager.

THE INDIAHOMA REFINING CO., operating oil refineries at East St. Louis, Ill., and Okmulgee, Okla., has arranged for a note issue of $900,000, for general operations, financing, etc.

Robert C. Rand has been appointed receiver for the ARISTA CHEMICAL CO., 305 Broadway, New York, N. Y.

THE HARBISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., manufacturer of firebrick and other refractory products, has arranged for a decrease in capital from $36,600,000 to $30,000,000. A special meeting of stockholders will be held on March 16.

Plans are being perfected for a merger of the BUTTE-BULLWHACKER CO., and the BUTTE-DULUTH COPPER CO., both of Butte, Mont., operating local copper-leaching plants.

THE MCGEARY FIREBRICK CO., Pittsburgh, Pa., has filed notice of dissolution under state laws.

THE OWOSSO BRONZE BEARING CO., Owosso, Mich., has filed notice of dissolution under state laws.

THE EXCELL BRASS FOUNDRY, 819 Frelinghuysen Ave., Newark, N. J., has filed notice of organization to manufacture brass, bronze and other metal castings. Thomas Proctor heads the company.

THE WALDO OIL CO., New York, N. Y., has been incorporated under Delaware laws, with a capital of $100,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

New Companies

THE MICHIGAN PORCELAIN TILE WORKS, INC., Ionia, Mich., has been incorporated with a capital of $100,000, to manufacture floor and wall tile and other ceramic products. The incorporators are Royal A. Hawley, Harry E. Kidder and T. B. Duston, all of Ionia. The company will build a local plant.

THE SANITARY FIBER CO., 342 South Hoyne Ave., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture fiber products. The incorporators are William W. Newell, R. F. Locke and Frank L. Childs.

H. F. SOMMER & CO., INC., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture leather products. The incorporators are Harry F., J. F. and William M. Sommer. The company is represented by Bilder & Bilder, 790 Broad St., Newark.

THE ALLIED PAPER MILLS, INC., New York, N. Y., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture paper products. The incorporators are S. B. Monroe, A. C. Gilman and F. A. Wagner. The company is represented by Davis, Wagner, Hester & Holton, Mutual Life Bldg., New York.

THE WON-DA PRODUCTS CO., INC., Hartford, Conn., has been incorporated with a capital of $100,000, to manufacture soaps, oils, compounds, etc. The incorporators are H. L. Rose, A. Goldberg and Richard Ryder, 46 Capen St., Hartford.

THE PURITAN REFINING CO., New York, N. Y., has been incorporated under Delaware laws with capital of $100,000, to manufacture refined oil products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE OIL CITY LUBRICANTS CORP., 1401 Madison Ave., Baltimore, Md., has been incorporated with a capital of $50,000, to manufacture oils, greases, etc. The incorporators are William S., F. A. and W. W. Paca.

THE UNDERCOAT PAINT CO., New York, N. Y., has been incorporated with a capital of $35,000, to manufacture paints, varnishes, etc. The incorporators are N. C. Latter, L. F. Kuntz and T. C. Tocknell. The company is represented by H. W. Kiralfy, 565 Fifth Ave., New York.

THE METUCHEN DYESTUFF CORP., Metuchen, N. J., has been incorporated with a capital of $100,000, to manufacture colors, dyes, chemicals, etc. The incorporators are Saul Ceasar, Albert G. Rich and Alexander C. Connor, Durham Ave., Metuchen.

THE CONTINENTAL LEATHER CO., Wilmington, Del., has been incorporated under Delaware laws with capital of $7,500,000, to manufacture leather products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE NONTOXO CHEMICAL CO., South Bend, Ind., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are John A. King, M. G. Mock and Louis J. Smith, all of South Bend.

THE PLEASANT LAKE MARL CO., Three Rivers, Mich., has been incorporated with a capital of $5,000, to manufacture lime and fertilizer products. The incorporators are Oliver T. Avery, F. A. Rohrer and M. W. Lott, all of Three Rivers.

THE ESSEX PAPER PRODUCTS CO., Lawrence, Mass., has been incorporated with a capital of $25,000, to manufacture paper goods. Albert J. Quimby is president, and Daniel J. Crowley, Jr., Lawrence, treasurer.

THE GRAHAM REFINING CO., Graham, Tex., has been incorporated with a capital of $30,000, to manufacture refined oil products. The incorporators are M. K. Graham, J. C. Kilgore and Thomas Morrises, all of Graham.

THE CONSUMERS' COLOR & CHEMICAL CO., 1823 West Lake St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are Adam Heckmann, Samuel J. Hefti and Gustav Ruchheit.

THE BALTIMORE CEMENT PRODUCTS CO., INC., 525 Overland Ave., Baltimore, Md., has been incorporated with a capital of $25,000, to manufacture brick, pipe, blocks and kindred products. The incorporators are Herbert L. and D. Lee Bowen, and George S. Hiller.

THE MATAWAN COLOR CO., Matawan Park, Matawan, N. J., has been incorporated with a capital of 500 shares of stock, no par value, to manufacture chemicals, colors, etc. The company is represented by Arthur W. Britton, 65 Cedar St., New York, N. Y.

THE BELLROSE STANDARD SILICA CO., Ottawa, Ill., has been incorporated with a capital of 3,500 shares of stock, no par value, to manufacture silica products. The incorporators are Robert O. Farrell, Holland M. Cassidy and Jesse Halsted, Ottawa. The company is represented by Chapman, Cutler & Parker, 111 West Monroe St., Chicago, Ill.

THE GOLD SEAL OIL CO., Reading, Pa., has been incorporated with a capital of $110,000, under Delaware laws, to manufacture petroleum products. The incorporators are Charles E. Keyee, Reading; Samuel T. Newhardt and Paul F. Erdman, Allentown, Pa. The company is represented by the Corporation Service Co., Wilmington, Del.

THE GOHEEN CORP. OF NEW JERSEY, Newark, N. J., has been incorporated with a capital of $20,000, to manufacture paints, varnishes, etc. The incorporators are S. Michael Cohen, Manuel M. Voitt and Nathaniel X. LePeau, 202 Emmet St., Newark.

THE LOUIS MESKAN BRASS FOUNDRY, INC., 422 South Robey St., Chicago, Ill., has been incorporated with a capital of $12,000, to manufacture brass, bronze and other metal castings. The incorporators are Louis Meskan and Edward Schauble.

THE BLUE DIAMOND MORTAR CO., 1007 Candler Bldg., Atlanta, Ga., has been incorporated with a capital of $150,000, to manufacture lime and affiliated products. A. P. McCallie is president and general manager; and B. Graham West, secretary and treasurer.

THE KEYSTONE REFINING CO., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture oil products. The incorporators are C. D. and D. Flanel, and S. Glaser. The company is represented by E. M. Ostrow, 63 Park Row, New York.

THE RODGERS PRINTING INK CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture inks and affiliated products. The incorporators are J. E. and J. M. Rodgers, and T. F. Torley. The company is represented by J. A. Turley, 233 Broadway, New York.

CHRISTIAN FLEISSNER, INC., Newark, N. J., has been incorporated with a capital of $150,000, to manufacture leather products. The incorporators are A. Fleissner, H. Croan and Christian Fleissner, 125 New Jersey Railroad Ave., Newark.

THE OSSIE OIL CO., Tulsa, Okla., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are T. B. Reese, Eugene DeBorgory and W. Shilig, all of Tulsa.

THE UNITED STATES REFRACTORIES CO., INC., Boston, Mass., has been incorporated with a capital of $200,000, to manufacture firebrick and other refractory products. Arthur W. Leavitt is president; and Dagmar Anderson, Dorchester, Mass., treasurer.

THE LIBERTY COLOR & CHEMICAL CO., Philadelphia, Pa., has been incorporated with a capital of $25,000, to manufacture chemicals, chemical byproducts, etc. Thomas D. O'Brien, 3911 North Park Ave., Philadelphia, is treasurer.

THE COMMERCIAL CHEMICAL CO. OF TENNESSEE, Nashville, Tenn., has been incorporated with a capital of $2,500,000, under Delaware laws, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE NEW SOUTHERN OIL CO., Dallas, Tex., has been incorporated with a capital of $75,000, to manufacture petroleum products. The incorporators are C. U. Connellee and O. B. Colquitt, both of Dallas.

THE ORA-LEE CO., Wilkes-Barre, Pa., has been incorporated with a capital of $30,000, to manufacture extracts, compounds, etc. John M. Walsh, Wilkes-Barre, is treasurer.

WISS SONS, INC., Newark, N. J., has been incorporated with a capital of $300,000, to manufacture glass products. The incorporators are Frederick, C. J. and Jerome B. Wiss, 665 Broad St., Newark.

THE MAMMOTH OIL CO., Wilmington, Del., has been incorporated with a capital of $100,000,000, under Delaware laws, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

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The Explosibility Of Ammonium Nitrate

WHEN the nitrogen fixation works of the Badische Company at Oppau were destroyed by a tremendous explosion last September, the interest of American scientists and manufacturers of explosives was immediately aroused on account of the apparently mysterious cause of the disaster. It was known in a general way what was going on at Oppau—the fixation of atmospheric nitrogen by the Haber process and the manufacture of nitrogen fertilizers, among which was a combination of ammonium nitrate and ammonium sulphate—and yet no valid reason could be assigned for the explosion. Although it was ascertained subsequently that the explosive decomposition of 4,500 tons of sulphonitrate of ammonia was responsible for the disaster, the cause is still unexplained. Investigations begun abroad and in this country are still in process from which it is hoped information will be derived not only to serve as an explanation of what happened at Oppau but to guide us in our own development and use of synthetic nitrogen fertilizers. The investigations are of particular importance in view of the rapidly expanding use of ammonium nitrate.

In our attempts to throw as much light as possible on the explosion we gathered material from various sources, and in an editorial comment on November 2, 1921, we made the following statement:

> Furthermore we are confronted with the fact that ammonium nitrate itself is something of a mystery. Those who know anything about powder plants cannot help recalling instances when it acted as it shouldn't. We are told that once upon a time, of twenty vessels working up ammonium nitrate, No. 6 and No. 18 suddenly exploded, demolishing several others. At the same instant some barrels of nitrate in a storage shed went off and only scattered holes in the ground were left to mark the places where they stood. Surrounding barrels were broken and charred, but did not explode.

The purport of our comment was to convey an idea that we found prevalent—namely, that there was a general lack of precise knowledge of the properties of ammonium nitrate and that consequently it was "something of a mystery" with regard to its explosibility. It appears, however, that our opinion was interpreted as meaning that one could not tell under what conditions ammonium nitrate might explode and that, therefore, there were some inherent and unknown dangers in its manufacture, transportation, handling and storage. This, of course, was a misinterpretation of our thought, because as far as we were then or are now aware, ammonium nitrate is explosive only under exceptional conditions of high pressure and powerful detonation. Our comment was, however, open to this criticism: That due to lack of complete information we made it appear that the two explosions mentioned were almost simultaneous, one dependent on the other, whereas they were widely separated, not only as to time but also as to locality.

What are the facts as to the explosibility of ammonium nitrate? Considering the apparent lack of precise knowledge of its properties and behavior, it seemed advisable, in the interest of scientific accuracy as well as industrial progress, to obtain from an authoritative source an article embodying our present knowledge of the material and of explosions in which it has played a part. Such an article is published in this issue from the pen of Dr. CHARLES E. MUNROE, Chairman of the Committee on Explosives Investigations, National Research Council. The merit of Dr. MUNROE'S article will be apparent to all who read it, but we may indicate some of its points of excellence. In the first place, it is a complete compilation of the known properties and behavior of ammonium nitrate; second, it embodies the only authoritative statements that have ever been published regarding four important disasters in which ammonium nitrate played a part; and third, it gives the results of tests on the explosibility of ammonium nitrate made in this country after the Oppau disaster. It will thus be seen that the article is an important contribution to our knowledge of the subject, and we believe there can be no dissension from the conclusions of the author, that while ammonium nitrate offers a fire hazard, it cannot be regarded as an explosive *per se* under ordinary conditions of transportation and storage.

Effectively Crippling Chemical Warfare Service

THE appropriation of half a million dollars for the next fiscal year's work of the Chemical Warfare Service was well characterized by one prominent government official as "absurdly small." This sum is wholly inadequate to the responsibility which is placed upon this branch of the Army, and it is to be hoped that the House of Representatives or the Senate will find occasion to increase this sum, which has just been recommended by the House Committee on Appropriations.

The report of this committee includes the following comment:

> The budget estimate for Chemical Warfare Service was $1,500,000, which was later reduced to $500,000 in view of present conditions. The latter amount is recommended by the committee to provide for a minimum amount of development work and training along lines compatible with present conditions, and maintaining Edgewood Arsenal in stand-by condition.

Behind this statement there is a bit of interesting history. The budget estimate was for continuance of C.W.S. on the same basis as recommended a year ago, but during the hearings on the bill certain officials in the War Department and the Army appeared before the Congressional sub-committee which was holding hearings and changed the basis of the recommendation. It is understood that they not only reduced to one-third the appropriation originally requested but also urged that C.W.S. be abolished and that the smaller sum recom-

mended be granted to the Ordnance Department, which, in their judgment, should do the work now under C.W.S.

In the course of writing the treaties at the Conference for the Limitation of Armaments, it became evident that the Chemical Warfare Service had influential enemies in high position; recent developments emphasize this fact. These officials apparently have succeeded now in making a move for crippling the Service.

The chemical industries of the country have come to look upon the Chemical Warfare Service as one of the links in our chain of industrial chemical activities. Our industries cannot view without apprehension any curtailment of the fundamental research and development activities of C.W.S. Chemists know too well from experience that the development of chemical agencies of attack or defense is not the work of days or weeks, but rather of months and years. They know how foolhardy it is for our nation to remain unprepared in matters such as this. They know that only chemists working under sympathetic supervision of other chemists can maintain the intimate acquaintance with chemical industry upon which chemical warfare of the future will so much depend if the occasion ever should arise for this type of military activity.

The officers of the Chemical Warfare Service are keenly alive to the seriousness of the situation. They are doing everything in their power to present fully to our legislators the pertinent facts. But they need and well deserve the co-operation of chemists and chemical industry generally. These latter must make it known that they do not regard as a safe procedure the curtailment of chemical warfare studies in any such ruthless manner as this. Moreover, they should make it evident to Congress that such curtailment is false economy, for through no other arm of the service can the defense of the country be so cheaply and effectively planned. Studies for defense are not prohibited by the letter or spirit of the pending treaty.

"Not Much Hope For Better Cement"

THIS is the heading under which one of the leading engineering and construction journals of the country recently presented a portion of its editorial review on concrete and cement. It is unfortunate that engineers who use most of the cement in the United States should be given this impression. Certainly the chemical industries in general, and the cement industry in particular, are not prepared to admit that there is no further opportunity for improvement of portland cement.

The review in question acknowledged that practically all commercial supplies of cement pass the present standard specifications and that proper use would almost invariably insure a certain strength of construction. However satisfactory this condition may be in general, it is not a welcome thing to have the added thought expressed "that the cement makers themselves are satisfied with the present situation, and that they are more anxious to preserve the present standard specification than to get a better product." It may be that a few in the business would be willing to take such a stand privately, but it is certain that there are in the portland cement industry of today those who are not content to permit this product, good as it is, to remain indefinitely of only the present standard of value.

Standard specifications of the sort which are now widely used for cement are certainly much more satisfactory than the many diverse specifications which were common 10 or 20 years ago. But present standards must not become a deadening influence on the industry. Progress must be maintained. And progress means continued increase in the rigidity of the specifications.

Any industry which would accept without challenge such a charge as has been made against cement would soon find itself supplanted by newcomers in the business or by other branches of industry which would furnish substitute products. Research is essential to progress in any business, and research must and will continue regarding materials, methods and marketing of portland cement. It is to be hoped that this criticism, which we believe is unjust, may prove an added stimulus to the industry for greater advancement.

A Suggestion for Fixing Wage Scales

ON MARCH 4 the Chemists' Club of New York had one of its several Saturday luncheons with speakers who are guaranteed not to be chemists. On this occasion IVY LEE, adviser to the Association of Railway Presidents in matters of publicity, spoke on "The Railroad Situation," and HUGH FRAYNE, organizer for the American Federation of Labor, on "What Labor Wants."

Both talked about wages, and they were in entire accord about the Railway Labor Board. Both agreed that the very presence of such a tribunal invited dispute, and that before a tribunal each side is likely to present maximum claims as minima—in other words, to bid high for itself. They were in agreement also that the best settlers of problems at issue are the interested parties themselves.

We have not space to review the many other features of the railroad situation brought out by Mr. LEE, or to record their sometimes sympathetic and sometimes opposing views in regard to the problems of labor. But to an attentive listener it seemed that both were talking around the fringes of applied psychology.

There is the unsolved problem of the feeble-minded in the ranks of labor. That was not discussed. It stands to reason, however, that they naturally gravitate to those occupations that do not call for mentality in work and that, like children, these defectives keep organized labor "in wrong" by their frequent breaches of agreement and their resorts to violence.

We believe, however, that the opportunity offers itself for a step in advance in the interest of both employers and organized labor, although it would have to be tried out in some establishment in which the employer and his organized workmen are on terms of cordial amity. There must be confidence on all sides for the experiment to be tried. Then the employer can say to the representatives of his men:

"We have a payroll of n dollars a week, and what I propose will not change that. And I do not propose any changes in the hours of labor. But in fixing rates of pay and in all our agreements, we have both been guessing. We have guessed and compromised to reach our present scale. We do not really know the comparative value of the service done in the various jobs in these works. Applied psychology can integrate these various parts of the work and fix comparative values. I propose to get from President ANGELL of Yale or President HAMERSCHLAG of Carnegie Tech of Pittsburgh, or from somebody else, a couple of good, experienced psychologists to come here and make a study of a comparative wage scale for our work. They won't

know anything until they have been here for several months. After they have made their study, however, they are to make their report and then let us take it up together. We shall not propose to cut wages for any job below an agreed minimum, but I want to know which positions carry the responsibility and to put a premium on these. I want also to know which positions do not call for thinking, and to keep them for our men who can't remember or can't see ahead. I shall not attempt to put through any new schedule until we have agreed on it, and I want you men to make this study with me."

By this means he would provide better pay for his more competent and ambitious men. He would take care of the incompetents who now drag the others down. He would establish an *esprit de corps* that would otherwise be unavailable. And he would do more for organized labor if he were to work this problem out with his men than forty new laws and a hundred strikes.

A Short Road To Fame

THERE was a time when it seemed to us that the peak of fame was attained when a locomotive with red wheels and brass trimmings was named for a man. With increasing stature our taste in fame changed, and we thought if our name were used for a good, free-smoking 5 cent cigar, for the purpose of drawing custom to it, that would represent popularity if not fame. Now with the mask of age grinning in the western offing our ambitions have become less definite.

But here is a new opportunity to make a name known. The chemical laboratories of the leading Polish universities and polytechnic institutes are without equipment. Every bit of platinum and all apparatus and reagents have been taken away by the armies that passed through. The students are there, and so are the professors, but they can't demonstrate, and they can't buy anything with Polish marks, and Polish marks are all they have. These are the universities of Lwow (Lemberg), Warsaw, Cracow, Posen and Wilno, and the Polytechnic Institutes at Lwow and Warsaw. At the current rate of exchange all their chemical laboratories could be generally equipped for about ten thousand dollars. The country is very democratic; they haven't any Order of the Green Eagle of the Sixth Class or Knighthood of the Royal Shoe Lace or other decorations to bestow. But they would put up a tablet in each laboratory, worded in Polish somewhat to this effect: "This laboratory was equipped after the devastation of war through the generosity of JOHN JONES, president of the Jones Company, Jonesville, Ohio, U.S.A." Then generations of educated Poles would honor and respect his name in enduring gratitude. It would be known throughout Poland. There would be Jones legends and Jones myths, all told with a whizzing and skyrocketing accompaniment of consonants in the Polish language. They would burn candles in memory of him when he died, and call their babies after him. He would stride down the aisle of Fame as the Benefactor of Science in Poland.

Any sum may be sent to HUGH GIBSON, U. S. Minister to Poland in Warsaw, for the purpose named, to be distributed through the Mianowski Foundation, of which the director is Dr. S. MICHALSKI, Vice-Minister of Education, and the Council is made up of representatives of the different universities.

How Did the 1919-20 Boom Happen?

WHEN business began tapering off in the latter part of 1920 the talk immediately arose that there was "a strike of buyers" and when business began to appear really stagnant a common remark was that resumption of activity merely awaited the quoting of lower prices—that men knew just what they were waiting for. Apparently we had the situation "doped out" pretty well.

More recently, however, there is a new view. There is not going to be a return to 1919-20 conditions, minus fancy prices. It is proved to be impossible to do that. We cannot have a much higher scale of living than we had before the war, and we may not be able to have even as good a scale, until we have made up for the waste of war. We shall have to work harder and more efficiently in order to get along at all.

The new teaching is very logical and appealing. It appears to hang together very nicely and to be in harmony with all the known facts, with one exception. The exception is that if these things are impossible, a better scale of living, more income with less work and all that sort of thing, how is it that it did happen in 1919 and 1920?

A partial but more than a 50 per cent answer is that it didn't. We did not have nearly as great industrial activity in 1919 and 1920 as we thought we had. We took our cue altogether too much from prices, judging that because a material was high priced it was in very heavy demand and that demand was outrunning supply. In many cases the supply was not large, and part of it was held back by speculators. Then, furthermore, we judged the physical volume of trade too much by the money standard. Reduced to physical units the quantity of business was not so large. Applying to the record of money turnover, as shown by debits to individual accounts at banks, a correction on account of prices and inflated values, it appears as if the physical volume of business was less in 1920 than in 1919 and that in 1921 it was larger than in 1920.

The explanation of the 1919-20 industrial activity—that it didn't occur—is incomplete. All the rest of the answer may not be available at the moment, but some further explanation of the phenomenon can be found. We had what appeared to be an active and profitable export trade, but the records show that a large part of the exported merchandise has not been paid for. According to the Federal Reserve Board's investigation, about three billion dollars of unfunded balance due to the United States accumulated during 1919 and 1920. We did not know at the time that we were not going to be paid with reasonable promptness, and in respect of this amount we were less prosperous than our imagination led us to believe.

Then we had some fictitious prosperity through the spending of what were considered profits made during the war, both before and after the United States entered. In numerous cases high prices were paid for commodities, the extra price being paid to reimburse the producer for the cost of additional plant facilities which would be more or less valueless after the war, but the recipients called the money real profits and did not apply it to writing down the property account.

In time it will no doubt be possible to explain away the apparent boom in 1919 and 1920, but we know enough already to be willing to admit that positively we cannot, in consequence of a great war, consume more in proportion to what we produce than we used to do.

Readers' Views and Comments

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having read the editorial in your issue of Feb. 22, page 338, and the comments of Wellington Gustin, page 341, I would like to point out to you that there is considerably more in this question than is indicated either in the editorial or in the communication referred to.

In the first place, if you will refer to "American and English Decisions in Equity," vol. 9, you will find that the appellate courts have decided such subjects as "Property Rights in Trade Secrets," "Who May Be Enjoined From Using or Disclosing Trade Secrets," "Contracts Not to Use or Communicate Trade Secrets," "Implied Contract Not to Divulge Trade Secrets," "Use of Knowledge Acquired During Employment" and the "Status of an Employee Who Discovers Secrets," together with many other decisions which more or less form complete information on the subject referred to.

I have in mind two cases which I arbitrated which come under this particular heading.

A certain firm engaged a chemist to make for it a number of improvements in one of its processes. This the chemist did and during the course of his work he made some important discoveries, which he patented. Before going to law in the first case, both the chemist and the employer decided to permit me to arbitrate the case, and I decided in favor of the chemist on the ground that he rendered useful service for the wages he received and that he was entitled to extra recompense for the intellectual property which he possessed, and the case was very satisfactorily settled, the chemist turning over the patents for what I considered a reasonable sum.

In another instance an improvement was made in a piece of apparatus which rightfully belonged to a chemist who had worked it out during his employment, and I again decided in favor of the chemist on the ground that he had given full value for the wages he obtained in the first place, and in the second place there was no contract between employer and employee which implied that the chemist was to turn over without consideration any invention that he should make. On the other hand, there is a well-known implication of law which works the other way, that no chemist after he leaves the corporation can make use of a process which he has learned during the time that he is employed. The rule in equity which is followed in this case is that when you engage a butler you do not tell him that he must not steal your silver, for such a condition is implied, so that anyone leaving a corporation's employ and taking with him intellectual property which he has acquired without any efforts of his own is clearly not entitled to use such information for his own benefit.

The whole question may be summed up into this, that chemists and other intelligent employees are engaged verbally or by written contract, and the question of intellectual property is seldom entered into. If a man obtains a position and gets a fair salary and makes a contract in writing that he will turn over all his discoveries in consideration for the salary he obtains, the decision in a case of that kind must be very obvious, but where nothing is stated, and where both parties are fair, it is very simple to arrive at a just conclusion, as in the two cases which came before my notice.

I have always contended that every professional man ought to listen to a six months' course of lectures on contracts during or directly after his college course.

New York City. MAXIMILIAN TOCH.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I wish to write you regarding your editorial on "When Does an Employment Contract Terminate?" in the issue of Feb. 22 and the interesting comment on it made by your Chicago correspondent in the same issue.

This writing of proper contracts is difficult. If in error, they have been generally unfair to the technical employee rather than to the corporation. About the only constructive criticism I have heard, other than that given by your Chicago correspondent, has been that the American Chemical Society or perhaps the more progressive and smaller organization, the American Institute of Chemical Engineers, should employ an attorney to get out forms of standardized contracts and also should arrange for this attorney to advise any chemist or chemical engineer as to proper types of contracts or as to the true meaning of contracts which are offered him by a corporation. It seems to me that it ought to be possible without great difficulty to get typical standardized contract forms which would be fair to both the technical man and the employer. RALPH H. MCKEE.

Department of Chemical Engineering,
Columbia University,
New York City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I read with considerable interest your editorial and comment regarding the relation of a chemist to his former employer.

When a man is doing research work, this research work is rather specific. He is either working on a particular compound or group of compounds, or on a particular reaction. The chemist brings to this work certain training and experience. The employer brings, we will say, certain private plant information and commercial knowledge. They work together on some agreed-on basis, and the results of the work, whatever they are, belong to the employer. Suppose the chemist quits or loses his job. What is his status? He has the same training and equipment as he had before he started on this particular piece of work, and he has in addition the advantage of experience in doing the work. The employer has taken nothing from him but the results of a particular piece of work, and presumably it was agreed in advance, for a definite remuneration, that these results should belong to the employer. The chemist is now free to find another job, and as far as I can see the whole field of chemistry is open to him without question, excepting the specific reaction or the specific compound or group of compounds on which he worked for this employer.

In long experience as a consultant with many employers I have never had a difference of opinion with any of them as to what lines it would be proper for me

to follow and what lines I should not follow in view of the work I had done for them and the private information they had necessarily given me. In dealing with chemists who work for me or under me, I have never had a difference of opinion either. In this latter case I ordinarily ask the men to refrain for 3 years from working on the particular problem on which they were doing research work for me. This is no limit of any consequence to the usefulness of the chemist or the broadness of his field of work, and sufficiently protects the employer. If there is a clear understanding at the outset of the work as to what the arrangement is under which the work is being done, and any tendency to be fair on both sides, no real question of conduct will arise at all. JOHN E. TEEPLE.

New York City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read both articles in CHEMICAL & METALLURGICAL ENGINEERING on "When Does an Employment Contract Terminate?" and I feel that there is a certain injustice in the rigid conditions that are often incorporated in the employment contracts of chemists and chemical engineers, but there are two sides to this question.

With a chemist who has actually brought something to his employer which is his own work and his own idea, the chances that his services will be dispensed with are very slight. Even under present heart-breaking conditions when it is imperative to reduce expenses to a minimum to safeguard the future of many establishments, he is likely to be retained. Such men in addition to a salary are as a rule given a share of the profits or savings of their invention and these payments continue for stipulated periods if for one reason or another they sever their connections with the firm.

If, on the other hand, a young man is taken into a laboratory or works where secret processes are in operation, with the development of which he has had nothing to do but with which he is made familiar in order to supervise their working, I think it is perfectly fair that he should be restrained from using such knowledge for his own benefit or that of others. Often such processes are based on the preliminary work on other products produced by his employer and are the result of years of untiring labor and the expenditure of vast sums.

In such cases a contract prohibiting him from engaging in work of a similar nature for a period of years is perfectly fair and equitable. F. G. ZINNSER.

Hastings-on-Hudson, N. Y.

The Needy Russian Scientists and Men of Letters

To the Editor of Chemical & Metallurgical Engineering

SIR:—In several of your editorials you have called attention to the suffering Russian scientists, suggesting that something be done to relieve their sad condition. I do not know whether there were any responses to your call, but if there were not it may not be for lack of sympathy or desire to help the starving Russian scientists, but rather on account of the uncertainty whether the help would reach them.

In view of the above I wish to call attention to the possibility of sending food products now through the American Relief Administration (Hoover's organization). This organization accepts money in units of $10 and through its agents in Russia delivers an equivalent in food products to the persons designated. Food can be sent to individuals or to the Mutual Aid Society of Scientists and Men of Letters. The address is as follows: House of Science, Basseynaya 11, Petrograd, Russia. Individuals can be reached at the same address.

Food remittance blanks can be obtained in most of the banks or directly from the American Relief Administration, Russian Food Remittance Department, 42 Broadway, New York City. IVAN M. BREGOWSKY.

Chicago, Ill.

The Manhood of Humanity

To the Editor of Chemical & Metallurgical Engineering

SIR:—I rather feared that somebody would take exception to my praise of Korzybski's book called "The Manhood of Humanity, or Human Engineering." It has been the subject of considerable disagreement between just such competent and level-headed persons as Mr. McDonald and Prof. Cassius J. Keyser. Then there are the rest of us who, without distinction as to our merits as thoughtful readers, seem to take sides about it.

I think all will admit that human society is in a bad way. There is a distressing lack of ideals in the public mind. The supreme need that we fulfill our obligations is not well developed in these days. I believe it will be generally agreed that society needs quickening in the consciousness of its obligations more than in any other respect.

To some of us this idea of time-binding, this requirement that we add our contribution to the work of the dead and pass it on to coming generations as the only way to maintain humanity in a state of progress, seems important. Time-binding does not present the requirement as a virtue, but rather as a necessity. It shows that if we destroy the work of the dead we rob future generations, and we become ghouls, as Count Korzybski puts it, who live on the dead. The distinction between what is good for humanity and what is bad for it is older than history. The book, to some of us, makes this distinction, which has grown rather cloudy under the blinding rages of war, clear and living again. This is important, even if only a few gather such light from it.

New York City. ELLWOOD HENDRICK.

The Electric Melting Furnace

To The Editor of Chemical & Metallurgical Engineering

SIR:—A scientific innovation is doomed to pass through a definite cycle of ups and downs before it finally comes to rest on a firm foundation of real and rational utility. Brought to light to a circle of the favored few, it is for a time an object of wonder, almost of veneration. Then follows the period of ridicule. The public seizes upon it as a curiosity, a dream creation, a plaything for highbrows. But practical? No!

Then some firm of established reputation adopts the new thing after careful and laborious investigation. A whirlwind of popularity ensues. The new invention immediately becomes a panacea for all evils. Wild advertising makes it a household world. It is invested with miraculous virtues it does not possess. It becomes the popular savior of a troubled technical world. Everyone who can possibly find or imagine a use for it quickly adds his name to the list of anxious purchasers.

Then the bubble bursts! It is found that brains and experience are adjuncts to success. The thing that required only cheap unskilled labor—according to the advertisements—is found to be as stubborn as a balky mule, and failure after failure is registered.

Finally popularity wanes, and the new invention finds its way to the hands of the few who know its uses, its

limitations and its difficulties. It has found its niche in the scheme of industry.

At the present time, the electric furnace is riding the crest of the wave. Tales of the electric furnace find their way into the transactions of our technical societies. Journals carry highly colored advertising. Purchasing agents will pay premiums for "electric steel."

The electric furnace is an ideal method for certain types of melting. Oxidation is almost negligible. Accuracy in composition can be obtained with reasonable certainty. The electric furnace is an admirable superheater. Heats can be held with safety at almost any range required. The electric furnace may be depended upon not to burn up good material that may be put into it. But while it proves to be a first-class nurse for healthy material, it is a poor doctor for sick material.

If we cut through the mass of variations heaped upon the principle of electric melting, what is left? If we disregard phase, single and multiple arcs, direct and indirect, electrodes top or side, vertical or inclined, what does the electric furnace become? Simply a crucible heated internally instead of externally. A crucible independent of impure fuel, and independent of careless firemen.

Every steel man knows that he cannot make good steel from poor materials in an externally heated crucible. Then by the simple expedient of changing the fuel, how does he expect to perform that miracle in an electric crucible? Yet that is just what many persons expect to accomplish. What wonderful cleansing power can there be in electric heat? The argument has been advanced that the atmosphere of an electric furnace is neutral, therefore no oxidation can take place. I admit that the electric furnace establishes a kind of quarantine against the atmosphere. A quarantine will probably protect against the entrance of outside poisons, but can a quarantine cure the effect of poisons already within?

In other words, can the electric furnace hope to reduce metal that is oxidized before it goes into the furnace? Will electric heat reduce rust? This is almost an impossibility in any other kind of furnace. We know that rusty, dirty scrap is the cause of endless trouble in the open hearth. I should like to see a heat of high-grade cast iron made in an electric furnace from a charge of burned grates. It has been contended that the electric furnace, because of a neutral atmosphere, permits heat to be held for a long time, when dirty baths can be cleaned by gravity. It may be possible to raise a goodly portion of contained fusible slag, but will infusible finely divided sonims rise? Will absorbed gases free themselves? Passing from theory to practice, why are foundries melting with electricity so liberal with aluminum when casting their metal? And why are so many porous castings poured from electric steel?

It is not my intention to ridicule the electric furnace. It is a valuable piece of equipment. But it is essentially a crucible and nothing else. If we restrict the use of the electric furnace to the production of alloys—its original field, where heat is the main essential—and to material of crucible quality—simple, safe melting of first-class materials—and if we take advantage of the ability of the electric furnace to produce crucible quality in quantity, then we shall have found the niche for this invention.

HENRY TRAPHAGEN.

Toledo, Ohio.

EDITOR'S NOTE.—Mr. Traphagen's letter is interesting as a protest against blatant exploitation of mediocre or even inferior material, simply because it has come from an electric furnace. He is doubtless correct in his inferred complaint that the electric furnace, *as ordinarily run,* will not reduce oxide; with no particular effort made to seal all openings, the furnace atmosphere is often powerfully oxidizing. Nor is there any wonderful cleansing power in electric heat.

However, the electric furnace has one distinct advantage which the crucible has not, and that is that the skilled metallurgist can make up various slags on his metal, and thereby submit the molten bath to a sequence of chemical reactions (aided by mechanical stirring) which are impossible in the crucible. This is unquestionably the reason why good open-hearth steel can be bettered in an electric furnace, *properly operated.*

Lacking a precise and convenient analysis for gases in metal and in view of our considerable ignorance on the constitution of slag inclusions, we can only infer the actual effect of oxide on steel. It is in consonance with the principles of physical chemistry to suppose that a steel refined under a calcium carbide slag free from metallic oxides, will itself be practically cleansed of oxide inclusions. We do know that when such steel, made of reasonably good material, is properly cast and forged it exhibits unexceptionable tensile properties and beautiful silky fractures, with little or no evidence of transverse brittleness. Few open-hearth steels can even approach this.

Sulphuric-Acid Air Lift

To the Editor of Chemical & Metallurical Engineering

SIR:—I have read with interest the letter of Mr. Imison regarding the Bihn-Jones automatic device for elevating sulphuric acid by compressed air, referred to in the article by Mr. Fairlie on the sulphuric-acid industry.

This device is for all practical purposes identical with the Plath Automatic Acid Elevator that has been manufactured in chemical stoneware by the General Ceramics Co. since 1907 for moving any kind of corrosive liquid. It was fully described in a paper presented by Dr. G. Plath before the Verein deutscher Chemiker on April 16, 1902. It was at that time manufactured by the Deutsche Ton & Steinzeugwerke of Berlin and had then to my knowledge already been on the market for some considerable time.

This would indicate that the idea originated with Dr. Plath and was possibly adopted by Mr. Barnes to construction in metal. Whether this is the case or not, it is quite certain, as Mr. Imison implies, that the credit is not due to Bihn-Jones.

PERCY C. KINGSBURY.

New York, N. Y.

Greensand as a Source of Fertilizer Potash

To the Editor of Chemical & Metallurgical Engineering

SIR:—In "Greensand as a Source of Fertilizer Potash," published on page 1056, vol. 25, the weight of mother liquor, caustic soda (37.5 deg. Bé.) was given as 90 grams. This should read 900 grams.

New York City. R. NORRIS SHREVE.

Study of Gas From Destructive Distillation of a Mixture of Water-Gas Tar and Coal

To the Editor of Chemical & Metallurgical Engineering

SIR:—The heading of the fourth column of Table III in my article, published in the issue of Feb. 22, should read "Theoretical Alcohol Equivalents in Grams" instead of "Hydrocarbons in Grams."

Pittsburgh, Pa. RALPH L. BROWN.

The Explosibility of Ammonium Nitrate

A Review of Its Known Properties and Behavior and a Study of Accidents in Which It Was Involved—These and the Results of Recent Scientific Tests Form the Basis of Important Conclusions Regarding Transportation, Storage and Use of Ammonium Nitrate

By CHARLES E. MUNROE
Chairman, Committee on the Investigation of the Explosibility of Ammonium Compounds, National Research Council

THE very severe and most disastrous explosion which occurred on Sept. 21, 1921, in the nitrogen fixation factory at Oppau, where ammonium nitrate was being produced on a large scale, has led to the publication of many articles indicating a lack of precise knowledge of the properties of this compound. Nothwithstanding the many records in the literature and the relatively recent and definite statement of the Bureau of Mines,[1] these articles often manifest a rather general feeling of surprise at the fact that ammonium nitrate is, under certain circumstances, explosive *per se.* In view of the long-continued use of ammonium nitrate and its very rapidly growing importance in our industries, and in view, further, of the fact that a lack of precise knowledge of the properties and behavior of this substance may lead to unnecessary and burdensome restrictions being placed upon its manufacture, transportation, storage and use, it seems advisable to review the case for ammonium nitrate and, in doing so, to present the results of recent tests that have been placed at my disposal.

Uses of Ammonium Nitrate

For Producing Nitrous Oxide: With the identification of nitrous oxide (laughing gas) by Priestley in 1776, the discovery of its physiological effects by Davy in 1800 and its application as an anæsthetic by the American dentist Dr. H. Wells in 1844, this substance, produced by the thermolysis of ammonium nitrate, came into a continually extended use in dentistry and in more recent years as a component of anæsthetics for other purposes. Statistics of ammonium nitrate for this use are difficult to obtain, since, though from the standpoint of use this is a very important industry, from the standpoint of monetary value it is a very minor one. The U. S. Census of 1905[2] reported a consumption of 75,894 lb. of ammonium nitrate for the production of nitrous oxide. From the circumstances of the case it is believed that this figure was too low and there is little doubt that at the present time the amount so consumed is many times this.

In Explosives: It is obvious that ammonium nitrate, like saltpeter and other nitrates, readily and easily forms explosive mixtures with combustible substances. Many such mixtures have been proposed and a considerable number used. As early as May 31, 1867 (the same year in which Nobel obtained his English patent for dynamite), a Swedish patent was issued to Ohlson and Norrbin for an explosive composed of a mixture of ammonium nitrate, nitroglycerine and carbon. The hygroscopicity of ammonium nitrate was an obstacle to the use of such compositions, but when, on Feb. 10, 1885, U. S. Patent 312,010 was issued to R. S. Penniman for "Protected Nitrate of Ammonia for Use in Explosive Compounds," a new impetus was given to the use of this salt, for, by coating the grains of the ammonium nitrate with petrolatum, Penniman waterproofed them sufficiently for economic use. Partly because of this and partly from other causes the use of ammonium nitrate in explosive compositions, and especially the so-called "safety explosives," has steadily increased, so that, according to Howell,[3] 90 per cent of all "permissible explosives" sold in the United States in 1920 belonged to the ammonium nitrate class and that the total quantity of ammonium nitrate in them aggregated 31,831,000 lb. It is probable that the quantity of ammonium nitrate used in the 229,112,084 lb. of high explosives other than "permissibles" sold in this country in 1920 greatly exceeded this amount.

During the late war ammonium nitrate found wide acceptance as a component of the amatols, ammonals, sabulites and many other explosive compositions that were extensively used in military operations. Considering all the circumstances, Crowell's statement[4] that before the Great War 58,000,000 lb. of ammonium nitrate was used annually in the manufacture of commercial explosives in this country and that our total capacity for the production of this salt at the time of the signing of the armistice was 20,000,000 lb. per month is well within the mark.

Ammonium nitrate in the explosives industry affords a convenient and economic means of utilizing the weak nitric acid recovered from the spent acids of this industry.

As a Fertilizer: Ammonium nitrate contains upward of 35 per cent of fixed nitrogen available as plant food. One half of this nitrogen is present in the nitric form, and the other half in the amino form. Compared with other substances used as fertilizers ammonium nitrate is found to contain more than twice the nitrogen content of sodium nitrate, nearly 14 per cent more nitrogen than ammonium sulphate, practically the same nitrogen content as calcium cyanamide and but about 12 per cent less nitrogen than urea, this comparison being based upon the assumption that each of the compounds named is pure and in the anhydrous condition. Ammonium nitrate possesses the advantage over ammonium sulphate, calcium cyanamide and urea in that, while the entire nitrogen content of each of these three bodies is in the amino condition, one-half of that of ammonium nitrate is in the nitric condition, and over sodium nitrate in that, while containing about 1 per cent more of

[1] "The Analysis of Permissible Explosives," C. G. Storm, Bull. 96, Bureau of Mines. Washington, (1916), p. 7-8.

[2] "Chemicals and Allied Products," Charles E. Munroe, Bull. 92, Census of Manufactures, 1905. Washington (1908).

[3] "Production of Explosives in the United States During the Calendar Year 1920," William W. Adams, p. 21, Tech. Paper 291, U. S. Bureau of Mines, (1921).

[4] "America's Munitions 1917-18," Benedict Crowell, p. 115, Washington Government Printing Office (1920).

nitric nitrogen than sodium nitrate, it possesses in addition nearly 17.5 per cent of amino nitrogen.

The hygroscopic and deliquescent properties of ammonium nitrate have militated against its use as a fertilizer, since they cause it to tend to cake and liquefy in storage, transportation and use. These characteristics also interfere seriously with the efforts of the farmer to spread the material on the fields, and of the manufacturer to make use of it as a component of compounded fertilizers. With the development of the Haber and Claude processes for the fixation of nitrogen, ammonium nitrate may be produced in a pure condition in enormous quantities and there is little doubt that in the fertilizer industry, as has been done in the explosives industry, means will be devised by which its objectionable characteristics will be so overcome that its proved valuable qualities as a fertilizer may be availed of. It is to be noted that the proposed contract of Henry Ford for Muscle Shoals calls for an annual production of 110,000 tons.[5]

Explosiveness of Ammonium Nitrate

In the seventeenth century Glauber knew ammonium nitrate, which he styled nitrum flammans[6]. Gmelin[7] styled it also flammender saltpeter and cites Marchand as stating that "when rapidly and violently heated, as for instance when thrown on a red-hot porcelain plate, it burns with a pale yellow light and very slight noise, and gives off water, nitrous and nitrogen gas. It explodes when thrown on red-hot charcoal." In Turner's Chemistry[8] it is stated that "when this salt is exposed to fire, it liquefies, emits aqueous vapor, dries and detonates." But the most complete investigation was made by Berthelot.

Berthelot's Researches

In 1869 Berthelot published his "Nouvelle recherches de thermochimie,"[9] in which, on pages 77 to 82, he treated of the decomposition of ammonium nitrate by heat, pointing out that the reaction taking place might be such as to absorb heat or to evolve heat and that the character of the reaction was determined by the heat applied according to whether the temperature is moderate or is increased rapidly.

He also states, on page 78, that when a crystal of ammonium nitrate is thrown into a red-hot crucible it decomposes with a flash of light, indicating the disengagement of considerable heat.

Berthelot returned to the consideration of this topic in 1875 in his "Sur les oxydes de l'azote,"[10] where, on page 188, he recognizes five different modes of decomposition of ammonium nitrate, and again in 1877 in his "Decomposition pyrogénée de l'azote,"[11] where he demonstrates the sublimation of ammonium nitrate and points out errors in the data of his former papers.

The results of his continued investigations are brought together and systematically presented in his "Sur la force des matières explosives d'apres la thermochimie,"[12] where, on pages 20 to 23 of vol. 1, we find the following:

Thermal Decompositions: The decompositions which ammonium nitrate undergoes under the influence of heat are seven in number, as follows:

1. The dissociation or partial decomposition of fused or even gaseous ammonium nitrate into gaseous nitric acid and ammonia, which seem to be first produced and at a low temperature, as follows:

$$NH_4NO_3 = HNO_3 + NH_3$$

It takes place necessarily with absorption of heat—namely: —41,300 cal. when the solid nitrate is used, and about —37,000 when the salt is fused.

2. The formation of nitrogen monoxide (laughing gas) from ammonium nitrate at a higher temperature, and when the heat is carefully regulated. The reaction

$$NH_4NO_3 = N_2O + 2H_2O \text{ (gas)}$$

develops +10,200 cal. for the solid nitrate and about +14,000 cal. for the fused salt.

If the salt be supposed to have been previously decomposed into gaseous nitric acid and ammonia, and the reaction to have taken place between these two compounds with the formation of nitrogen monoxide, as follows:

$$HNO_3 \text{ (gas)} + NH_3 \text{ (gas)} = N_2O + 2H_2O,$$

then this reaction would develop +51,500 cal.

3. When rapidly heated, the explosive decompositions, properly so called, of ammonium nitrate take place; one of them produces nitrogen and oxygen, as follows:

$$2NH_4NO_3 = 2N_2 + O_2 + 4H_2O \text{ (gas)}$$

This reaction develops from the solid salt +30,700 cal.; and from the fused salt about +35,000 cal.

4. Or nitrogen and nitrogen dioxide may also be formed, as follows:

$$2NH_4NO_3 = N_2O_2 + N_2 + 4H_2O$$

and +9,200 cal. is given off when the salt is solid and about +13,000 cal. when it is fused.

5. Heat is also liberated when ammonium nitrate gives rise to nitrogen, water and nitrogen tetroxide

$$4NH_4NO_3 = 3N_2 + N_2O_4 + 8H_2O$$

+29,500 cal. being set free from the solid salt, and +33,500 cal. from the fused salt.

6. The ammonium nitrate may also be conceived as being transformed into nitrogen, water and nitrogen trioxide.

$$3NH_4NO_3 = 2N_2 + N_2O_3 + 6H_2O$$

This reaction liberates +23,300 cal. from the solid salt, and about +27,000 cal. from the fused; but it never takes place alone, as nitrogen trioxide exists in the dissociated state only in presence of nitrogen dioxide and nitrogen tetroxide.

7. Lastly, ammonium nitrate can be resolved into gaseous nitric acid, nitrogen and aqueous vapor under certain influences such as that of spongy platinum

$$5NH_4NO_3 = 2HNO_3 + 4N_2 + 9H_2O$$

yielding +33,400 cal. from the solid salt and about +37,500 cal. from the fused.

Effects of Temperature and Rapidity of Heating: These different modes of decomposition of ammonium nitrate, which may be separate or simultaneous, or, more exactly, the predominance of any one of them, depend on the relative rapidity and on the temperature at which decomposition is produced. This temperature is not fixed, but is itself subordinate to the rapidity of heating. It has been established by a great number of observations that each mode of decomposition of a given substance commences at a certain temperature and in a given time a limited weight of substance is decomposed.

Special stress is laid upon the singular property which ammonium nitrate possesses of undergoing several distinct modes of decomposition, according to the rapidity of heating and the temperature to which the substance is raised. Of these decompositions, some take place with liberation of heat, others with absorption of heat.

On pages 182 to 187 of vol. 2 Berthelot further discusses this topic and from the thermochemical data deduces the temperature and pressure developed in the decomposition of ammonium nitrate for each of the several reactions it undergoes.

Attention is first called to the fact that this salt begins to decompose at a temperature a little above 100 deg. C.

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[5] "Secretary Weeks Analyzes Ford's Offer for Muscle Shoals," Chem. & Met. Eng., vol. 26, No. 6, p. 274, Feb. 8, 1922.

[6] "A History of Chemistry," James Campbell Brown. P. Blakiston & Co., Philadelphia (1913), p. 206.

[7] "Handbook of Chemistry," Leopold Gmelin, translated by Henry Watts. Cavendish Society (1849), vol. 2, p. 490.

[8] "Elements of Chemistry," Edward Turner, 5th Am. ed., by Franklin Bache, Philadelphia (1835), p. 446.

[9] *Ann. chim. phys.*, vol. 18 [4], pp. 5-201 (1869).

[10] *Ann. chim. phys.*, vol. 6 [5], pp. 145-208 (1875).

[11] *Ann. chim. phys.*, vol. 10 [5], pp. 362-365 (1877).

[12] Third edition in two volumes, Paris, Gauthier-Villars, 1883.

while at the same time subliming in part. At about 200 deg. C. it is separated into nitrogen monoxide (laughing gas) and water without, however, there being a fixed temperature at which this reaction takes place. If the salt is superheated, and especially from 230 deg. C. upward, the decomposition accelerates itself more and more (nitrum flammans) and it ends by becoming explosive, while at the same time the salt becomes incandescent.

By thermochemical calculations Berthelot finds the theoretical temperatures developed under constant volume and the pressures developed for a given mass of the nitrate decomposed in its own volume with the water produced in the liquid or the gas phase. The highest results given are for reaction 3, in which the theoretical temperature is 1,501 deg. C. and the pressures, with water liquid, 3,200 kg. per sq.cm., and with water gaseous, 11,200 kg. per sq.cm. For reaction 4 the theoretical temperature is 518 deg. and the pressure, with water gaseous, 4,860 kg. per sq.cm. For reaction 2 the theoretical temperature is 555 deg. C. and the pressure, with water gaseous, is 4,500 kg. per sq.cm.

Explosion in Confinement

The direct explosion of ammonium nitrate *per se* through the use of an initiating agent was effected by Lobry de Bruyn[13] in 1891. For this purpose he employed a shell of 8-cm. caliber, weighing 7 kg., and a charge of about 2 kg. When the shell was loaded with ammonium nitrate and fired with a detonator containing 3 g. of mercury fulminate, the shell was burst and but sixty-two fragments, weighing about 6 kg., could be recovered. In a second experiment the shell was charged with 180 g. of ammonium nitrate primed with about 10 g. of bellite and fired by a detonator containing 1 g. of mercury fulminate. The shell was so comminuted by the explosion that but 230 fragments, weighing altogether 2.75 kg., could be recovered, as the rest of the shell had been reduced to powder.

In 1907 Lheure[14] compressed ammonium nitrate into cartridges under a pressure of 20 kg. per sq.cm. Three such cartridges, weighing 50 g. each, were confined in a bore hole in clay, by tamping them with 6 dm. of stemming, and they were fired by a piece of cordeau, 7.3 mm. in diameter, which traversed all three of the cartridges. The detonation of the ammonium nitrate was complete.

Pressure Developed: In his address before the Royal Institution on "Some War Developments of Explosives" Sir Robert Robertson[15] gave a table of pressures developed by ammonium nitrate, amatols and TNT on explosion as determined by Bertram Hopkinson's pressure bar,[16] in which it appears that while TNT developed on explosion a pressure of 55 tons per sq.in. in 0.5×10^{-5} seconds, ammonium nitrate developed a pressure of 12.5 tons in the same time.

Accidents Involving Ammonium Nitrate

The foregoing record shows beyond question that ammonium nitrate under certain circumstances is, by itself, explosive. This is true of may substances occurring in commerce, some of which are quite widely used. The question arises, Is ammonium nitrate to be regarded as an explosive and treated as such under all circumstances? We may get the answer by consideration of accidents in which it was involved and from the results of tests.

There have been fires in which ammonium nitrate was involved, and in none of them, so far as the record goes, was there any explosion unless some other explosive was involved or unless material which could form an explosive mixture with ammonium nitrate was present. Thus at Barksdale, Wis., a building containing 30,000 lb. of ammonium nitrate stored in barrels on the floor was completely burned, yet there was no explosion and some of the ammonium nitrate was left unconsumed. But the most important instance, because of the quantity involved, is that of the steamer Hallfried.

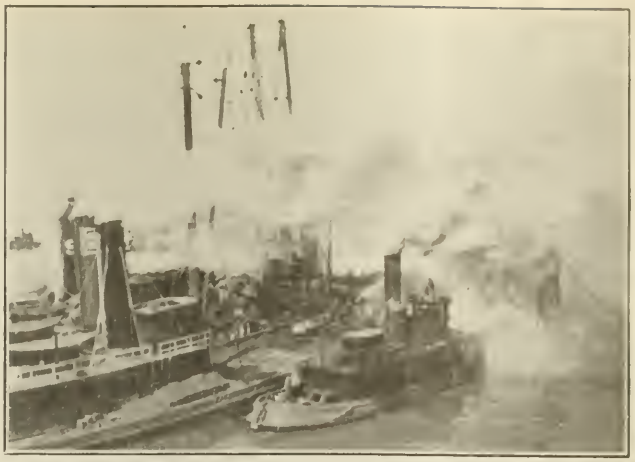


FIG. 1—EXTINGUISHING FIRE ABOARD THE STEAMER HALLFRIED*

Fire on Steamer Hallfried

At about 12:40 noon, on April 14, 1920, a fire broke out in the forward compartment of the steamer Hallfried as she lay at Pier 5, Bush Docks, Brooklyn, N. Y., discharging cargo from all four of her compartments onto lighters alongside and when she had already discharged about one-third of her cargo. She had sailed from Menstad, Norway, with a mixed cargo of raw skins, paper, ammonium nitrate, nitrate of soda and some chlorate, and it is believed the latter was the cause of the outbreak. There were on board 8,460 casks containing about 4,230,000 lb. of ammonium nitrite distributed among compartments 1, 2 and 3. Of this amount 3,111 casks were burned up in the ship and 778 casks

FIG. 2—STEAMER HALLFRIED AFTER THE FIRE WAS EXTINGUISHED

[13] "Sur l'explosivité de l'azotate d'ammonium," C. A. Lobry de Bruyn, *Recueil des travaux chimiques des Pays-Bas*, vol. 10, pp. 127-131 (1891).

[14] "L'amélioration de la sécurité dans les mines grisouteuses par emploi d'un nouveau dispositif d'amorcage des explosifs," Lheure, *Annales des Mines*, Paris, vol. 12 [10], pp. 169-188 (1907).

[15] *Nature*, vol. 107, pp. 524-527 (1921).

[16] *Vide Proc. Roy. Soc., London* (A), vol. 89, pp. 411-413 and *Trans. Roy. Soc.*, London (A), vol. 213; pp. 437-456 (1914).

*Photos reproduced in Figs. 1 and 2 were supplied by the Merritt & Chapman Derrick & Wrecking Co., which extinguished the fire.

on the lighters. After the extinction of the fire 2,077 casks, most of which were sound, were discharged from compartment 3. All that had not been discharged from compartments 1 and 2 before the fire were destroyed. Although the fire was a fierce one and 1,944,500 lb. of ammonium nitrate was destroyed in it, there was no explosion.

In discussions of the Oppau explosion frequent allusions have been made to explosions at the Oakdale plant of the Aetna Co. and the Repauno plant of the du Pont Co., as well as to the explosion at Morgan, N. J. The Oakdale and Repauno explosions have a special interest in that they occurred during the manufacture of ammonium nitrate and its process of crystallization.

Repauno Explosion

The circumstances of the Repauno explosion are described as follows by the director of the chemical division of the company in a private communication:

> At 10 p.m. on Jan. 14, 1916, an explosion occurred in the ammonium nitrate evaporating and crystallizing plant of E. I. du Pont de Nemours & Co., located at Repauno Works, Gibbstown, N. J., inflicting heavy damage to the plant property and resulting in the loss of one life and more or less serious injuries to twelve employees, none of whom suffered permanent disability.
>
> The plant consisted of a row of five evaporating pans and a row of five crystallizing kettles located parallel to each other and numbered consecutively from right to left when facing the pans with back to the kettles. The evaporating pans were separated from one another by a space of approximately 3 ft. and the kettles by a space of approximately 3 ft. and the row of pans was approximately 15 ft. distant from the row of crystallizing kettles. At the time of the explosion, evaporating pan 3 contained a charge of approximately 4,000 lb. of ammonium nitrate which had been about completely evaporated and was ready to be discharged into crystallizing kettles 1, 2 and 3. Evaporating pan 5 contained a charge of ammonium nitrate liquor which was being evaporated, the actual ammonium nitrate content of which was about 2,000 lb. Evaporating pans 1, 2 and 4 were empty.
>
> Crystallizing kettles 2, 3 and 4 each contained approximately 1,000 lb. of ammonium nitrate. Kettle 1 had just been emptied and kettle 5 was not in use.
>
> The explosion occurred in evaporating pan 3, as evidenced by a crater about 5 ft. in depth directly beneath this pan, and so far as could be ascertained none of the other ammonium nitrate exploded. The steam pressure in the coils of pan 3 was probably in the neighborhood of 100 lb. per sq.in. at the time of the explosion. For several days the atmospheric temperature had been high and the humidity very great, and on the night of the explosion there had been a sudden drop in temperature. It seems probable that there was a stoppage of the air supply to the agitating pipes in the evaporating pans, due to frozen water in the supply pipe, and that due to this failure of the air supply, molten ammonium nitrate was forced into the agitating pipes, under which confinement rapid local decomposition took place, which finally extended to the entire charge.

The conditions for overheating in the Repauno accident are analogous to those in the manufacture of laughing gas except that the latter affords an easier opportunity for that rapid application of a high-temperature source of heat which Berthelot states is likely to bring about explosive decomposition. Yet I have found but a single record of such an explosion, and this by Daniel,[1] who cites an accident at Kensington, March 20, 1896, following the heating of 18 lb. of ammonium nitrate in an enameled iron retort by Dr. Orchard, a dentist, for the purpose of producing laughing gas, when explosive decomposition set in and the plant was wrecked.

[1] "Dictionnaire des matières explosives," J. Daniel, Paris (1902), p. 458.

Oakdale Explosion

The following description of the Oakdale explosion was supplied to the writer by Superintendent Johnson:

> The accident occurred on Sept. 15, 1916, at 8:50 p.m. An explosion occurred in one of the pre-boiling tanks. There were three or four of these tanks, which sat on the side hill between the neutralizing tanks and the graining bowls. These tanks were approximately 4½ ft. wide, 3½ ft. deep and 8 ft. long. They were old crystallizing tanks from the Carnegie TNT plant. The explosion tore one of these tanks into small bits, the largest piece we found being three-quarters of a mile from the explosion. It weighed 173 lb. This was near the Greggs Station. Another of these tanks was found up the hill above the neutralizing tanks near the boiler house, or a distance of about 25 ft. higher on the hill, back approximately 50 ft. from its foundation. These tanks were ordinary boiler plate and were equipped with cast-iron coils, put together by rust joints.
>
> For some weeks prior to this we had been trying to produce ammonium nitrate of 99 per cent or better purity for the government. We were using ammonia liquor, I believe, which was shipped us by The Barrett Co. or the Semet-Solvay Co. The nitric acid was a mixture of the weak from the still acid and the recovered nitric from the TNT spent. Only a very small proportion was still acid. Inasmuch as we had not been very successful in obtaining a high grade of ammonium nitrate, we decided about 10 days prior to the date of the accident that it would be necessary to empty and wash out the settling tanks, which were 10 x 10 wooden tanks. These settling tanks had been washed out and the charge that blew was the first one to be boiled down after they had been cleaned out. The charge was put into the tank some time during the day. It occurs to me that it was before noon. As we were very anxious concerning the results, Mr. Hutchinson, then acid foreman, and I made several visits and spent quite some time watching this particular charge. I was informed by Mr. Hutchinson that it was necessary to extinguish a small blaze on the charge several times during the day, although the liquor apparently had been thoroughly settled, judging from the appearance and the length of time, having been better than 4 days.
>
> At the investigation after the accident, at which Messrs. Fox, Crewe and one or two others were present, it was decided that the accident was due to the TNT in the acid. While this may have been the explanation, Mr. Diehl and I concluded, after conversation with a couple of prominent chemistry instructors, that the accident was due to the presence of unstable nitrites, due to the excessively high oxides in the acid. This of course is usually found to be the condition of nitric acid recovered from TNT, and the assumption was based on some German literature to which reference has been made. I regret that I am unable to furnish these references at this time. Either explanation, however, is only theoretical, as the exact reason is not known. My reason for believing the latter theory was that the neutralized ammonia liquor had such a clear appearance that it seemed to me that this was a more reasonable explanation.
>
> The explosion was felt for a distance of about 15 miles away, which will give some idea of the intensity of the blow. I think that approximately 3,000 lb. of nitrate of ammonia was in the exploding charge.

It might be well to point out that in both the Repauno and Oakdale cases weak nitric acid recovered from TNT waste acid was being used in manufacturing the ammonium nitrate. It is known that such weak acid contains nitro bodies and it is possible that these nitro bodies may have had something to do with initiating the explosions.

Morgan Explosion

Among the great disasters in which ammonium nitrate played an important part was that which occurred at the plant of the T. A. Gillespie Loading Co., Morgan, N. J. This started with a fire in the extruding plant for loading amatol into shells, which was situated in the northwest corner of the tract of 2,600 acres occupied by this plant. The fire started just before 8

p.m. Friday, Oct. 4, 1918, and continued to rage until the night of Oct. 5. At the time the fire broke out there was assembled within the above-mentioned area 30,855,076 lb. of explosives, some stored in magazines and some in loaded shell, part of the latter being in dumps on the ground and part on railway cars. Shortly after the fire started shells began to explode, many of them being projected to a distance before they exploded, and a fitful bombardment continued through Oct. 6, even after the general conflagration had ceased. In this disaster 12,155,839 lb. of explosive was destroyed. Among the materials at Morgan was upward of 9,000,000 lb. of ammonium nitrate. I visited the scene of this disaster on Tuesday, Oct. 8, as soon as it was at all possible to permit of inspection, and noted particularly the locations at which ammonium nitrate had been stored, observing in instances partly burned barrels and heaps of fused material surrounding barrels of this nitrate that were perfectly intact, but finding special interest in the enormous craters excavated at sites where storehouses containing ammonium nitrate had been located. One of these craters 150 ft. long, 140 ft. wide and 30 ft. in depth was exceeded, in one dimension only, by that at the site of a large dump of loaded shell, and also that at a place where three cars loaded with TNT had been parked.

There is no doubt whatever that the ammonium nitrate that was in storage at the locations cited detonated very completely. It is equally certain that ammonium nitrate stored at other sites within this area did not detonate or even explode, although exposed to fire and to the shock of the many heavy detonations which occurred within this area. Where so many factors obtain as in this case it is not possible to determine definitely the cause of the detonations of the ammonium nitrate that did occur, but considering all the circumstances it seems not improbable they were due to the explosion within the ammonium-nitrate storehouses of high-explosive shell loaded with amatol.

I have added to the information gathered in my visit by perusal of Congressional documents and the excellent report by F. Hawkes. The latter was in intimate touch with the Morgan plant from the beginning of its construction and throughout its operation. He was at the plant throughout the period of its destruction and observed its progress from its beginning to the end. He states that "all major explosions at the plant were preceded by flames which could be seen mounting higher and higher, in each case culminating in a huge column of smoke and flame, the shock of detonation reaching us a little time afterward." "It is certain that actual detonations of large amounts of ammonium nitrate took place at the destruction of the Morgan plant, these detonations being preceded by fierce fires, during the time when amatol-loaded shells were being projected or had been projected from other parts of the plant." "There were certainly no explosions of ammonium nitrate previous to those which occurred during the destruction of the plant."

Recent Tests of Ammonium Nitrate

I now present the results of tests which I have compiled from a mass of data supplied to me by F. C. Zeisberg of the du Pont company, covering not only the solid nitrate of commerce, but also the molten nitrate such as is found in the crystallizing pans.

Effects of Heating: Because of the explosions that had occurred in crystallizing pans during the manufacture of ammonium nitrate, tests were made of both the anhydrous and the hydrous material in the molten condition, the first observations made being as to the effect of heat upon it. For this purpose 10 lb. of the salt, containing 99.11 per cent of ammonium nitrate and 0.08 per cent of moisture, was placed in a 10-qt. enameled kettle, a standardized base-metal thermocouple inserted in the salt, the kettle with its contents placed on an improvised cylindrical stove, in which was a coke fire, and heated. The temperatures in the mass were read by a millivoltmeter.

In the first tests the mass attained a temperature of 29 deg. C. in 1 minute and white fumes in small quantity were given off. In 4 minutes more the temperature had risen to 72 deg. C. and white fumes were given off in considerable quantity. In 1.5 minutes more the temperature had risen to 261 deg. C. and red fumes appeared mixed with the white ones. One minute later

FIG. 3—BURNING TEST WITH THREE BARRELS, EACH CONTAINING 500 LB. AMMONIUM NITRATE

the temperature observed was 289 deg. C. and at that point yellow fumes appeared mixed with the white. In 1.5 minutes more the temperature noted was 348 deg. C. and the fumes had begun to lessen. One minute later, or 10 minutes from the start, a temperature of 375 deg. C. was reached and the fumes had ceased. Close examination showed that all of the ammonium nitrate had disappeared, leaving the kettle empty. There was no explosion.

This test was twice repeated with some slight variations, but, though analogous rapid rises in temperature and volatilization of the ammonium nitrate, accompanied at the higher temperatures by red and yellow fumes, due undoubtedly to nitrogen oxides from thermolysis of the nitrate, occurred, there was no detonation in any instance. The only approach to an explosion was in test 2, in which an 8-in. length of 1-in. iron pipe, filled with freshly crystallized ammonium nitrate and closed at both ends with iron caps, which were screwed on them, was imbedded in the charge of ammonium nitrate in the kettle to serve possibly as a primer for the latter, for at the expiration 11 minutes and when the temperature had reached 318 deg. C. there was a slight report and flash. It was found that the pipe had been split, was appre-

ciably shattered, as was one of its caps also, and that the kettle was split, while some of the ammonium nitrate was found scattered on the ground. This latter suggested that the flash observed may have been caused by the projection of molten nitrate into the fire.

FIG. 4—IMPACT TESTING MACHINE

Sensitiveness of Molten Nitrate: Aqueous solutions of ammonium nitrate were evaporated to the crystallizing point, the temperature raised to insure complete liquefaction, and detonators or blasting gelatine exploded in the mass. The tests were conducted in open kettles and 10-lb. charges of ammonium nitrate were used. Although No. 8 detonators, singly and in groups of three, and 100-g. masses of explosive gelatine, primed with cordeau, were exploded in these "hot liquors," there was in no instance any approach to detonation on the part of the ammonium nitrate.

Pendulum Friction Test: Using 10 g. of fine-grained nitrate, containing 99.11 per cent ammonium nitrate and 0.08 per cent of moisture, on the steel anvil and a fall of 2½ m. for the steel shoe, negative results were obtained in 190 tests. There was no explosion or local crackling in any case.

Impact Test: In ten tests of the above-mentioned ammonium nitrate no explosions occurred when a weight of 20 kg. falling through a meter in height impinged upon the nitrate confined between steel surfaces.

Tests of Explosibility: Tests of explosibility were made on ammonium nitrate from different sources by firing a cartridge of blasting gelatine, exploded by cordeau, in contact with the nitrate.

FIG. 5—PENDULUM FRICTION TESTING MACHINE

EXPLOSIBILITY TESTS

Kind of Am. Nitrate	Moisture Content Per Cent	Weight of Am. Nitrate	Weight of Blasting Gelatine	Result
German "as received"	0.26	15 lbs.	240 grams	Detonated
Brünner-Mond, "as received"	0.84	15 lbs.	240 grams	Partial detonation
No. 2 cast	1.45	40 lbs.	243 grams	Detonated
German, "as received"	0.16	135 lbs.	243 grams	Detonated and produced crater 12 ft. in diameter and 4 ft. deep.

Effect of Admixture With Ammonium Sulphate

Test of mixtures of No. 3 ammonium nitrate made from German ammonia with ammonium sulphate were made in a similar manner to those just described, except that the charge was placed on a lead block, as described below. The two salts were mechanically mixed "dry."

FIG. 6—DETONATION TEST OF 40-LB. KEG OF AMMONIUM NITRATE BY 240 GRAMS (½ LB.) CARTRIDGE OF BLASTING GELATINE

EXPLOSIBILITY OF MIXTURES OF AMMONIUM NITRATE AND AMMONIUM SULPHATE

Parts of NH_4NO_3	Parts of $(NH_4)_2SO_4$	Weight of Blasting Gelatine, Grams	Result	Compression of Lead Block, Inches
90	10	100	Detonation	¼
90	10	75	Detonation	¾
90	10	50	No detonation	None
80	20	100	Detonation	¼
80	20	75	Detonation	½
80	20	50	No detonation	None
70	30	100	No detonation	None
60	40	100	No detonation	None

Sensitiveness to Detonation by Blasting Gelatine

Tests of sensitiveness of ammonium nitrate to detonation by blasting gelatine were made by placing 400 g. of the dry nitrate in a beaker which rested on a lead block 4 in. high and 2¼ in. in diameter. The firing was done with different known weights of blasting gelatine exploded in the ammonium nitrate by means of cordeau

SENSITIVENESS OF AMMONIUM NITRATE TO DETONATION BY BLASTING GELATINE

Weight of Blasting Gelatine, Grams	Result	Compression of Lead Block, Inches
100	Detonation	⅝
75	Detonation	½
50	Detonation	⅜
25	No detonation	None

detonant and the effect on the lead block measured. The ammonium nitrate used was No. 3 made from German ammonia.

Relation of Temperature to Sensitiveness to Explosion

The tests were made by placing 2-lb. charges of fine-grained ammonium nitrate, 99.1 per cent pure, in tin

FIG. 7—CONDITION OF KEGS AND CONTENTS OF AMMONIUM NITRATE AFTER FIRE AND WATER TESTS

Three kegs were supported over open fire in a closed room and were extinguished after 15 minutes through operation of automatic sprinkler device.

cans 4 in. in diameter by 5 in. in height, heating the can and contents in a paraffine bath to the desired temperature, placing this system on a lead block 2¼ in. in diameter by 4 in. in height, then imbedding in the ammonium nitrate one or more No. 8 electric detonators and firing them. The results obtained were as follows:

Temperature of Nitrate, Deg. C.	Number of Detonators Fired in Charge	Result	Compression of Lead Block, Inches
21	8	No detonation	None
50	5	No detonation	None
50	6	Partial detonation	None
70	5	Partial detonation	None
92.5	1	No detonation	None
92.5	2	No detonation	None
92.5	3	Detonation	5/16

Propagation of Detonation in Ammonium Nitrate

For these experiments use was made in each case of a wooden trough, approximately 5½ in. square in cross-section and 10 ft. long, which rested on the ground. Such a trough held approximately 125 lb. of ammonium nitrate. Use was made of both warm nitrate having a purity of 99.64 per cent, moisture content 0.05 per cent and a temperature of 52 deg. C., and of cold nitrate having a purity of 99.19 per cent, moisture content 0.02 per cent and temperature of 21 deg. C. The warm nitrate was made use of to insure detonation and was placed at the initiating end of the train. The effect was determined by the size and extent of the crater produced beneath the box.

Test 1. The box was filled for a distance of 3 ft. with warm ammonium nitrate and the remainder with cold nitrate. Eight special tetryl electric detonators were imbedded in the warm nitrate and shot, but the caps only fired and there was no explosion of the nitrate.

Test 2. The above loading conditions were duplicated except that in place of the tetryl detonators a stick of blasting gelatine was used as the primer. A complete detonation of the ammonium nitrate resulted, giving a crater 11 in. deep x 6 ft. 6 in. wide at the initiating end and 7 in. deep × 5 ft. wide at the opposite end. The total length of the crater was 13 ft.

Test 3. In this case the box was completely filled with warm ammonium nitrate and primed with two sticks of blasting gelatine. The crater was practically the same as in test 2—i.e., 10 in. deep x 6 ft. 6 in. wide and 7 in. deep x 5½ ft. wide and 13 ft. long; the chief difference being in the width of the far end of the crater, which may have been due to a higher order of detonation caused by the increased priming charge.

Test 4. Warm ammonium nitrate only was used in this test. In the center of the box, and for a distance of 2 ft., a layer of nitrate 1 in. deep x 5½ in. wide was maintained. From each end of this 2-ft. length ammonium nitrate was sloped up flush with the ends of the 10-ft. box. A stick of blasting gelatine was placed at one end and on firing, the first half of the ammonium nitrate train detonated, but the wave failed to propagate through the 2-ft. length of powder which was but 1 in. deep. The crater was 8 in. deep, 3½ ft. wide and approximately 4½ ft. long.

In general the results show that ammonium nitrate *per se* will propagate its own wave of detonation, but the force gradually falls off, as shown by the decrease in depth and width of the crater at the end opposite the priming charge. Test 4 also shows that the explosion

FIGS. 8 AND 9

Fig. 8 (above)—Setting for test of propagation of detonation with seven 40-lb. kegs of ammonium nitrate. (Center keg contained blasting cartridge as in Fig. 6.)

Fig. 9 (below)—Results of explosion in 7-keg propagation test. The bottom of center keg and some unexpended nitrate will be observed. Contents of other barrels scattered but not exploded.

wave failed to travel through a 1-in. layer of ammonium nitrate.

Present Conclusions and Plans for Future Investigations

Some of the tests described above and many other tests by fire were observed by Mr. Schoen, and they are described by him in a well-illustrated report.[18] He concludes "that ammonium nitrate offers very much the same fire hazard as sodium nitrate—that is, an indirect hazard through the liberation of oxygen at moderately high temperatures, which gas serves to intensify combustion and tends to increase the extent and spread of fire"—in which conclusion I concur.

There is need for a decision on the explosion hazard also and I believe from all the evidence thus far at hand we are justified in holding that ammonium nitrate when stored by itself in wooden receptacles and apart from explosive substances is, for transportation and storage, not an explosive.

There still remains much to learn as to the behavior of ammonium nitrate, especially when associated with other ammonium compounds, as at Oppau, and this topic will be made the subject of investigation by a special committee appointed by the National Research Council consisting of Charles P. Beistle, Bureau of Explosives, A.R.A.; C. A. Bigelow, Institute of Makers of Explosives; S. P. Howell, Bureau of Mines; Charles E. Munroe, National Research Council; C. G. Storm, Ordnance Department, U. S. A.; R. C. Tolman, Fixed Nitrogen Research Laboratory, and a representative of the Bureau of Ordnance, U. S. N., to be named later.

National Research Council,
Washington, D. C.

Legal Notes

By Wellington Gustin

Negligence in Explosion Cases Construed

In the consolidated cases of the Republic of France, the King of Great Britain and Ireland and the Aetna Explosives Co. against the Lehigh Valley Railway Co., the Supreme Court of New Jersey, the actions involved grew out of the same explosion. (114 Atlantic R., 242.)

Part of the claim of France was for benzene and wet guncotton in railroad cars on the Lehigh Valley dock. For this the jury rendered a verdict for France which was not questioned. But part of the claim of France was for wet guncotton in cars on the Central Railroad dock; part for picric acid, N. C. powder and cannon powder in cars in the barge Rockwell; and on these the verdict was against France, which appealed.

The claim of the King of Great Britain was for smokeless powder on barges, that of the Aetna Explosives Co. was for powder on a barge; the verdict was against these claimants, who appealed.

It was urged that if the jury was right in finding in favor of France for the benzene and wet guncotton on the Lehigh Valley dock, it must logically have found negligence with reference to the guncotton on the Central Railroad dock. But the court said this argument overlooks the fact that there was an element of negligence as to these explosives that was not present in the case of the other explosives belonging to France. One of the causes of negligence alleged was the failure to provide adequate facilities and proper measures for removing and isolating cars which caught fire and cars loaded with dangerous explosives likely to explode in or near which fire might be discovered. And it might properly be found that there was no negligence on the part of the Lehigh Valley Railroad Co., so far as concerned the starting of the fire, and yet quite properly found that there was negligence after the fire started in removing or isolating cars on its dock. This theory of liability is not applicable to cars standing on the Central Railroad dock with which the Lehigh Valley had nothing to do, said the court, and the verdict against France was upheld.

The question of liability in the cases of Great Britain and the Aetna Explosives Co. was more difficult. It appears that the claimants' stocks of supplies were on barges which had, without right and apparently without knowledge of the railroad company, been tied up to the Lehigh Valley wharf, one barge to another, and after the fire started had cut loose and were being towed away. The court held that persons who tied their barges to other barges tied up to the wharf of another were guilty of trespass on the rights of the wharf owner. And he could properly assume, in the absence of notice to the contrary, that owners of barges loaded with dangerous explosives would not tie their barges to barges tied at the wharf and loaded with dangerous explosives in violation of harbor regulations, and hence was under no duty to them, and they were not entitled to recover damages for an explosion where a fire started at the wharf.

Orders by Commission Merchants for Foreign Corporations

A case of interest to foreign corporations contemplating the doing of or doing business in the State of New York comes from the Appellate Division of the New York Supreme Court (197 App. Div., 788). Action was brought by the Eagle Manufacturing Co., Inc., against Arkell & Douglas, Inc., for goods sold. One of the defenses to the action for the purchase price of the goods was that the plaintiff was doing business in New York in violation of the general corporation law.

The orders were taken by Malone & Nicholson, who were engaged on their own account in business as brokers or commission merchants in New York City. They represented a number of foreign corporations having factories, including the plaintiff. The lease of the premises occupied by the brokers was in their own name, as was also the telephone contract. The manufacturing firm had nothing to do with the running of this New York office or its expenses, and contributed nothing toward its maintenance. The only goods of the factory in the possession of the brokers were samples. The goods sold never passed through the broker's hands.

Further, the plaintiff never had any stock of merchandise in the State of New York, nor did it have any bank account or any offices there, nor did it keep any books in the state. The goods involved in the suit were sold f.o.b. factory in West Virginia.

By a vote of 3 to 2 the court held that this state of facts established as a matter of law that the plaintiff was not doing business in the State of New York as contemplated by statute, so that non-compliance with section 15 of the corporation law would prevent actions on contracts based on the brokers' orders.

[18] "Ammonium Nitrate (NH_4NO_3)," A. M. Schoen, chief engineer, Southeastern Underwriters Association, Jan. 18, 1922, 7 pages.

X-Ray Data on Martensite Formed Spontaneously From Austenite

Coarse-Grained Austenite, After Fifteen Months at Room Temperature, Is Found Unchanged in General Appearance, but Has Become Very Hard and Magnetic—Its Present X-Ray Spectrogram Is That Characteristic of Very Fine-Grained Ferrite

By EDGAR C. BAIN

HULL'S METHOD of crystal analysis,[1] although usually applied to very fine-grained metal or powders, affords data for estimating grain size over quite a range. In general it could not compete with an actual grain count under a microscope, but several orders of grain size can be recognized quite definitely by the appearance of the bands of the film pattern. Furthermore, as we shall see, it is useful for grain study where the microscope fails entirely. The Hull method and its minor modifications have been amply described from time to time, but it may be fitting to consider how these grain size data are obtained.

X-Rays for Estimating Grain Size

If a single crystal is mounted in a monochromatic beam of X-rays after the fashion of the early workers,[2] a definite number of positions with respect to the beam will be found which will partly deflect the beam. In these positions a diffraction image of the source is projected in some direction. Assume the crystal to be in a position to produce an interference maximum and then rotate it with the beam as axis, and a conical path will be traced by the deflected beam. A single grain placed at random has small chance of being in a position to "reflect" the beam at all. Its chances depend upon the number of possible plane spacings in the crystal which exceed one-half the wave-length and upon the divergence of the beam. If we increase the number of differently oriented crystals in the beam, we proportionally improve the chances for some diffraction image to be projected. Only a limited photosensitive surface is ordinarily provided to record these deflections of the beam, and if the area is small, it again lessens the number of reflections recorded. As an example, there are usually about five diffraction images recorded on the author's films from the mounted specimen whose grains are 1 sq.mm. in cross-section on the average.[3] Such a dashed spectrogram is Fig. 8.

FIG. 1—ORIGINAL AUSTENITE. × 100. ETCHED WITH HNO_3

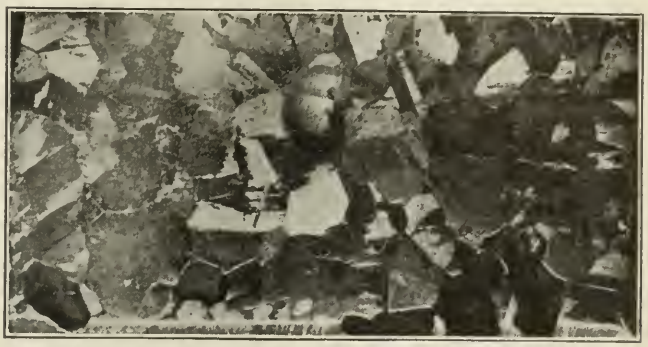


FIG. 2—ORIGINAL AUSTENITE, × 4½. OBLIQUE ILLUMINATION. ETCHED WITH HNO_3

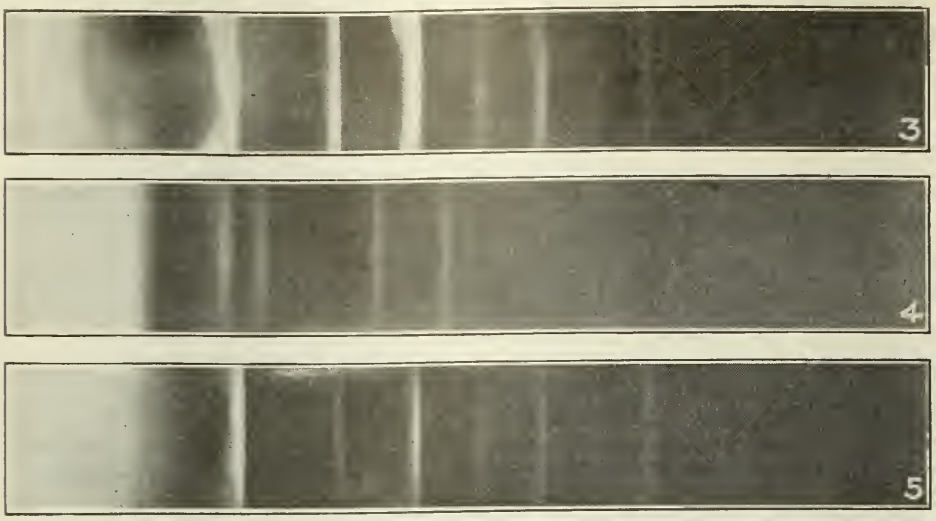
When there are sufficiently numerous grains or crystal fragments in the beam, the number of tiny images from similar orientations is so great that they overlap on the film and produce a smooth, evenly dark band. The largest grain size which can give this sort of band is of course the optimum for crystal study. This situation represents one general order of grain size and is easily recognized.

It may perhaps be of interest to note that as we refine the grain size still further we reach a condition at which the bands widen and lose contrast. This condition is realized very seldom indeed in metals, but doubtless crystalline fragments of colloidal size would yield such patterns. In general to keep the diffraction band from spreading over one degree in width the crystalline metallic fragments should have all gradations in size from 75 to 150 atom rows. To sum up then, with the very coarse structures we have only dashes on the

[1] A. W. Hull, "The Position of Atoms in Metals," *Trans.*, A.I.E.E., 1919, vol. 38, Part 2, pp. 1445-1466; "A New Method of X-Ray Crystal Analysis," *Phys. Rev.*, vol. 10, No. 6, December, 1917; E. C. Bain, "Studies of Crystal Structure with X-Rays," CHEM. & MET. ENG., Oct. 5, 1921, pp. 657-664.

[2] Bragg's "X-Rays and Crystal Structure"; G. W. E. Kaye, "X-Rays," Chap. 13.

[3] E. C. Bain and Zay Jeffries, "Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformation," CHEM. & MET. ENG., Oct. 26, 1921, p. 776. In this paper the use of the X-ray spectrometer for following grain size change is described.



FIGS. 3 TO 5

Fig. 3 — Spectrogram of austenite after transformation to martensite.

Fig. 4 — Spectrogram of austenite. Ordinary grain size.

Fig. 5 — Spectrogram of pure ferrite, fine grain.

film which gradually become smaller with grain refinement until narrow continuous bands are produced. With further reduction in crystal size we gradually widen the smooth band.

According to the slip-interference theory advanced by Jeffries and Archer,[4] martensite is necessarily a fine-grained material. Regardless of the apparent grain size of the material, which is in reality the grain size of the parent austenite, it probably derives its hardness from the resistance to slip which very fine crystal fragments offer. Of course, the useful martensite of good practice is extremely fine-grained even as to microscopic appearance, being transformed from a fine-grained austenite. But if it could be shown that specially prepared martensite from coarse-grained austenite was also fine-grained, the theory would be enormously strengthened. The data offered below point conclusively to this situation.

It so happens that the specimens which exhibit such definite information on the state of aggregation of martensite also present the rarely noted spontaneous production of martensite from austenite at ordinary temperatures. The analysis of the steel employed for these studies is as follows:

	Per Cent
Carbon	0.32
Manganese	0.57
Phosphorus	0.031
Sulphur	0.013
Silicon	0.13
Nickel	2.81
Chromium	0.06

The specimens were produced by Prof. Chas. Y. Clayton of the School of Mines, University of Missouri, who supplied the analysis.

During the fall of 1921 the author received from Prof. Clayton some steel, presumably extremely coarse austenite, which had been prepared, examined and photographed in the early summer of 1920. Fig. 1 is the micrograph of the austenite at 100 diameters with vertical illumination and Fig. 2 is the same specimen at 4½ diameters with oblique illumination, both made at that time. The characteristic twinned crystals of quenched austenite are in evidence.

When placed in the X-ray spectrometer, the original polished and etched surface was in such perfect condition that no alteration was detected by a small pocket glass, but the author was astounded to find a normal spectrogram of ferrite, Fig. 3. Compare this with Fig. 4, the spectrogram of pure austenite in a fine-grained specimen. A test with the magnet gave no doubt that the supposed austenite was very largely transformed.

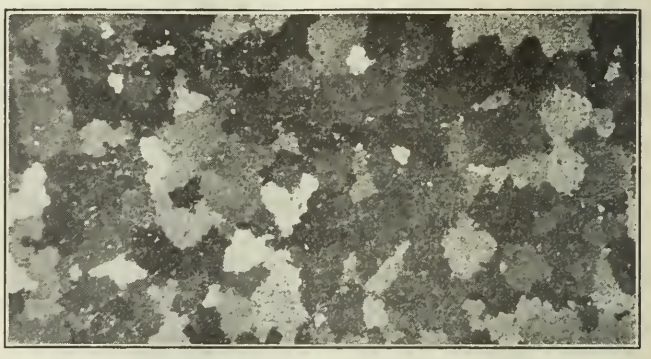


FIG. 7—SURFACE OF COURSE TUNGSTEN INGOT, × 7½. ETCHED WITH NaOH. OBLIQUE ILLUMINATION

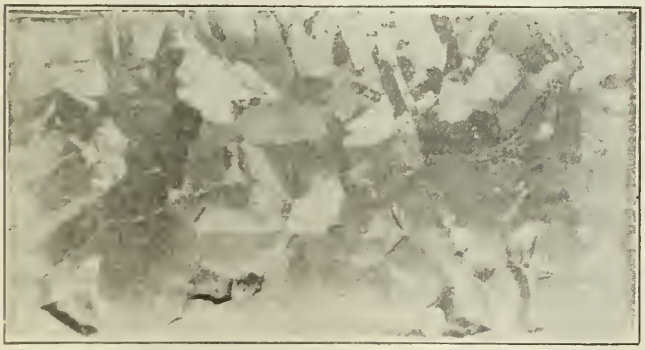
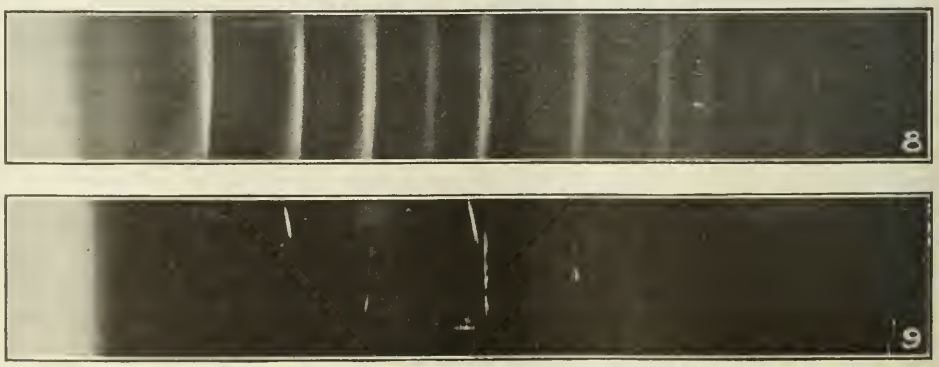


FIG. 6—SAME AREA AS FIG. 2 AFTER TRANSFORMATION



FIGS. 8 AND 9

Fig. 8—Spectrogram of coarse tungsten ingot shown in Fig. 7.

Fig. 9—Spectrogram of tungsten, fine grain.

[4] Zay Jeffries and R. S. Archer, "The Slip Interference Theory of the Hardening of Metals," CHEM. & MET. ENG., June 15, 1921, p. 1065.

For further comparison, Fig. 5 shows the spectrogram of a very fine powder of pure iron (ferrite).

Obviously the period of 15 months had been sufficient to convert the austenite to martensite at ordinary temperatures. Fig. 6 shows the same area as photographed in Fig. 2 after the transformation had taken place. At this magnification the macrostructures may be said to be identical.

Gradual change of austenite to martensite at ordinary temperatures has been observed by Honda and Idei.[5]

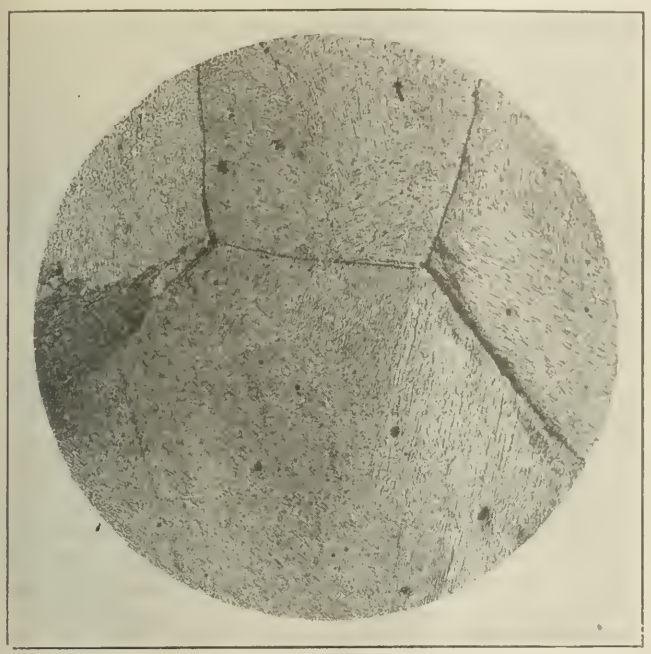


FIG. 10—MARTENSITE FROM SPECIMEN USED FOR SPECTROGRAM IN FIG. 3. × 100. ETCHED WITH PICRIC ACID

They measured the progress of the transformation by the increase in hardness as time elapsed. However, the starting material in that case was a mixture of austenite and martensite, while the material studied here was undoubtedly entirely austenite. The hardness history of these specimens is not at hand, but the changed material is 555 Brinell as against 652 for martensite of the same steel prepared as such at the same time as these specimens were treated to produce austenite.

Fine-Grained Despite Appearances

But the data show more than the spontaneous transformation. Fig. 7 is a photograph at 7½ diameters of a small ingot of coarse tungsten. It is obviously of somewhat finer grain size than the original austenite preserved in the martensite. Yet its spectrogram is the characteristic dashed one described above and shown in Fig. 8.[6] *The film of the martensite is not at all characteristic of such coarse-grained material, though derived from an apparent grain size which was larger.* The microscope here has proved misleading for true grain-size determination.

However, there is an interesting appearance in a deeply etched area of the martensite at 100 diameters. Fig. 10 is a micrograph of the same area which had been exposed to the X-rays. Within the original well-marked grains there appear very plainly discontinuities of etching figures. While these configurations could scarcely represent the new grain size of martensite, they do show that the region within the grain is a complex. On the other hand, the transformation, taking place at ordinary temperature, was probably very slow and might therefore give rather large areas of crystalline continuity. Perhaps in this one detail it is not representative martensite.

[5]Kotaro Honda and Sakae Idei, "On the Distribution of Hardness in Quenched Carbon Steels, and Quenching Cracks." *Science Reports*, Tohoku Imperial University, First Series, vol. 4, No. 6, December, 1920.

[6]Fig. 9 represents the spectrogram for fine-grained tungsten.

Summary

To summarize, we find in martensite an apparent grain size somewhat larger than that of a truly coarse-grained tungsten ingot which yields a pattern characteristic of a very fine-grained metal. The old grain boundaries do not inclose single orientations, but many crystal fragments which result from the allotropic transformation of the gamma iron arrangement to the alpha iron arrangement. This fact corroborates very conclusively the theory of the fine-grained nature of martensite.

Cleveland, Ohio.

German Substitutes for Ferromanganese

Efforts of the Germans to procure high-grade manganese ore from foreign countries during the war had very little success. The main sources of supply before the war were Russia (from which nearly 400,000 tons was imported in 1913), British India, Spain and Brazil. All those supplies stopped at the beginning of the war. Small quantities of manganese ore were then imported from Sweden, but this was entirely insufficient.

For this reason steel production was dependent almost entirely upon reserves of manganese already accumulated in the country. Greatest economy was required, and for this reason the available foreign ore was mixed with German ore. Increased production of the latter was taken energetically in hand. The main deposit to draw from was the hematite of the Lahn Valley, but even the iron ore in the Sieg district, containing a small percentage of manganese, was largely used by steel works.

Apart from this, ferromanganese was made from the so-called Siegerland slag, from blast furnaces smelting Sieg ore, a slag containing from 8 to 9 per cent of manganese. Vast supplies of this cinder, sufficient for many years, were available. This ferromanganese was called "Siegerland chip steel," and was produced by the blast furnaces being burdened with two-fifths Siegerland slag and three-fifths iron scrap or turnings. Slag obtained at the Austrian Steel Works in Donawitz was even better for such purposes.

All efforts to find a substitute for manganese for the deoxidation of steel proved futile. The industry so far succeeded, however, in adapting the deoxidation process to low-grade spiegels and ferros that they were able to produce satisfactory results with the means at their disposal. Good results were obtained by using the deoxidation agent in liquid state. It should be mentioned that ferro-aluminum, containing from 15 to 20 per cent aluminum, was used during the war for a deoxidizer.

Since the war the importation of manganese ore has again been resumed, but the main sources of pre-war supply are not drawn upon, Sweden and Spain now furnishing most of the tonnage. These imports are in no way equal to the pre-war imports, no doubt due to the considerably reduced steel production, but also to the fact that the experience gained during the war has made Germany's steel industry less dependent upon foreign manganese ore.

The Problems of the American Shale-Oil Industry

An Outline Intended to Show Briefly the Present State of Our Knowledge in Various Divisions of the Field of Oil-Shale Technology and to Suggest Some Channels Which Future Investigational Effort May Take

By CHARLES L. JONES

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THE one fundamental problem of the shale-oil industry may be stated in a sentence: it must make money from oil-shale. Expressed more specifically, it must afford products, and especially staple products of value to civilization, at the lowest possible cost. Its object is not to produce oil from shale with high thermal efficiency, high recovery of saturated oils, or under ideal conditions in any other respect, except in so far as this can be done in such a way as to supply commercial demand at low cost. The real problem, then, is to obtain all necessary fundamental information on our American oil-shales by systematic research; to develop industrial-scale apparatus which is suited to deal with these shales, simple and economical in operation, and based on sound scientific principles; to refine the crude oil thus obtained into staple products for which there is a ready market; to develop markets for such products of the industry as cannot find an advantageous sale under present conditions; and so to organize the various processes involved that oil-shale may be turned into profit.

Oil-Shale an Indefinite Term

It should be emphasized strongly at the start that "oil-shale" is a term which is even more indefinite than petroleum. Certain shales, for example those of New Brunswick, yield crude oils of relatively non-paraffinaceous mixed base, whose nature is such that their refining may not be effected economically with recovery of any other products than motor fuels and fuel oil, while, on the other hand, crude oils containing large percentages of paraffine may be obtained from such shales as that at Elko, Nev., and offer refining possibilities of an entirely different nature. In fact, it may be said that the most outstanding characteristic of oil-shales is their variability. Obviously, oil-shales may be classified as above on the basis of their destructive distillation products. It has also been suggested by W. A. Hamor that a more logical classification might be made on the basis of the predominating hydrocarbon minerals associated with various oil-shales whose distillation products are generally similar to those from the accompanying oil-shales. For example, Arcadian shale might be classified as albertitic; Australian, coorongitic; Kentucky, grahamitic; Scottish, torbanitic; and Colorado, gilsonitic.

When it is considered that it is possible to produce a considerable variation in the crude oil from any one of these oil-shales by varying the conditions of retorting, it is seen at once that a complete solution, if possible, of the problems of producing finished products from a given shale will by no means represent any solution of the problems of the American shale-oil industry. The folly of reasoning from one oil-shale to another by analogy has been demonstrated; perhaps never more clearly than in the case of the Commonwealth Oil Corporation, formerly operating in New South Wales. Complete Scotch retorts were installed in this case, without proper preliminary experiment, and soon had to be abandoned because of their inapplicability.

Growth of Oil-Shale Industry Likely to Parallel That of the Petroleum Industry

The fundamental ignorance of the properties of shale-oils produced from various American shales under different conditions, the uncertainty with regard to many questions as to the origin and nature of the shales themselves, and the dearth of scientific information respecting the hydrocarbons and oxygen, sulphur, and nitrogen compounds present make it seem probable that the primary development of the shale-oil industry in many ways will parallel the early growth of the petroleum industry, in that cut-and-try methods will be more in evidence than the intelligent application of scientific principles. A scientific principle must be established before it can be applied. However, the technical man will be more conspicuous than in the early petroleum industry, both because the processes involved in recovering and refining shale-oils are more complicated than those encountered in petroleum work, and because the shale-oil producer must face a market which, while not knowing exactly what it wants in all cases, nevertheless is educated beyond the wildest dreams of the early petroleum pioneers. Both these factors must influence profoundly the methods of attack upon the problems of the industry. It is interesting to note that, in 1860, the problem confronting the petroleum industry was to educate a public accustomed to lamp oil from crude coal-oil to the use of kerosene from petroleum, while the situation faced by the prospective shale-oil producer in many ways is practically the reverse of this.

Other Petroleum Substitutes Which May Compete With Shale-Oil Products

It is difficult to consider the problems of the shale-oil industry without at the same time taking into account the problems involved in the development of substitutes for petroleum and its products from other sources, such as the low-temperature distillation of coal, lignite, peat and miscellaneous organic materials. The effect of these products on the industry will be to limit the prices to which shale-oil products can rise after competition from natural petroleum has been eliminated by exhaustion of supply. However, the production of these low-temperature tars need not hinder the development of a shale-oil industry, inasmuch as the field is large

enough to accommodate all possible substitutes for petroleum. If there were at the present time a low-temperature carbonization industry of the proportions of the present byproduct coke industry, with a ready-made technology of preparing satisfactory petroleum substitutes economically, such an industry could supply less than 5 per cent of the current national demand for petroleum. To be sure, the byproduct coking industry is expanding rapidly, but this will afford some conception of the impossibility of supplying our future needs for petroleum by low-temperature carbonization alone. On the other hand, alcohol represents a different type of competing product, in that its production is limited only by price and demand, so that it may reasonably be assumed that ultimately the limiting price for motor fuels will be fixed by the price of alcohol. Again the statement must be qualified by the consideration that, until economic conditions are such that tropical vegetation may be used as a source of raw materials, potential alcohol production from the various available domestic sources, and especially from foodstuffs, is not sufficient to dominate the motor-fuel market. It is not the province of this paper to discuss the influence of these related products on the future of the shale-oil industry; but they are mentioned to direct attention to the facts that the production of oil from shale by destructive distillation is fundamentally an economic compromise, that its problems are economic problems, and that, for their proper solution, some acquaintance with these related fields, and especially the development of much information not yet available in these fields, will be necessary.

No One Solution for All Cases

Further, in solving problems which do come up, it is manifestly impossible that one solution will fit all cases. Not only will local variations in transportation, climate, water supply and demand for products largely influence the methods used in treating various shales, but the inherent variations in the oil-shales themselves are so great that the utmost caution must be exercised in applying proved facts regarding one shale to other shales, or in forming generalizations based on limited evidence.

On the other hand, there are many fundamental problems which can be solved without the expense incidental to repeating research work on a large number of shales. For example, most American shale-oils appear to have certain characteristics in common, such as their relatively high percentage of unsaturated compounds, their objectionable odor, their characteristic oxidation colors, and the presence of nitrogenous alkaloidal tars of high molecular weight. Each of these characteristics suggests certain fundamental problems which can be solved by working on a limited number of shale-oils.

The outline of the problems of the oil-shale industry which follows does not aim to deal further with the details of many of the economic problems which must arise; but it is intended to show very briefly the present state of our knowledge in various divisions of the field of oil-shale technology and to suggest some channels which future investigational effort may take, both in the development of commercial processes and in the collecting of fundamental scientific information. It is intended to be suggestive rather than inclusive in its scope.

The material listed has been divided logically into (1) problems for pure-science research and (2) technological problems to be met.

I. Problems for Pure-Science Research

A. The Study of the Nature of Kerogen

1. Morphology, Microscopy and Physical Characteristics

These subjects belong rather to the field of the geologist and petrographer than to that of the chemist. However, the study of the nature of the material from which the kerogen originated and of its various forms must precede definite chemical study; it will also suggest the most profitable lines of attack from a purely chemical standpoint. The field has by no means been exhausted, but work now being done along these lines by Dr. Reinhardt Thiessen,[1] of the United States Bureau of Mines, should add much to our knowledge of American shales.

2. The Chemical Nature of Kerogen

(*a*) Separation of kerogen from inorganic material.

(1) By flotation. This has been attempted at the Mellon Institute, but without much success. Starting with a material containing 65.8 per cent ash, a concentrate containing 61.25 per cent and tailings containing 68.68 per cent ash were obtained in a Callow cell, using a small amount of pine oil as the flotative agent. While it is possible that different conditions may effect greater concentration, it is not probable that ash-free kerogen can be prepared in this manner.

(2) By gravity separation.

(3) By the Trent process.[2] This has been attempted by the U. S. Bureau of Mines, with results very similar to those obtained in the case of flotation.[3]

(4) By heating oil-shale under high-pressures, with the idea of using pressures sufficiently high to retard the formation of oil vapors, which would be accompanied by increase in volume. Negative results were obtained by this method, up to 1,600 lb. per sq.in. pressure.[4]

(5) By the action of solvents on the kerogen. No known solvent seems capable of effecting such a separation; hence the action of solvents is included below under the chemical study of kerogen, rather than under its separation from ash.

(6) By the action of solvents on the ash. Numerous attempts have been made by various investigators to dissolve the ash from finely divided shale by means of acids, with only partial success. Alternate treatments with hydrofluoric acid and aqua regia seem to be most effective, but even these are not capable of reducing the ash content to zero, and the kerogen seems to be considerably altered by the chlorinating and oxidizing action of the aqua regia. Hydrofluoric and hydrochloric acids, alternately used, do not change the kerogen so much.

(*b*) The study of the chemical nature of kerogen as shown by its reactions. In general, it may be said that the investigations of the chemical constitution of coal could be repeated profitably on oil-shale, if its chemical nature is to be elucidated and its exact relation to coal fixed definitely. As a guide for this work,

[1] See, for example, *Bull. Geol. Soc. Am.*, vol. 32 (1921), pp. 72-3; or *Econ. Geol.*, vol. 16 (1921), pp. 289-300.

[2] On the Trent process, see Bacon and Hamor, "American Fuels," vol. 1, McGraw-Hill Co., 1922.

[3] Private communication.

[4] Unpublished work, Mellon Institute of Industrial Research.

the review of the literature on the constitution of coal prepared by Wheeler and Stopes[5] is valuable, while the later work of the Kaiser-Wilhelm Institut für Kohlenforschung[6] is suggestive in many cases. Some lines of purely scientific research which should be covered are indicated as follows:

(1) Ozone has been used to produce considerable percentages of water-soluble materials from coal, but its action on oil-shale has never been studied.[7]

(2) Studies of the solvent action of the following and other solvents should be extended to cover a larger number of shales. Especially should uniform conditions of extraction be established, and the properties of the products obtained reported in terms which would permit some comparison of the work of different investigators.[8]

(*a*) Pyridine,
(*b*) Aniline,
(*c*) Phenol,
(*d*) Liquid sulphur dioxide,[9] and
(*e*) Liquid ammonia, suggested by the presence in oil-shales of complex nitrogen compounds which reasonably could be expected to be soluble in it.

The solvent action of the ordinary bitumen solvents is so slight as to offer little promise of yielding any significant results; but extractions at relatively high temperatures and pressures with benzene, carbon bisulphide, chloroform and carbon tetrachloride might give interesting products. In this connection a study from a quantitative standpoint of the adsorption of crude shale-oils or extracted bitumen by finely divided clays is needed, for the percentage of material dissolved out of a shale by any of these solvents bears no necessary relation to the percentage of soluble material present, owing to adsorption effects.

(3) Studies should be made of the solvent action of various reagents which react chemically with the kerogen. Some of the solvents listed under (2) may be placed in this class.

(*a*) Selenium oxychloride. Preliminary work has been done with this compound by a number of investigators, but it seems to so alter the kerogen as to offer small hope for any clean-cut results.

(*b*) Sulphuryl chloride is said to be superior to selenium oxychloride in many respects, some work having been done with it as well.

(*c*) Acetylation, sulphonation, nitration and chlorination may be carried out on the oil-yielding substance, but so far as is known the products have never been examined. In some cases—e.g., nitration—it is necessary to employ a solvent to extract the products formed.

(*d*) The kerogen forms a dark colored complex with sulphuric acid,[10] at 110-120 deg. C. The study of this product might throw further light on the chemical nature of kerogen.

(*e*) Determination of methoxyl content.[11]

(*c*) The study of the chemical nature of kerogen as revealed by ultimate analyses. Very few ultimate analyses are now available on oil-shales from various parts of the United States.[12] If the importance of the ultimate composition of kerogen in its influence on the quality of oil formed were established, an incentive would be provided for obtaining other information of interest. The oil-shale laboratory of the U. S. Bureau of Mines is now studying the ultimate composition of oil-shales.

(*d*) The hydrolysis of kerogen. In many shales the exines of lycopodiaceous spores are quite numerous, and the microscopic evidence on this point seems good, but it is not so well established chemically. Steuart,[13] who made an "artificial shale" from lycopodium spores and fullers earth, obtained crude oil from it very like Scotch shale-oil in gravity and setting point. Evidence of the presence of fatty acids in oil-shale or their production from it by hydrolysis would be more nearly conclusive.[14]

Thermal Decomposition of Kerogen

(*e*) The thermal decomposition of kerogen. The work of Jones and Wheeler[15] on the distillation of coal in vacuo should be carried out on oil-shales. This would involve slow distillation at a pressure of, say, 20 mm., raising the temperature in 50 deg. steps, each step to last long enough for equilibrium to be established. Of course fractions should be separately examined.

The results to be obtained should include the following for each step:

(1) A complete gas analysis, including the determination of olefines heavier than ethylene, and fixing the temperature limits of the evolution of each constituent of the gas.

(2) An examination of the aqueous distillate for ammonia, pyridine and higher bases, and especially for other water-soluble compounds. It has been noted that when oil-shale is distilled at atmospheric pressure, foul-smelling sulphur compounds distill over with the aqueous distillate considerably below the temperature of first oil formation. The suggestion is obvious that some of the compounds responsible for the offensive odor of shale oils are produced by the destructive distillation of a material in the shale distinct from the oil-yielding material. However, practically nothing is known of these changes.

(3) The distribution of nitrogen among the water, the oil and the gas.

(4) The examination of the oil to determine the important physical constants, ultimate composition and constituents soluble in alkali and in dilute acid.

B. Fundamental Research on the Hydrocarbons, Oxygen, Nitrogen and Sulphur Compounds Present in Shale-Oils

This section of the problems of the industry is related so closely to the needs of the petroleum and coal-tar industries along the same line that only a few questions, more or less peculiar to shale-oils, will be taken up. Some idea of the lack of information on the great majority of the compounds present in mineral

[5]Wheeler and Stopes, "The Constitution of Coal," Department of Industrial and Scientific Research, London, 1918.

[6]"Gesammelte Abhandlungen zur Kenntnis der Kohle," Mulheim am Ruhr, 1916, *et seq.*

[7]See Fischer and Niggeman, "Gesammelte Abhandlungen zur Kenntnis der Kohle," vol. 1 (1917), pp. 30-42; also *Ber.*, vol. 49 (1916), pp. 1472-4.

[8]As an example of the importance of clearly defined and uniform methods of extraction, see Bone and Sarjant, *Proc. Roy. Soc.*, London, vol. 96A (1919), pp. 119-36; and *Chem. Abs.*, vol. 14 (1920), p. 111, on the influence of the access of oxygen and of various physical conditions on the extraction of coal substance with pyridine.

[9]*Cf.* Fischer and Glund, *Ber.*, vol. 49 (1916), pp. 1469-74.

[10]See Marcusson, *Chem. Zeit.*, vol. 42 (1918), pp. 437-9, on the formation of similar complexes from coals.

[11]*Cf.* Fischer and Tropsch, "Gesammelte Abhandlungen zur Kenntnis der Kohle," vol. 2 (1917), pp. 151-3.

[12]See Winchester, U. S. Geol. Surv. *Bull.* 641-F, for a few ultimate analyses of American shales; and Botkin, CHEM. & MET. ENG., vol. 24 (1921), pp. 876-80, on the relation between ultimate analysis and quality of oil.

[13]Steuart, *Mem. Geol. Surv. Scotland*, "The Oil-Shales of the Lothians," 1912, p. 164.

[14]Langer has reported in *Arch. de Pharm.*, vol. 27 (1889), pp. 241-65 and 289-309, a series of experiments on *Lycopodium clavatum*, which support this contention.

[15]*J. Chem. Soc.*, vol. 97 (1919), pp. 99 and 649.

oils may be gleaned from numerous contributions to the literature.[16] The case for further research on non-benzenoid hydrocarbons has been stated by Brooks.[17] Scientific inquiry along these lines would be of direct assistance to the shale-oil industry.

Among the subjects of pure-science research of especial interest in connection with shale-oils are the following:

(1) All shale oils appear to contain nitrogenous tars of high molecular weight. The particular interest attached to them lies in the fact that they comprise a large part of the relatively large loss suffered in refining shale-oils, and may constitute as much as one-fourth part by weight of the oily distillate.[18]

While it is believed that the various series of nitrogen compounds may extend from their simplest members through heavier tars to solid compounds stable at high temperatures,[19] little is known of any but the lowest members.

It is possible to hydrolyze tars obtained from some shale-oils, with the production of simpler nitrogen bases, and it seems quite probable that a better knowledge of some of the higher nitrogenous compounds may suggest a commercially feasible process of cracking or treating them to produce non-nitrogenous oils, or at least products of value. As is well known, at the present time the Scotch acid-tars, which are made up largely of these nitrogenous compounds, are burned.

Other possibilities are suggested by the fact that some of these tars, as well as the "asphaltenes" separated from crude shale-oils by means of petroleum ether, are quite soluble in 95 per cent ethyl alcohol. This behavior suggests a fundamental point of difference from petroleum asphalts, which indicates a probable difference in other properties as well.

(2) Many shale-oils, and perhaps all, yield light distillates which rapidly oxidize in sunlight to a wine color. The nature of this coloring material is quite unknown, but research on it may lead to valuable results.

It is suggestive that the material is soluble in dilute ethyl alcohol, is reduced to a colorless compound (leuco base?) by sodium hydrogen sulphite, and is red in acid, but colorless to yellow in alkaline solutions.

(3) The closer study of the gum-forming materials in shale-oil gasolines from a purely scientific viewpoint, and the establishment of the relationships between these and similar compounds in pressure distillates from petroleum should be attempted. The work of Steuart[20] will furnish a starting point.

II. Technological Problems

A. Mining Problems

Our present knowledge of the mining of oil-shale is restricted to the Scotch oil-shale industry. Many favorable factors make it appear that the mining of oil-shale will present no insurmountable problems, but, as in any industry whose profits depend upon tonnage, a big field is open to the engineer's skill in lowering costs by efficient handling of materials.

B. Crude-Oil Works Problems

In the crude-oil works also, methods of handling materials will play an important part. However, the fundamental problems are two: What retort shall be used? And under what conditions shall it be operated?

A number of variously designed retorts have been operated in Scotland and elsewhere. While it is not the function of this paper to discuss their development through the periods when burning oils, paraffine and later ammonium sulphate were the principal desiderata, it should be emphasized that a thorough study of these retorts is a necessary preliminary to any proper consideration of the problems before the American shale oil industry.

During the past five years there has been an almost continuous flow of designs for oil-shale retorts into the U. S. Patent Office. These applications include many permutations and combinations of various simple elements, most of which are by no means novel, but many possible arrangements have been overlooked. Owing to this fortuitous circumstance, it is still possible to invent an oil-shale retorting process, and the enthusiasm of prospective inventors should by no means suffer any diminution.

It should be noted, however, that the success or failure of the considerable number of processes which seem to be designed upon sound principles will be based not upon the sublime inspiration embodied in the patent specifications so much as upon the intelligence with which mechanical difficulties are overcome, and upon the care and technical skill shown in determining and regulating conditions of operation. It is probable that at least a half-dozen of the processes proposed to date are fundamentally sound enough to survive competition if applied to retorting a shale under conditions to which they are suited, and if they are developed intelligently to the point where continuous and economical operation can be obtained.

In accordance with this view, the effort has been made to list only problems which appear to be fundamental. For example, if a certain oil-shale seems to require stirring in thin layers, it may make small difference whether it be stirred in A's agitated retort or in B's, provided that the mechanical efficiencies and operating advantages of the various agitating devices are the same, and assuming good engineering.

1. Retorting Problems

(*a*) What is the best practice in crushing oil-shale before retorting?

It is impossible to present this problem as a general one, as the optimum size of particles depends to a large extent upon the retort which is to be used. In Scotch practice fines are undesirable, while in many of the proposed retorts which contemplate stirring the shale in thin layers and putting it through in very short periods, fine grinding may be essential.

A series of experiments, in which oil-shale particles of various sizes were plunged into a lead bath at constant temperature, indicated that crushing finer than about ¼ in. caused no more rapid evolution of vapor.[21] The whole problem needs closer consideration and determination in a way that will define the physical factors involved independently of any particular retort.

(*b*) Shall steam be used? If so, shall steaming be practiced in the same retort in which oil is produced,

[16] See, for example, Gurwitsch, "Wissenschaftliche Grundlagen der Erdölarbeitung," pp. 1 *seq.*

[17] Chem. & Met. Eng., vol. 22 (1920), pp. 933-7.

[18] Beilby, *J. Soc. Chem. Ind.*, vol. 3 (1884), p. 216.

[19] Beilby, *ibid.*

[20] Steuart, *J. Soc. Chem. Ind.*, vol. 18 (1899), p. 239.

[21] Unpublished work. The shale in these experiments was not stirred.

or shall the residue from retorting be treated in a separate chamber?

The answers to these questions must vary with the retort which is used. The Scotch retort in its present form operated without the use of steam would be an absurdity, while it is possible to design a retort which will produce just as good oils without the use of steam as with it.[22] Granting, then, freedom of choice in retort design, it would seem that the use or non-use of steam depends upon the cost of steam under the given conditions, the increased yield of ammonia obtained, and the difference in retorting cost caused by its use. The latter would require analysis for each new case, and would include difference in capital cost and operating cost on retorts, plus the additional expense caused by manufacturing a relatively large volume of water-gas, which must be handled, stored and burned, in place of burning the gas-forming constituents directly out of the spent shale. The determination of the magnitude of these various factors for different shales presents a large field for research.

The present state of our knowledge on the effect of steam and gases in ammonia recovery has been summarized by Franks.[23]

Rate of Heating

(*c*) What is the proper rate of heating to employ? Is oil that is produced in a retorting time of 30 minutes or less as good as oil that is produced in 3 or 4 hours or more?

This problem has received some attention, and many conflicting opinions may be found in the literature, but the issues in connection with it have not been differentiated clearly. Objections offered to short retorting periods usually are based on inferiority in experimental short-time oil, due to the fact that it has been necessary, as a consequence of the design of the experimental retort, to employ high temperatures in order to secure short retorting times.

Again, the quality of the oil obtained depends upon time, temperature and pressure during its sojourn in the retort, so that an oil made in 3 hours with the use of large amounts of steam or gases to remove oil vapors from the retort may represent the same actual contact time at the retort temperature for the oil itself as a similar oil made without steam in about one-sixth the time.

These conditions are not always easy to determine; but it should be possible to settle this controversy satisfactorily by small-scale experiment, provided care is taken to define completely vapor contact times, refluxing effects and actual wall temperatures, as well as the retorting time. A simple comparison of oils made with short and long retorting times means absolutely nothing without these other data.

Influence of Secondary Decomposition

(*d*) What is the influence of secondary decomposition? What is the maximum permissible temperature along the walls of a retort, and what is the effect of the time factor in this connection?

It has been accepted generally as axiomatic that the maximum yield of good oil is obtained by withdrawing all vapors as soon as possible without heating them above the temperatures at which they are formed. There is a basis for this belief, but it is a half-truth.

By secondary decomposition is ordinarily meant avoidable cracking, which reduces the oil yield below the maximum obtainable. The exact point where primary pyrolysis of kerogen to form oil ceases and secondary decomposition begins never has been defined, but it might be well to accept the yield and quality of oil obtainable from a given shale under optimum conditions in a laboratory retort as the criterion, and assume that any reduction of this yield, due to overheating of vapors, is a measure of secondary decomposition.

Secondary decomposition, in this sense, is a chemical reaction and cannot be defined fully in terms of temperature. It must depend upon time, pressure and the presence or absence of catalysts as well.

It has been shown at the Mellon Institute that shale-oil vapors may be heated as much as 250 deg. C. above the temperatures at which they are formed, for short contact times of the order of 1 second, without suffering any marked change in yield, gravity or unsaturation. On the other hand, it is known that much milder overheating for longer periods of time decreases the yield; while, if samples of shale-oil are maintained at or even below the temperatures at which they were formed, in stills provided with refluxing condensers, they may be cracked to coke and gas within several hours.

It may never be possible to treat the reactions involved with the mathematical nicety of simpler ones; but a broad field for research is open, and it may some day be possible to predict the percentage of the theoretical yield which will be obtained in a proposed retort, from a knowledge of its volume, the rate of evolution of vapor, its wall temperature at all points, the magnitude of refluxing effects and the pressure and gas-tightness under given operating conditions.

Temperature at End of Run

(*e*) What is the best "finish" temperature to use in the retort—i.e., how hot should the shale be heated before discharging?

The answer to this question will depend largely on whether steam is to be used or not.[24] If steam is used, "finish" temperatures should be sufficiently high to permit practically complete removal of fixed carbon from the spent shale by the steam, according to the water-gas reaction. The maximum temperature in Scotch practice is about 1,300 deg. F. Where steam is not used, the desirable "finish" temperature depends entirely upon the disposition of the spent shale. If this is to be burned, it would seem to be economical to carry the distillation no further than is required to recover all obtainable oil, since it is cheaper to burn a given amount of gas-forming constituents out of the spent shale than to distill the gas from them, handle it, store it in gas-holders, and then burn it. The spent shale as discharged is already hot and in ideal condition for immediate combustion. It appears that it can be burned easily under the proper conditions, but many problems remain to be considered adequately.

(*f*) What pressure should be used in the retort?

Mechanical limitations must influence the decision as to pressure. If ovens or retorts of ceramic material are used, it will be desirable to operate at very slight positive pressure, in order that the retorts may be self-

[22] See Botkin, CHEM. & MET. ENG., vol. 24 (1921), p. 876; and *U. S. Bureau of Mines Reports of Investigations*, No. 2254. For an exposition of the opposite view, see George, *Colorado Geological Survey Bull.* 25.

[23] CHEM. & MET. ENG., vol. 23 (1920), p. 1149.

[24] The question of the use of steam has been considered in (*b*), pages 549 and 550.

sealing and any unnecessary oxidation of oil vapors may be avoided. Byproduct coke-oven practice is available for guidance in such cases.

On the other hand, where retorts are constructed of iron or alloys, more latitude in pressure may be enjoyed, and it may be desirable to operate under negative pressure, to assist in removing vapors quickly. Retorting under higher pressure yields a larger percentage of saturated oils, as has been reported by George.[25]

While pressure cracking of oil-shale might present problems which could not be solved economically on a commercial scale, the influence of pressure on the character of the oils formed requires attention.

(*g*) What is the influence of the admission of air or combustion gases retaining some oxygen on the quality of the oils formed?

Certain inventors propose to pass the combustion gases through oil-shale, to assist in the retorting process; and while it is known that shale oils are very susceptible to oxidation, the exact effects of small percentages of oxygen in the retort atmosphere do not seem to have been determined. The practice of introducing a small amount of air in the Young and Beilby retort is an argument for the utility of the above procedure.

Influence of Various Added Materials

(*h*) What is the influence of adding various materials to the oil-shale during the retorting process?

The field for any modification of the retorting process such as is suggested by this question would be very limited indeed, in view of the large tonnage of low-grade material which must be handled and the fact that few possible materials are available at low enough cost which might have beneficial effects.

Gypsum has been mixed with shale before retorting, and the effect of the steam produced has been shown to be similar to the effect of the same amount of steam introduced from an external source.[26] Aluminum chloride[27] also has been mixed with shale before retorting; but it was shown that it sublimes into the condenser for the most part before oil is evolved from the shale, later polymerizing the vapors entering the condenser to a solid plug of bituminous material. It also has been proposed to introduce iron or iron salts in the retort to reduce the sulphur content of the oils.[28]

The study of the action of various catalysts and reacting substances should give at least a new insight into the retorting process, if it is not productive of important commercial results.

Choice of Fuel

(*i*) What fuel shall be used? What is the heat balance in the retorting operation?

The question of the sufficiency or insufficiency of fixed gases as retort fuel has been considered most fully by Gavin and Sharp,[29] who have made an excellent start in this field of inquiry.

(1) The results of researches such as the above should be extended to include a larger number of shales. However, much of this horizontal increase in our knowledge of oil-shale must await commercial development on a scale sufficient to pay for research.

(2) The effect of the "finish" temperature on the gas yield has not been considered fully. For example, Gavin and Sharp[29] assume that the amount and calorific value of gas recovered at 482 deg. C. and at 925 deg. C. is the same, although they mention the fact that higher "finish" temperatures produce more gas. A clear distinction must be drawn in this connection between retorting temperatures and "finish" temperatures, since there is no necessary connection between the two.

(3) The heat of reaction involved in the formation of oil from kerogen is a figure essential for striking a proper heat balance, but there is much that is not known about it.

McKee and Lyder[30] have made an impressive beginning in the field by developing a calorimetric method for the direct determination of the heat of reaction. Their results, however, indicate a considerable endothermic reaction, while the investigation of Gavin and Sharp[31] shows a rather strong exothermic reaction. The discrepancy seems to indicate a field for further investigation inasmuch as both pieces of work are quite authentic.

2. Ammonia Recovery Problems

The production of ammonia in the retort has been considered; and inasmuch as the manufacture of sulphate of ammonia *per se* is in effect a separate industry, having its own problems and its own equipment purchasable in the open market, it need not be discussed here. It is pertinent, however, to call attention to the profound influence which ammonia recovery may have on the solution of the retorting problem.

3. The Disposal of Spent Shale

In the majority of cases, spent shale probably will prove to be valueless and will have to be dumped. In particular cases, however, it is entirely possible that the manufacture of byproducts from spent shale may rival the main business of manufacturing shale-oil. Among the possibilities suggested are the following:

(*a*) The recovery of potash.

The spent shale obtained from many shales contains a small percentage of potash, and in some cases this might be leached out at a profit. The problems presented should not be difficult to solve, but have not yet been met.

(*b*) Use direct as a fertilizer.

Used alone, the potash content of spent shale would scarcely be sufficient to class it as a fertilizer. It seems probable, however, that, in certain cases where the shale plants are located in agricultural districts and no freight charges must be met, the spent shale might be sold locally as a filler for compounded fertilizers, and might command a price based on its soluble potash content.

(*c*) Preparation of decolorizing "carbon" from spent shale.

While this field does not seem to offer promise, it must be admitted that its possibilities have not been explored to any extent.

(*d*) Recovery of precious metals.

This "problem" seems to give more trouble to the unwary investor than to the technologist, but "values" have been reported in some oil-shales, and it is not impossible, though unlikely, that in particu-

[25]R. D. George, *Bull.* 25, Colorado Geological Survey, p. 65.
[26]George, *Colorado Geological Survey Bull.* 25.
[27]Unpublished work, Mellon Institute of Industrial Research.
[28]G. E. Heyl, British Pat. 115,452, September, 1917.
[29]State Colorado Co-operative Oil Shale Investigation, *Bull.* 1.
[30]*J. Ind. Eng. Chem.*, vol. 13 (1921), pp. 678-84.
[31]*Loc. cit.*

lar instances commercial recovery may be carried out.

(*e*) Use as an insulating material.

Schmidt[32] has advocated the use of spent Wurtemburg shale as a heat-insulating material. While such a use might have only local significance in this country, it should receive further consideration, if only as a possible source of insulating brick for use in shale works not near better raw material.

(*f*) Brick manufacture.

Thomas[33] has discussed the use of spent shale in brick manufacture and reports that practical tests have shown that satisfactory brick can be made from spent Colorado shale.

The success of such a plan will depend almost entirely upon the nearness to the market, and it appears that, in the case of our richest Western deposits, the manufacture of any large quantity of heavy low-grade products of this sort will be out of the question. On the other hand, there are shale fields more favorably located where conditions are more promising. Only a very limited number of ash analyses have been made, and a broad field is open for further work.

(*g*) Manufacture of portland cement.

A process of retorting oil-shale has been proposed,[34] in which the spent shale is burned in a rotary cement kiln and in which the retort proper is heated by waste heat from the kiln.

The suggestion that portland cement be made from spent shale apparently has occurred to many, but little actually is known about the suitability of spent shales from various localities. The economic limitation imposed by transportation also seems likely to restrict this use to certain deposits.

4. The Disposal of Excess Gas

No problem is presented in disposing of excess gas, since the communities which must be built up to operate shale works of any size can absorb any excess not used around the works.

It should be pointed out, however, that shale gases made without steam contain considerable percentages of olefines, the amount reaching 10 per cent in some cases. This should be sufficient to warrant the use of the gas as the basis of a chemical products industry at some future time. It is beyond the province of this paper to detail the possibilities, as the olefine-products industry forms a separate field.[35]

C. Refinery Problems

The problems of the petroleum industry[36] are to a large extent also the problems of the shale-oil industry. However, problems such as the disposal of acid sludge take on a new significance where the amount produced exceeds 20 per cent of the volume of crude oil refined.

It will not be attempted here to deal with all the problems of shale-oil refining. Of course, the oil should be refined to recover products of maximum value, and in view of the wide variations among shale-oils, no general or sweeping statements can be made. Many problems can be handled ably by those experienced in petroleum refining.

On the other hand, there are certain fundamental differences between shale-oils and petroleum oils which suggest problems not familiar to the refiner of petroleum. Some of these will be presented.

The most important problem before the prospective shale-oil refiner is the general one of refining a highly unsaturated oil economically. So far as the lighter fractions are concerned, the problem is similar to that of refining pressure distillates, and yet it possesses points of difference from the latter, in that the percentage of unsaturates found in shale-oil gasoline fractions probably averages higher than in the case of pyrolytic gasoline, and in that compounds are present in the light shale-oil distillates which are not found in ordinary pressure distillates.

The problem is met in the Scotch industry by using small quantities of acid and by resorting to several redistillations. The intention of the Scotch refiner is to use as much acid in treatment as is possible without attacking the olefines.[37]

While Scotch practice might be followed on American shale-oils not requiring more drastic desulphurization, it appears that there is excellent chance for improvement in the procedure. The possibility of refining entirely by fullers earth,[38] bauxite, silica gel and various other adsorptive agents has occurred to many. It may be stated confidently that these and all other means of refining which avoid sulphuric acid treatment may look to shale-oils with more hope than to most petroleum refining, not because any proof has been advanced of their superiority, but because the need for some economical method of refining is greater, and because there is more room for improvement in the case of shale-oils. It is possible that the practice of refining oils with sulphuric acid may some day be abandoned.

In case sulphuric acid treatment is adhered to as the basis of the refining treatment, for the lighter fractions other problems must be met. The most important of these is, how far must refining be carried to produce a satisfactory product? Refining loss can be reduced considerably if odor and color are ignored, and a red product is marketed. It is not entirely clear whether such a red color would be an asset or a liability, but we do not yet know to what extent the color is produced by gum-depositing compounds whose presence to any extent in a shale motor-fuel or burning-oil would be objectionable. Refining must certainly be carried far enough to reduce the gummy polymerization or oxidation products within permissible limits. Does this necessitate the removal of the red color or not?

The question of whether lighter acid can be used to advantage has not been dealt with properly. What is the advantage of blending a crude shale-oil with petroleum before refining, if any? Could a cracking distillation be so regulated as to yield a higher percentage of desirable oils in the "once-run oil" from the nitrogenous tars in the crude shale-oil? Could these tars be separated from the oil, and separately treated or cracked to produce more valuable products?

Recovery of Lubricating Oils

Coming to the lubricating oil fractions, and taking into account the variations which may be expected, certain fundamental peculiarities seem again to distinguish these from similar products obtained from petroleum. In general, shale-oils provide a source of only relatively low viscosity lubricants, containing con-

[32] "Die Verwertung des Oelschiefers," Wittwer, Stuttgart, 1920.

[33] Chem. & Met. Eng., vol. 24 (1921), p. 389.

[34] R. W. Lesley, U. S. Pat. 1,323,294.

[35] See Curme, Chem. & Met. Eng., vol 25 (1921), pp. 907 *seq.*

[36] On some of the problems of the petroleum industry, see, for example, Hamor, Chem. & Met. Eng., vol. 23 (1920), p. 425.

[37] Steuart, *J. Soc. Chem. Ind.*, vol. 8 (1889), p. 100.

[38] In this connection see U. S. Pat. 1,340,889.

siderable amounts of easily oxidizable material which must be removed.

Even though in the earlier stages of the shale-oil industry in this country no attempt may be made to recover lubricating oils, it must be realized that, although other substitutes may be found for motor fuel, it is probable that oil-shale and coal will be ultimately the only important sources of lubricants, unless some way is found of greatly cheapening vegetable or animal oils. Hence it is important that some means be developed for manufacturing economically as wide a range of lubricants as possible from shale-oils.[39] Means have been found for increasing the viscosity of low temperature coal-tar fractions,[40] which have potential value for this purpose.

Shale-Oil Residues

Another set of problems will accompany the application of shale-oil residues to the common uses for petroleum residues, such as for roofing, paving and compounding with other asphalt products for various purposes. Practice in the Scotch industry has been to carry out a first and partly destructive distillation to coke. This treatment, logical enough in the case of the Scotch shale-oil, the most valuable product of which is paraffine, certainly will not fit all American shale-oils. Not very much is known of the properties of shale-oil asphalts,[41] although from their nature it is to be expected that they will prove intermediate in properties between petroleum residua on the one hand and coal-tar pitches on the other. Studies of air-blowing and sulphurization of shale-oil asphalts do not appear to have been made, but deserve attention. Owing to their nitrogen content, some peculiar properties may be found which will indicate special applications. Mention has been made of the presence in the crude shale-oil of tars soluble in 95 per cent ethyl alcohol.

Minor Byproducts of Shale-Oil Refining

In addition to the staple products mentioned above, a considerable number of specialties may be manufactured from shale-oil; and while these may never assume great commercial importance, they may form the basis of small branches of manufacture under especially favorable circumstances.

On account of their unsaturated nature and accompanying reactivity, shale-oils may possess potentialities not possessed by petroleum as a basis for the chemical manufacture of fatty acids, drying oils and other products. This field is quite untouched, since most of the possibilities of the better-known petroleum industry along this line have not yet unfolded.

Certain shale-oil fractions differ sufficiently in composition from the corresponding petroleum solvents to make it seem reasonable that their characteristic properties may command a market different from or even better than that open to petroleum solvents.

The preparation of various dyestuffs from shale-oils has been advocated by many persons, though mostly by typical promoters of the worst sort. However, it cannot be denied that this field is entirely open, and that it is by no means impossible that a variety of dyestuffs may some day be prepared from shale oils.

The possible preparation of polymerization resins similar to coumarone resins from coal-tar distillates is another field so far unexplored.[42]

Ichthyol,[43] a product manufactured from an Austrian fossiliferous shale, may be prepared from certain American bituminous minerals. However, it commands a relatively small market, and would not repay any great amount of effort.

Judged by present specifications, shale-oils are ill-adapted to furnish impregnating oils for timber. As these specifications are based upon properties desirable in coal-tar impregnating oils, however, it is quite possible that shale-oils should be judged by different standards. Their content of unsaturated hydrocarbons and nitrogen compounds distinguishes them from petroleums and coal tars for this purpose. The Forest Products Laboratory, at Madison, Wis., is obviously fitted to consider the problem.

The application of shale-oils to the froth flotation of low-grade ores has occurred to many workers; but while numercus tests have been made with them, they have not yet been applied commercially with success, to the writer's knowledge. Preliminary tests have not indicated that crude Colorado shale-oils show any marked superiority over crude petroleum under the conditions of experiment. At least one company[44] is said to be marketing shale-oils for flotation, however, and has advertised for sale a trade-marked brand of flotation oil manufactured from oil-shale. It is possible that, with the return of the copper industry to normal, a considerable field may be opened for the application of shale-oils to ore flotation.

Many other proposed byproducts have come in for attention, all of which present problems before anything commercially profitable can be developed from them. In the present state of the art, these can be listed only as suggestive of possibilities, for information is not available nor has the writer the specialized experience to catalog the problems which would be met in attempting their commercial application. Sheep dips, shale soaps[45] and insecticides[46] may be mentioned.

In almost all departments of the shale industry, many problems remain to be met, and in many cases the present knowledge is so fragmentary and proposed applications of this knowledge are so embryonic that one cannot even state intelligently the problems to be met. But that they will and must be solved cannot be doubted.

Potential Demand for Cosmetics in China

A potential demand for cheap grades of cosmetics in increasing quantities exists in China, says Consul General Cunningham in a report to the Department of Commerce. Native preparations are gradually giving way to imported articles. Highly perfumed toilet waters, face cream, powder and tooth paste are in demand.

[39] In this connection see Brownlee, U. S. Pat. 1,309,432.

[40] Fischer, "Ges. Abhandl. zur Kenntnis der Kohle," vol. 1 (1917), p. 254.

[41] *Cf.* Botkin, C. W., Chem. & Met. Eng., vol. 26, p. 398, March 1, 1922; p. 445, March 8, 1922.

[42] For a review of the literature on coumarone resins from coal tars and their uses see *J. Ind. Eng. Chem.*, vol. 8 (1916), p. 797.

[43] For general information on ichthyol see "Tariff Information Surveys," A-12, Par. 561, Washington, 1921. It should be noted in this connection that the Meadows Chemical Corporation, 52 Vanderbilt Ave., New York City, has placed on the market an ammonium ichthyolate obtained from an asphaltic limestone found near Burnet, Tex. United States Pat. 1,271,387 and 1,073,548, owned by the Atlantic Refining Co., cover the preparation of a similar ichthyol substitute from filtered lubricating distillates from petroleum.

[44] Reference is had to the Muscle Shoals Oil Refineries (Ginet process), of Denver, Col., and "Mutual 100 Flotation Oil."

[45] The Oil Shale Mining Co., of Hastings, Neb., has put on the market soaps which are said to contain shale-oils.

[46] On the use of petroleum oils as insecticides see *J. Econ. Entom.*, vol. 11 (1918), pp. 70 and 299. It would seem that shale-oils, by reason of their unsaturated hydrocarbons and their content of alkaloidal compounds, might be expected to compare favorably with insecticides from petroleum.

"Science as Applied to Industry" at Yale*

By William E. Ford
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A NEW course of study known as "Science Applied to Industry" has this year been offered to the students in the Sheffield Scientific School for the first time. Since this new course has proved to be the most popular choice of the present Sophomore class in the Scientific School, it having been elected by almost one-quarter of the entire class, it should be of interest to examine somewhat in detail its contents and aim.

In the past, many graduates of the Sheffield Scientific School who had taken technical courses, such as those offered in the various fields of engineering or in chemistry, have become after graduation managers and executives in various lines of industry rather than the technical men for whom their undergraduate course was designed. These men desired in their college course a thorough knowledge of the scientific fundamentals of their work and a mental training in scientific methods of thinking, but they did not need all the details of technical knowledge that a professional engineer or chemist requires. It was for this class of men—always numerous but increasingly so in the last decade—that the course known as Administrative Engineering was established last year, to be followed this year by the course in Science as Applied to Industry. To quote from the description of the latter course in the Scientific School pamphlet, "This course is not designed for those students who are seeking preparation for a professional career in some particular branch of science, such as chemistry or metallurgy, where problems of production are likely to occupy his attention; such professional training can best be secured in other courses. The prospective professional chemist, to mention a single instance, requires a training different from the prospective business manager in a chemical-manufacturing plant. It is to supply the training necessary for men to function intelligently and efficiently in important executive and managerial positions in the business world, where a knowledge of science and of the scientific approach to business problems is indispensable, that this course has been provided."

Plan of the Curriculum

In planning the curriculum of the course, naturally the first requirement was that it should include the elementary but indispensable courses in physics, chemistry and mathematics. Next, it was felt that no attempt should be made to cover the whole field of natural and physical science, but rather attention should be concentrated upon three branches of science—viz., chemistry, metallurgy and geology. The work in these sciences is so arranged that a natural and logical order of development is followed, covering, in some cases, 4 years of work in a single subject. A graduate of this course will therefore have acquired quite a comprehensive knowledge of these three scientific fields.

A business manager should be familiar with the characters and occurrences of the raw materials with which his business deals. The courses in mineralogy and geology cover this field for the mineral products while the course in zoology and botany which is offered as an option in Junior year will serve in a similar way for the animal and vegetable products. Secondly, he should be familiar with the methods by which these raw materials are prepared for industrial use. The courses in chemistry and metallurgy will, at least in part, meet this requirement.

In addition to these scientific subjects, the course includes in Junior and Senior years a series of courses grouped under the general heads of Social Sciences and Business Administration. These latter courses are naturally of great interest to the prospective executive.

The various courses offered are:

Sophomore Year. The total number of hours per week, including the hours allowed for preparation, is 48. The number of hours assigned to each subject is indicated in parentheses after the name of the course.

Mathematics (9). Physics (12). Modern Language (9). English Composition (4). Qualitative Analysis (8). Mineralogy (6).

Junior Year. The total number of hours per week for Junior year is 45.5. Of these, 34.5 are required, and one of the two options offered will provide the remaining 9 hours.

Physical Chemistry (6). Physical and Historical Geology (6). Elementary Metallurgy (9). Drawing (3). Industrial Mineralogy (3). Economics and Business Finance (7.5). The two options are Elementary Botany and Biology (9). Modern Language (9).

Senior Year. In Senior year the total hours must number 45, of which 37.5 are required, while the balance is to be made up of choice from a group of elective courses.

General and Physical Chemistry (9). Economic Geology, Elementary Petrology and Applied Structural Geology (9). Industrial Management (6). Statistics and Reports (3.75). Metals and Alloys (3.75). Principles of Accounting and Cost Analysis (6). The electives include Elementary Organic Chemistry (9), Industrial Chemistry (8), Economic and Regional Geology (6), Business Law (3.75). Insurance (3.75). Metallurgy of Iron and Steel (1.5). Transportation (3.75). Economic Problems (3.75).

The recent reorganization of the university led the Corporation to constitute the Sheffield Scientific School the undergraduate school for "professional study in Science and Engineering," while Yale College is to be the school for "non-professional study in the Liberal Arts and Sciences." It was further provided that the courses of study offered in the Scientific School should have "the major portion of their total work in approved courses in the Physical, Mathematical and Natural Sciences," while for students in Yale College "the 'Humanities' should normally constitute the major portion of their total work." The course Science as Applied to Industry is the least technical of the courses now offered by the Scientific School, yet its subjects of study fall well within the established limits. The total number of hours required during the three years in the Scientific School is approximately 137, of which the minimum number of hours that must be devoted to the physical, mathematical and natural sciences would be 84, or over 61 per cent of the total. By varying the character of the electives chosen, this percentage could be considerably increased.

This course is naturally only in its initial stages, and will doubtless undergo numerous minor modifications which time and experience may show to be desirable. It seems to the writer, however, that the fundamental ideas of the course are thoroughly sound and that it should give to an increasingly large group of men information of value to them in their business lives, and, what is of greater importance, a training in accuracy of thought and precision of judgment that is most essential to success.

*Reprinted from the *Yale Alumni Weekly* of Dec. 16, 1921.

Contributions to the Study of Ammonia Catalysts—II

Description of Apparatus Developed by the Fixed Nitrogen Research Laboratory and Used in the Small-Scale Testing of Ammonia Catalysts at Variable Pressures*

By A. T. LARSON and A. P. BROOKS

IN ANY comprehensive study of ammonia catalysts it is essential to have available a relatively small simple apparatus capable of operating under variable pressures of at least 30 atmospheres and preferably up to 100 atmospheres. Such an apparatus should possess mechanical simplicity, ease of construction, alternation and repair and flexibility of control, and yet be capable of sufficient precision to assure results of reasonable accuracy.

An apparatus of this type affords a much more rigorous test of catalysts than is afforded by the still simpler tests at atmospheric pressure. It is admirably adapted to the study of the effect of pressure, temperature, space velocity and poisoning by water or carbon monoxide.

It is not so suitable for such studies as deterioration of catalysts over long periods of time as is a larger and more elaborate testing plant. Furthermore, it bears little relation to a commercial unit and is therefore unsuited for a study of such factors at temperature gradient within the catalyst, or heat recovery.

In August, 1918, the Geophysical Laboratory, working under a grant from the Nitrate Division, Ordnance Department, U. S. Army, began a study of the ammonia synthesis problem, and an apparatus of the type described above was designed by Adams, Franklin and Meldrum. At the end of a year this work was abandoned by the Geophysical Laboratory and the apparatus was transferred to the Fixed Nitrogen Research Laboratory. The apparatus described in the present article is a development of that set up by the Geophysical Laboratory, in which many of the original features have been retained and others modified or abandoned as experience has indicated.

In the main this report considers only the apparatus as at present employed, including, however, certain features not now in use, but which may perhaps be useful to others. It is not intended to be an exhaustive study of the entire problem and will therefore not consider other possible methods of achieving the same results.

Outline of Complete Apparatus

In order to clarify subsequent detailed discussion of individual items it seems desirable to outline at this point the apparatus as a whole, referring to Fig. 1 for illustration.

The crude nitrogen: hydrogen mixture issuing from the high-pressure line passes through appropriate valves into the purification system. Four cylinders of the gas mixture are floated in the line to balance pressure changes. The purification system consists of a bomb containing colloidal Al_2O_3 for preliminary removal of moisture, oil or other readily condensible vapors; a bomb containing metallic copper at 400 deg. C. to serve as deoxidizer; a bomb containing a nickel catalyst at 275 deg. C. to hydrogenate carbon monoxide and other compounds; a series of three bombs containing Al_2O_3 to effect final removal of water vapor and other condensible gases.

From the purifying system the gas passes either directly to the catalyst bomb or to the humidifiers, according as dry or moist gas is to be tested. The humidifiers are essentially two small bombs containing water, the first at room temperature and the second maintained at a temperature designed to give the desired vapor pressure of water to the gas. Following the humidifiers is a trap, from which the gas passes directly to the catalyst bomb. From the catalyst bomb the gas passes through a valve, from which it issues at atmospheric pressure to the flowmeter and to the outlet tube from which samples for analysis are taken.

Copper tubing $\frac{1}{16}$ in. internal and $\frac{1}{8}$ in. external diameter is used to carry the gases. This tubing is connected through the walls of bombs and into valves, unions and tees by a standard device developed from the geophysical cone and gland and shown in Fig. 5. This consists of a steel tube $\frac{1}{8}$ in. in external diameter, terminating in a cone of $\frac{1}{4}$ in. diameter and a 59 deg. angle. Over the tube is fitted a steel gland, $\frac{5}{16}$ in. diameter, with $\frac{1}{24}$-in. pitch to its thread and a $\frac{1}{2}$-in. hexagon nut. By means of a steel sleeve the copper tubing is silver-soldered to the steel tube. This "cone and gland" is fitted into the shell of a bomb, or into a valve by cutting a standard gland and cone seat having a 60 deg. angle. By this device the bearing surface is reduced to a single line at the extreme inner edge of the cone tip. The torque required on the bushing nut to tighten the joint is very small and may be obtained by the use of a very small wrench or by hand. This type of connection is so frequently used and referred to that the above detailed description has seemed desirable.

Sources of Crude Nitrogen:Hydrogen Mixtures for Testing

Commercial cylinders of nitrogen and hydrogen under high pressures, provided with appropriate reducing valves and pressure flowmeters, may serve as the source of crude gas. The impurities in such gas, always considerable, and the attention needed for control of flowmeters render this method the least desirable.

A mixture of nitrogen and hydrogen gases in the ratio of 1 : 3 by volume may be obtained by decomposing ("cracking") ammonia, and if this is accomplished under pressure a self-contained apparatus becomes possible in which compressors are unnecessary. Such an apparatus, employing liquid ammonia as a source of both pressure and ammonia, has been developed by the Fixed Nitrogen Research Laboratory after designs originated

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*For Part I see CHEM. & MET. ENG., vol. 26, No. 11, p. 493, March 15, 1922.

by the Geophysical Laboratory and has operated successfully for pressures not above 30 atmospheres.

The method finally selected for obtaining nitrogen: hydrogen mixtures consists in using gas "cracked" at atmospheric pressure and compressed to about 1,500 lb. by the large-scale testing plant of the laboratory. The "cracker" used will be described in the third article of this series. This method allows wide pressure range and extreme simplicity of handling and is to be recommended whenever compression facilities are available.

Reduction of pressure from the high-pressure line to the pressure selected for operation was at first achieved by periodically charging a series of cylinders arranged in parallel, of such capacity that considerable amounts of gas might be drawn from them without substantial change in pressure.

Later this method was replaced by the use of commercial gas-reducing valves of sufficient capacity and range to deliver gas at the desired pressure in quantity sufficient for the operation of several bombs at once. The valve used for 30-atmosphere testing is a modified Cash standard reducing valve.

Preliminary Purification

The importance of delivering to the catalyst bomb only gas of the highest possible purity or containing known amounts of definite impurities, as may be desired, can scarcely be overestimated. As mentioned in the preceding article, it is essential in a purifying system not only that it shall remove impurities present in the gas but also that it shall not introduce any impurities. The purification system herein described and indeed the apparatus as a whole is designed to achieve both of these results.

The gas received from the large-scale testing plant has already been subjected to purification, having been scrubbed with water, deoxidized and dried with alkaline driers. It is therefore free from ammonia and acidic constituents. It may, however, contain small amounts of carbon monoxide and in process of transfer to and from the storage cylinders it may acquire small amounts of moisture, oxygen and oil, from which it is almost impossible to free the steel cylinders. Preliminary purification of the gas is achieved by the use of a bomb containing granules of colloidal Al_2O_3. This serves to remove moisture, oil and other readily condensible vapors. The bomb is identical in construction and contents with those described later for the final drying. After this preliminary treatment the gas passes to the deoxidizer.

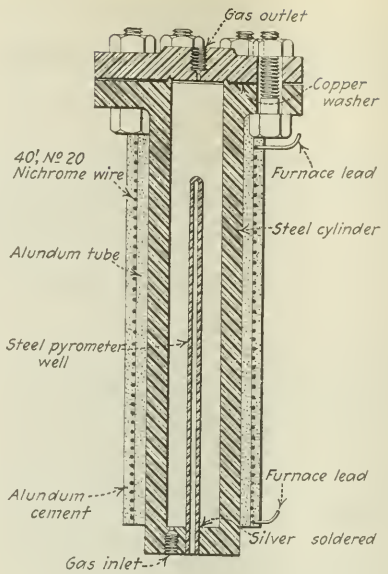


FIG. 2—DETAIL OF BOMB USED FOR COPPER DEOXIDIZER AND NICKEL CATALYST

Removal of Oxygen

Oxygen is removed by passing the gas over metallic copper heated to 400 deg. C. The final design of bomb for this purpose is shown in Fig. 2. It consists of a steel cylinder, 10 in. long, 2 in. external and 1⅛ in. internal diameter, closed at one end and widened at the other into a flange 4⅜ in. in diameter and ⅝ in. thick. A

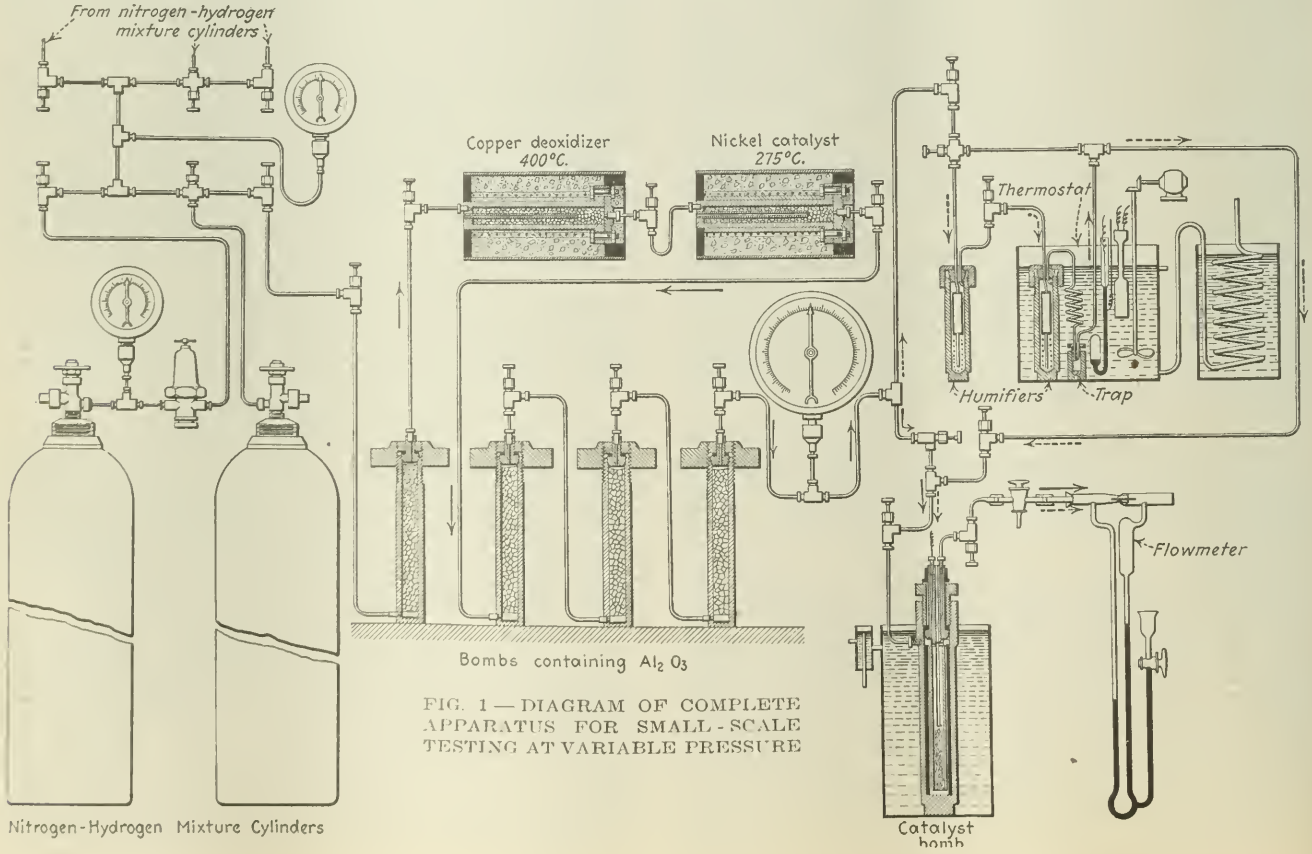


FIG. 1—DIAGRAM OF COMPLETE APPARATUS FOR SMALL-SCALE TESTING AT VARIABLE PRESSURE

head of the same diameter is fastened to the flange by seven ½-in. steel bolts. A copper washer fitting into an annular groove serves to make a gas-tight connection. The head is pierced in the center by a standard gland and cone seat as described above to serve as gas outlet. The other end of the bomb is pierced by a ¼-in. hole into which is silver-soldered a heavy wall steel pyrometer well 8½ in. long for temperature measurement. At one side of the pyrometer well a standard gland and cone seat is placed to serve as gas inlet. Over the steel bomb there is slipped an alundum tube wound with nichrome wire and packed with alundum cement, the whole fitting into a sheet-iron container. This bomb is charged with copper oxide, which is then reduced by the nitrogen: hydrogen mixture at as low a temperature as possible and is then ready for use as a deoxidizer.

Hydrogenation of Carbon Monoxide and Other Substances

It has been shown by Greenwood and Cowper[1] that small amounts of carbon monoxide are completely removed from hydrogen even at high space velocities by passing the mixture through a properly prepared nickel catalyst at 250 to 300 deg. C. The carbon monoxide is converted into methane, which is entirely inert toward ammonia catalysts. Other unsaturated bodies may be also hydrogenated and thus rendered more inert. In addition, the nickel may effect a marked rise in the boiling point of certain substances, thus rendering them more readily absorbable by Al_2O_3. This point is discussed later.

The catalyst used in the present purifier follows Greenwood's specifications. It is prepared by impregnating nonpareil brick, crushed and screened to 4 to 8 mesh, with sufficient nickel nitrate solution so that on subsequent ignition and reduction the product contains 10 per cent reduced nickel. The material is dried at 150 deg. C., placed in a bomb identical with that described for the copper deoxidizer and reduced at as low a temperature as possible in a current of nitrogen: hydrogen gas. the temperature of operation is 280 deg. C. ± 10 deg.

Removal of Moisture and Other Condensible Vapors

Three bombs containing granular colloidal Al_2O_3 (Fig. 1) similar to that used for preliminary purification serve for the final removal of any readily condensible gases, particularly moisture. The method of preparation of colloidal Al_2O_3 was described in the previous article and will not be discussed here. It should be noted, however, that subsequent drying with P_2O_5 produces no change in the behavior of the catalyst, nor does scrubbing with liquid Na-K alloy, which was used in early experiments.

The bombs used to contain the Al_2O_3 were not specially designed for the purpose and therefore do not represent any features of particular interest. They have, however, been quite satisfactory. They consist of a steel shell, 12 in. long by 2 in. external and 1¼ in. internal diameter, fitted at the top with external standard pipe threads, 11½ threads to the inch. The shell is drilled out at the top to 1$\frac{7}{16}$ in. diameter, ½ in. deep to form a seat for the lower face of the head. A steel head with a conical base fits into this seat, a soft copper gasket serving to make gas-tight connection between the two. The head is kept in place by a large steel nut, fitting over the head and screwing over the end of the shell, a washer of Monel metal being placed between the head and the nut. The steel head is pierced by a standard gland and cone seat to serve as gas outlet and the bottom of the shell is pierced by a similar gland and cone seat to serve as gas inlet.

After passing through three of these Al_2O_3 bombs the gas is free from detectable moisture and is ready to enter the catalyst bombs for experiments on pure dry gas.

The effectiveness of the purifying train may be illustrated by a series of experiments carried out upon the gas at different stages of its purification. A coil of glass tubing was prepared through which the gas at any point in the line could be passed after reduction to atmospheric pressure by a valve. This coil was immersed in liquid air contained in a vacuum flask. On testing in this way the crude gas issuing directly from the high-pressure line at the rate of 500 c.c. per minute, an immediate cloudiness appeared in the upper part of the coil much above the liquid air, indicating the presence of considerable quantities of high-boiling liquid, probably largely water. There also appeared in a colder part of the coil just above the liquid air a condensate of very low-boiling material which evaporated very readily when the coil was removed from the liquid air, giving an odor characteristic of organic substances. On testing similarly the gas after passing the nickel catalyst, the low-boiling material had disappeared, leaving only a condensate of high-boiling material. Assuming that the low-boiling material consisted of hydrocarbons or their derivatives, the effect of the nickel catalyst had evidently been to convert them to substances having a boiling point of the order of that of water. On testing the gas after passing the aluminum oxide towers, no trace of condensate of any kind appeared for half an hour, when a faint cloudiness due to high-boiling material appeared. It is thus evident that a very complete removal of water or any other substance condensible by liquid air has been effected by the purifying system.

Introduction of Moisture and Other Poisons When Desired

Since in any commercial plant it is almost certain that the gas used will contain small amounts of certain impurities, it is essential to be able to study the effect upon the behavior of the catalyst when definite amounts of impurities are introduced into the gas stream. The two chief impurities which will probably always be present in commercial gas are water vapor and (when water-gas hydrogen is used) carbon monoxide.

Water vapor is introduced into the system when desired by passing the gas issuing from the purification system through two humidifiers.

These consist essentially of small bombs of brass containing water through which the gas is bubbled. Brass is used instead of steel in order to avoid rusting and also because of ease of construction and rapidity of heat interchange. Their construction is shown in Fig. 3. They consist of a brass shell, 7¼ in. long by 1¾ in. external and ⅞ in. internal diameter, fitted at the top with 1 in. of external pipe threads, 14 threads to the inch, to which the head is screwed. The head consists of two parts, a plug of Monel metal, as illustrated, pierced by two holes into which the inlet and outlet tubes, of ⅛ in. copper tubing, are soldered. Over this plug the head, a hexagonal nut of brass, 2⅜ in. diam-

[1]Munitions Invention Department, Ammonia Synthesis, No. 12.

eter and 1½ in. thick, is fitted, screwing over the top of the shell. The inlet tube terminates in a brass safety trap, designed to prevent water from accidentally sucking back into the system.

Following the second humidifier is a small brass trap of simple design (Fig. 3). It consists of a shell of brass 2 in. long by 1¼ in. external and ½ in. internal diameter, fitted at the top with internal screw threads to hold the head, and at the bottom pierced by a hole into which is soldered a short drain of ⅛-in. copper tubing. This drain is closed by a soft solder plug to permit

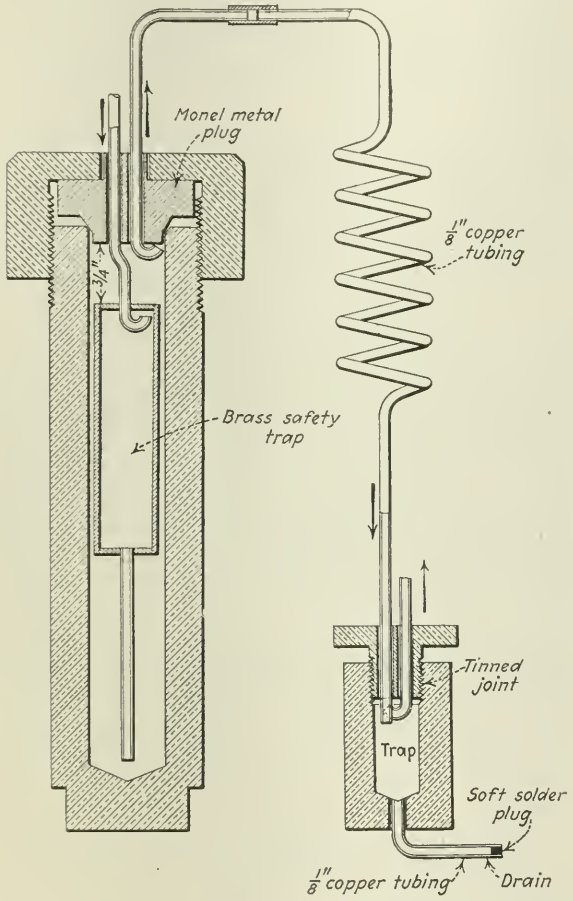


FIG. 3—HUMIDIFIER AND TRAP

drainage when desired. The head is a simple brass nut, pierced by two holes through which the inlet and outlet tubes of ⅛-in. copper tubing are soldered.

In practice, two of these humidifiers are used in series, the first one operating at room temperature and the other (with the trap) at a temperature controlled accurately by a thermostat at such a point as to give the desired degree of humidification. In this way saturation of the gas with water vapor at the desired temperature is achieved from the supersaturation side rather than the unsaturation side, a method which is shown to give more uniform results.

The gas issuing from the purification system passes through a tee valve, either directly to a manifold line leading to the catalyst bombs or through the humidifiers to a separate manifold. It is thus possible to operate one catalyst on dry gas while another is being operated on moist gas and at the same time to avoid contaminating the entire system with water vapor.

Carbon monoxide is usually introduced into the gas when desired at the large-scale testing plant where it is mixed with the nitrogen and hydrogen prior to compression. It may also be introduced into the storage cylinders at low pressure before filling them with the nitrogen: hydrogen mixture from the high-pressure line. When testing gas poisoned with carbon monoxide the nickel catalyst is, of course, not operated.

Description of the Catalyst Bomb

The catalyst bomb is the most elaborate single unit of the complete apparatus and one which represents some of the greatest difficulties of construction. Its design is essentially based upon that of the bomb developed at the Geophysical Laboratory by L. H. Adams. A detailed sketch of the modified bomb is shown in Fig. 4 and should be used in following the description.

The shell is of steel, 15¼ in. long by 2⅝ in. external and 1 1/16 in. internal diameter, enlarged at the head to 2 5/16 in. external and 2⅛ in. internal diameter, and fitted at the head with internal screw threads, nine threads to the inch. Just below the screw threads several seats

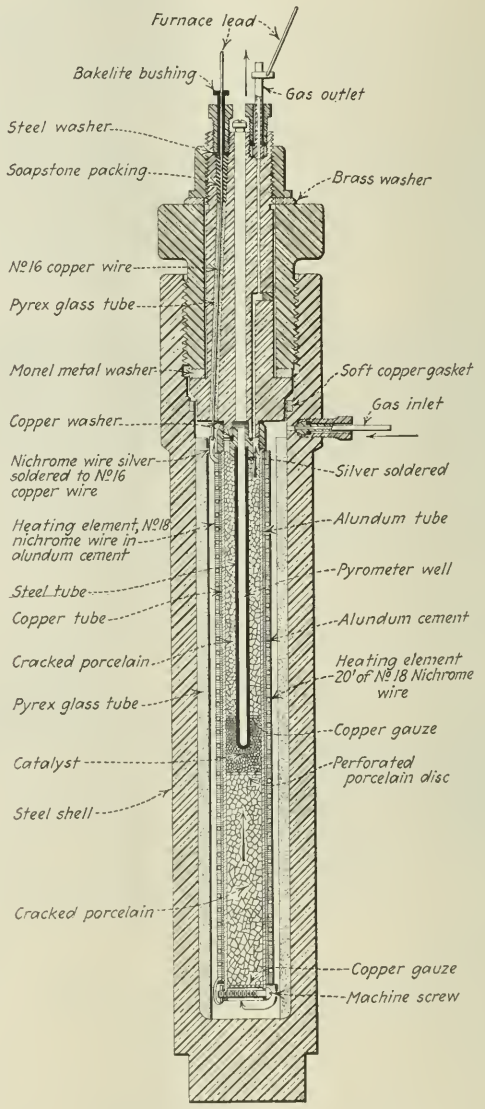


FIG. 4—CROSS-SECTION OF CATALYST BOMB

are provided, as illustrated, to fit the head and various washers, and just below these seats the side is tapped by a standard gland and cone seat to serve as gas inlet.

The head, itself of two distinct units, contains the pyrometer well, the gas outlet (a standard gland and cone seat) and the lead wire for the internal heating

element. The two parts of the head are fitted to each other by an upper washer of brass and a lower one of Monel metal. Gas-tight connection between the shell and the head is effected by the use of a gasket of soft annealed copper. It should be noted that only at this gasket is there a connection between head and shell which is subject to the stream of high-pressure gas.

One of the heating leads is connected directly to the head; the other is insulated from the head by passing through a Bakelite bushing into a conical soapstone plug, held in place by a steel washer. This type of high-pressure insulation has proved quite satisfactory. A Pyrex tube protects the lead wire from contact with the head after passing the soapstone plug, until it reaches the heating element to which it is silver-soldered.

The copper catalyst tube, 10½ in. long by ¾ in. external and 0.642 in. internal diameter, is open at both ends and is silver-soldered to a steel sleeve which screws into the lower end of the head.

Surrounding the copper tube is a thin alundum tube on which is wound the heating element, 20 ft. of No. 18 nichrome wire, imbedded in alundum cement. The winding is so designed as to give as little temperature gradient as possible within that portion of the tube containing the catalyst. A Pyrex tube, fitting closely the interior of the steel shell, serves to protect the steel from the hot gases and lessen the heat transfer to the walls of the shell.

Operation of Catalyst Bomb

The operation of the bomb will be briefly described. The catalyst tube is filled by unscrewing the head with catalyst tube attached, reversing it and filling the tube half full of broken porcelain. Upon this is placed a copper gauze and upon this the layer of catalyst, about 1 in. in depth, so adjusted that the end of the pyrometer well is near its center. A perforated porcelain disk covers the catalyst and the tube is then completely filled with more broken porcelain, kept in place finally with a copper gauze, which in turn is held in place by a bolt to which the lower end of the heating element is attached. After being filled the head is then turned right side up and screwed into the shell.

The gas entering through the side of the shell above the catalyst tube passes down between the heating element and the outer Pyrex tube, thus becoming preheated, then upward through the catalyst tube and through the outlet in the head.

This bomb may be operated at any pressure up to 100 atmospheres and is capable of rapid temperature variation when desired. In order to permit the rapid temperature change the bomb is immersed in hot water, which, although causing a larger current consumption, permits greater rapidity of reaching temperature equilibrium than would be the case if the bomb were packed in heat-insulating material. The water also serves to diminish the temperature of the head, thus avoiding damage to the insulating device and sticking of the screw threads.

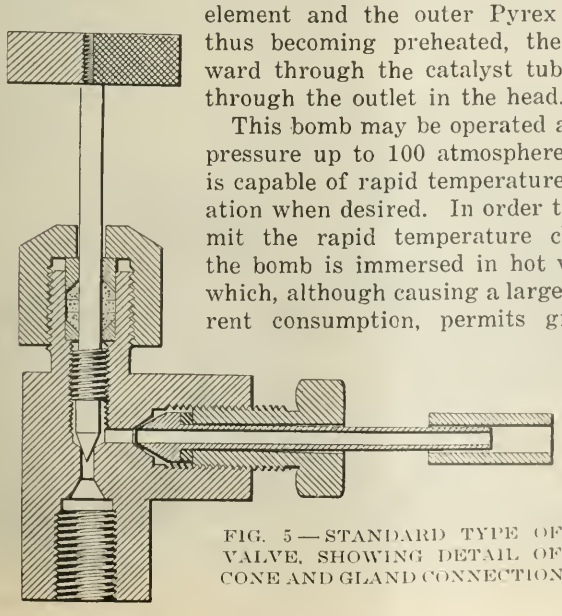


FIG. 5—STANDARD TYPE OF VALVE, SHOWING DETAIL OF CONE AND GLAND CONNECTION

It should be noted that when first constructed such a bomb (as the case of all other steel apparatus) is apt to contain considerable amounts of oil, soaked into the steel. This can best be removed by heating the bomb at about 600 deg. C. for several days in a current of pure gas until there is no longer evidence that oil is being carried through.

Control and Measurement of Gas Flow

The gas issuing from the high-pressure line passes through a commercial diaphragm reducing valve to a series of cylinders simply serving to balance the system against sudden changes of pressure. From this time on its control is achieved by the use of a number of small steel valves, whose design in shown in Fig. 5. These valves are connected into the pipe line, by means of the standard gland and cone seat, between all items of the system, and also serve for bypasses where desired. One of them releases the pressure after the gas passes the catalyst bomb.

Fig. 5 is almost self-explanatory, but it should be pointed out that the cone of the stem has a 30 deg. angle; that the stem packing of asbestos, previously slightly lubricated with paraffine and placed between cupped steel washers, has proved satisfactory; and that it is an advantage to make the diameter of the stem equal to that of the root of the screw thread—namely, ⅛ inch.

The measurement of gas flow is effected after reduction of pressure by a glass flowmeter of standard type, xylene being used as measuring liquid in the arms. These meters[2] are calibrated by stopwatch and water displacement.

Control and Measurement of Pressure

Pressure in the system is controlled by the reducing valve previously mentioned. It may be noted that in a self-contained apparatus utilizing liquid NH_3 as a source of both gas and pressure, the pressure is determined by the temperature at which the ammonia cylinder is kept.

Pressure is measured on 8½-in. American standard hydraulic gages, graduated in 5-lb. divisions. All gages are of the usual Bourdon copper tube type. They are carefully calibrated from time to time against a hydraulic apparatus, using known weights as pressure standards.

Control and Measurement of Temperature

Temperature control is needed (1) in the copper deoxidizer, (2) in the nickel catalyst, (3) in the second humidifier and (4) in the catalyst bomb.

With the exception of the humidifier, which is immersed in a water thermostat of appropriate size, the heating is effected in all of these cases by the use of nichrome heating elements, operating on the 110-volt circuit in series with rheostats. The rheostats are made in very fine steps, permitting continuous variation of temperature over a considerable range. No automatic control of temperature is attempted.

Temperature measurement is effected by chromel-

[2] *J. Ind. Eng. Chem.*, vol. 11, p. 623 (1919).

alumel thermocouples leading into the pyrometer wells, the cold junction being maintained in a vacuum flask filled with crushed ice.

The temperatures are read by means of a White double potentiometer, manufactured by Leeds & Northrup and permitting the estimation of temperature to within ½ deg. C. over the entire range of 200 to 700 deg. C.

It is most important in a critical study of ammonia catalysts that the temperature of the catalyst mass should be as uniform as possible and that the recorded temperatures should correspond exactly to those existing in the catalyst. The method of winding the heating element and the high thermal conductivity of the copper catalyst tube and steel pyrometer well contribute to achieving the former result; the latter is effected by careful calibration of all thermocouples every 2 weeks, against boiling sulphur. It is believed that the recorded temperatures do not vary from those actually existing in the catalyst mass by more than 2 to 3 deg. C.

Analytical Control

Since the effectiveness of the catalyst is measured by the ratio of ammonia to nitrogen: hydrogen in the outlet gases, this represents the only necessary analytical determination. The method of analysis finally adopted is to pass the gas issuing from the catalyst bomb, after being reduced to atmospheric pressure, through a 4 per cent solution of boric acid, to absorb ammonia, and then into a compensometer[3] by means of which the volume of the nitrogen: hydrogen mixture can be rapidly and conveniently measured. The boric acid solution is then titrated directly with standard H_2SO_4, using methyl orange as indicator, and titrating to a definite color standard as end point. Experiments show that absorption of ammonia from the gas stream by boric acid is extremely rapid and complete and the method permits the use of only a single standard solution.

Conclusion

The apparatus herein described has been used for testing ammonia catalysts under varying conditions of pressure, temperature, space velocity and purity of gas. The results of these investigations will be discussed in the fourth article of this series.

(*The third article of this series, describing a moderate-scale apparatus for testing ammonia catalysts at* 100 *atmospheres pressure, will appear in a subsequent issue.*)

Coal Available in Case of Strike

An analysis of the coal situation, the purpose of which is to give business men information regarding possible fuel supplies in the event of a strike of miners on April 1, has been issued by the Coal Bureau of the Natural Resources Department of the Chamber of Commerce of the United States. The bulletin carries charts covering conditions in particular localities.

As the anthracite field is 100 per cent unionized, all supplies in the event of a complete closing of the mines will have to be drawn from stocks on hand. Reliable figures on which to base an estimate covering possible anthracite supplies in the event of a strike completely closing the mines are not available.

Assuming this year's bituminous consumption to be comparable to that of 1921, 7,600,000 tons per week, the supply from non-union fields would fall short 3,600,000 tons per week of meeting the demand.

[3] See Chem. & Met. Eng., vol. 23, No. 23, Dec. 8, 1920, p. 1104.

A Paddlewheel Fan Adapted for the Removal of Suspended Particles

A modification in the design of the ordinary paddlewheel type of fan blower, whereby it is adapted for the removal of cinders and dust from the air it handles, has been developed by the B. F. Sturtevant Co. Buckets are provided at the inlet edges of the blades as shown in Fig. 1. From each bucket an inclined channel leads the dust to a special dust chamber, where it drops out of suspension and is removed from hoppers periodically.

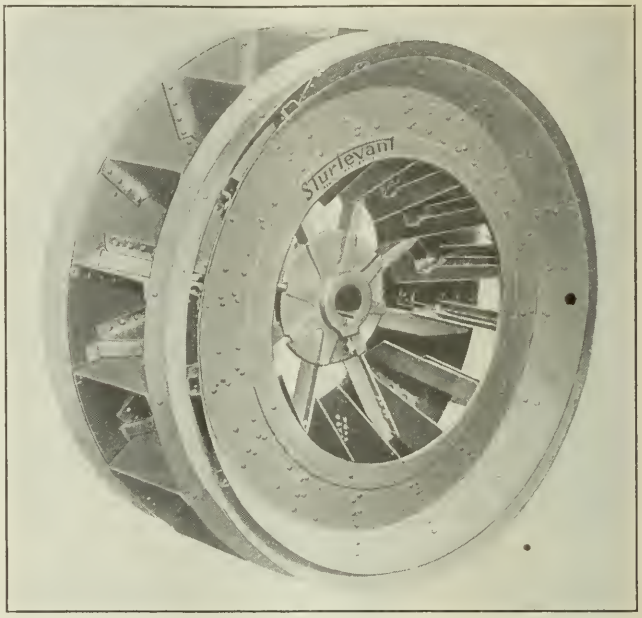


FIG. 1—ROTOR OF FAN, SHOWING COLLECTING BUCKETS AND CHANNELS

It is claimed that this type of blower is just as efficient as a fan as the average induced draft fan and that it removes up to 75 per cent of the solid matter in the air, depending, of course, on the nature of the material. Two large fans installed in connection with six 500-hp. boilers in New York City each remove about 250 lb. of cinders per hour when the boilers are operating at 200 per cent of rating. This type of fan has also found successful application in connection with boilers using pulverized fuel and should be useful in the chemical and metallurgical industries where the removal of suspended matter from gases is desirable.

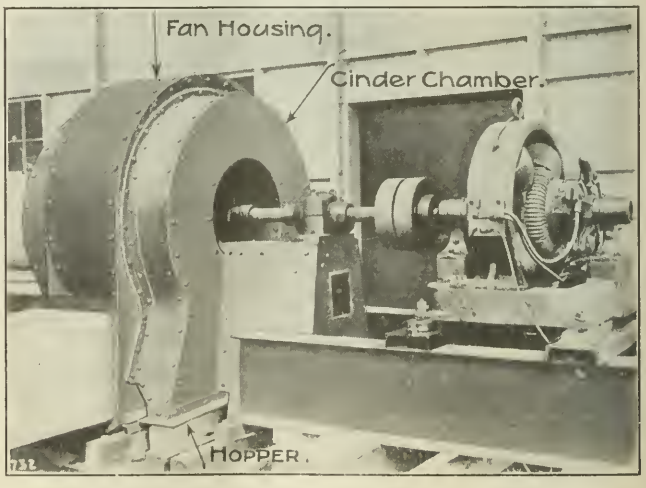
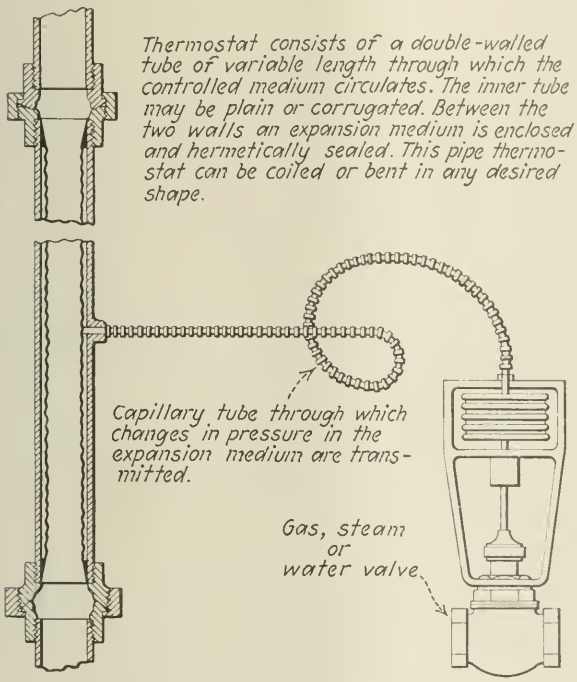


FIG. 2—ASSEMBLED FAN, SHOWING CINDER CHAMBER AND HOPPER

A New Temperature Regulator

Most of the temperature regulators on the market at the present time use tabular thermostats similar to the bulb of a distance thermometer. This tubular thermostat is commonly inserted in the heater, tank or receptacle the temperature of which is controlled. It frequently happens, however, that there is no room for the thermostat in this location and it is necessary to insert it in an outside pipe or a special chamber. This has certain obvious disadvantages. For instance, it involves extra expense in installation and the pipe or chamber tends to form a pocket, hindering the flow of the liquid, which in turn may result in irregularity of control.

A consideration of the problem involved and the existing methods has suggested the use of a pipe thermostat of the type shown in the accompanying illustration. This thermostat, which was recently developed


Thermostat consists of a double-walled tube of variable length through which the controlled medium circulates. The inner tube may be plain or corrugated. Between the two walls an expansion medium is enclosed and hermetically sealed. This pipe thermostat can be coiled or bent in any desired shape.
Capillary tube through which changes in pressure in the expansion medium are transmitted.
Gas, steam or water valve

and patented by H. J. C. Wells of the Sarco Co., Inc., consists of a two-wall pipe in which the expansion medium, whether a sensitive oil or a volatile fluid, such as ether, is located between the two walls. In this construction not only is the controlled liquid allowed a free passage but the sensitiveness of the regulator can be greatly increased. This latter point will be appreciated if one takes into account that an ordinary thermostat tube or bulb has a certain definite proportion of heat-interchanging surface for a given content of the expansion medium it contains. On the other hand, with a pipe thermostat it is feasible to extend the length of the pipe considerably and its two walls can be so close together as to take between them little more than a film of liquid or a layer of gas; thus the ratio of heat-interchanging surface and volume of expansion medium is increased almost indefinitely. This results in nearly instantaneous heat interchange and reaction. The lengthening of the pipe thermostat involves no particular constructional difficulties, as it can be coiled, bent or otherwise deformed and in fact may constitute a part of the regular conduit used to convey the medium controlled.

Many applications for such a thermostat suggest themselves. For instance, certain heaters for liquids can be equipped with a pipe thermostat simply by substituting it for the exit pipe. Another application is in connection with the temperature control of the cooling water systems of air compressors and of gas and oil engines. The pipe thermostat takes the place of the discharge pipe and occupies practically the same space as the pipe now used. With gas-fired boilers, the pipe thermostat would be placed in the return circulation pipe and directly control the gas supply. In pasteurizers for milk, cider and other fruit juices, which are heated while in circulation, the pipe thermostat is preferable, because of its greater sensitivity and the ease with which it can be cleaned. The construction of the thermostat in the form of an open pipe may have other advantages, where the temperature of corrosive gas or liquids is controlled, since the inner wall can be of some acid-resisting material and the use of internal joints and solder entirely avoided.

Without impairing the useful field of the tubular thermostat for ordinary tank control, the pipe thermostat appears to offer decided advantages in these special applications.

Synopsis of Recent Chemical & Metallurgical Literature

Developments in Refrigeration.—In a paper on this subject read before the Glasgow Section of the Society of Chemical Industry by Dr. W. R. Ormandy and E. C. Craven and printed in *Chemical Age*, of London, on Feb. 4, 1922, the authors pointed out the disadvantages of the ammonia absorption system of refrigeration using water as an absorbing medium and suggested the use of solid ammonium nitrate for absorbing the ammonia gas.

When ammonia gas is passed over cooled ammonium nitrate, a liquid is formed possessing at ordinary temperatures the composition $2NH_4NO_3NH_3$ and freezing at 22 deg. C. At lower temperatures a compound $NH_4NO_3NH_3$ appears to be formed.

It was found under certain conditions the ammonium nitrate was changed into a cellular state, in which the full vapor pressure of the liquid compound was not exerted. To overcome this difficulty the liquid compound was absorbed in kieselguhr in such proportions that a dry powder was formed, reducing this possibility to a minimum.

In application to practice the authors state that against back pressures up to 190 lb. per sq.in. absolute all the ammonia-ammonium nitrate bodies containing over 6 per cent of ammonia were decomposed at a temperature of 230 deg. F., and that it required so much heat to drive off the remainder of the ammonia gas as to be uneconomical. At 144 lb. per sq.in. absolute back pressure all the bodies over 6 per cent NH_3 were decomposed below the boiling point of water. A stationary plant without agitation would work with ammonium nitrate-kieselguhr in the ratio 3 to 2 by weight, provided the cooling arrangements in the generator for the absorption period were adequate. There was no difficulty during generation with the absorbent present.

Determination of Oxygen in Hydrogen.—Alfred T. Larson and Ernest C. White of the Fixed Nitrogen Laboratory at Washington have made a valable contribution to the operation of the Haber process by publishing a simple and rapid method for determining traces of oxygen in hydrogen. The paper appears in the January, 1922, number of the *Journal of the American Chemical Society* (vol. 44, No. 1, p. 20). One method has been to estimate the oxygen content by passing the gases over a contact mass which converts the

oxygen into water; the water being collected in an absorbent, usually phosphorus pentoxide, and then weighed. It is desirable to determine the presence of oxygen down to 0.001 per cent, and at this dilution it requires no less than 62 liters of the gas to produce 1 mg. of water. Because of the difficulties involved in the weighing of such small quantities of water, the method is both slow and inaccurate. Another method depends on the conversion of colorless cuprous solutions into blue cupric solutions by the presence of oxygen. The intensity of the color change becomes the measure of the oxygen content, but it lacks accuracy in low concentrations.

The new method is rapid and accurate for concentrations down to 0.001 per cent, and it is based in principle on the method of Lamb and Larson in determining low concentrations of carbon monoxide in air. In the new method, the trace of contained oxygen is catalyzed by platinum with the excess of hydrogen at a temperature of 275 to 300 deg. C. The temperature rise due to the exothermic reaction is measured by a copper-constantan thermocouple and a sensitive potentiometer. The apparatus must be calibrated by the use of gas mixtures of known concentrations, but this proves to be a very simple matter, the potentiometer deflection being plotted against the oxygen content, making possible results accurate to 0.00003 per cent of oxygen. Full details of construction and manipulation of the apparatus are given.

Brinell Hardness of Cementite.—The Brinell hardness of cementite is not known, according to Messrs. Portevin and Bernard in a paper entitled "Contributions to the Study of Coalescence in Steels and Its Commercial Results" before the Paris meeting of the British Iron and Steel Institute. It is not even possible to ascertain it directly by any of the usual methods on account of its extreme brittleness. The investigation, however, of the products of coalescence furnish the following methods of ascertaining it indirectly by extrapolation:

It is known that the hardness of binary alloys formed of a mixture of two similar constituents in variable proportions is practically a linear function of the composition when the structural elements remain constant in size. Furthermore, if the proportions of the constituents remain constant, the hardness will tend to increase as the fineness of the structural elements.

Iron-carbon alloys in the annealed state consist of two

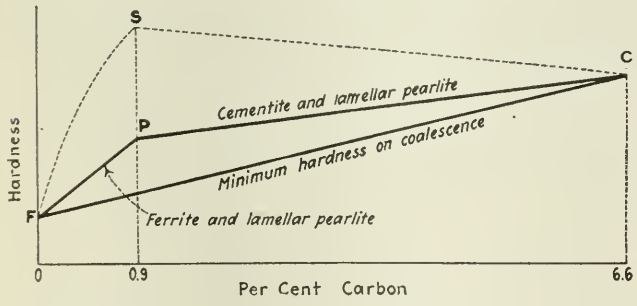


FIG. 1—BRINELL HARDNESS OF IRON-CARBON ALLOYS

phases, Fe_γ and Fe_3C, intermingled, but the structural elements of which these elements are composed vary considerably in size according as they do or do not form part of the eutectic pearlite in its lamellar form. This lamellar pearlite forms a definite aggregate with 0.9 per cent of carbon and a Brinell hardness in the neighborhood of 250.

According to the rule just enunciated the Brinell hardness of iron-carbon alloys, starting with pure iron and going up to 6.60 per cent of cementite in the annealed state, can be represented as in Fig. 1. Thus: For the products containing pearlite in the lamellar state, by two straight lines, *FP* and *PC*, connecting the points indicative of the hardness of pure iron (*F*), of lamellar pearlite (*P*), and of the cementite (*C*). For the coalesced products in such a manner as to connect all the cementite elements in globular form, and of the same order of size, by a straight line of minimum hardness, *FC*. And lastly, for the products containing the whole of their carbon in the sorbitic state by an ill-defined curve, *FSC*, relating to the maximum hardness in the annealed state.

It is practicable to plot points on the line *FC*, the minimum hardness of various steels and cast irons, a value which may be estimated by studying the degree of spheroidization of the cementite. Thus, whereas a piece of 1 per cent carbon-steel exhibiting lamellar pearlite, had a Brinell hardness of 262, after proper spheroidizing or coalescing, it dropped to 137. Accepting the hardness of ferrite as 75 (according to Howe) the Brinell hardness of cementite becomes about 400.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Heating Practice.—Arthur E. Bellis, of Springfield, Mass., recommends that metal be heated in a salt bath prior to forging, rolling or other hot work. Accurate temperature control is possible, and when withdrawn the metal is covered with a thin film of salt which prevents surface oxidation and helps to avoid uneven chilling by variable air currents. In this manner scaling is reduced to a great extent and trouble and expense consequent to oxidation are avoided. (1,399,044. Dec. 6, 1921.)

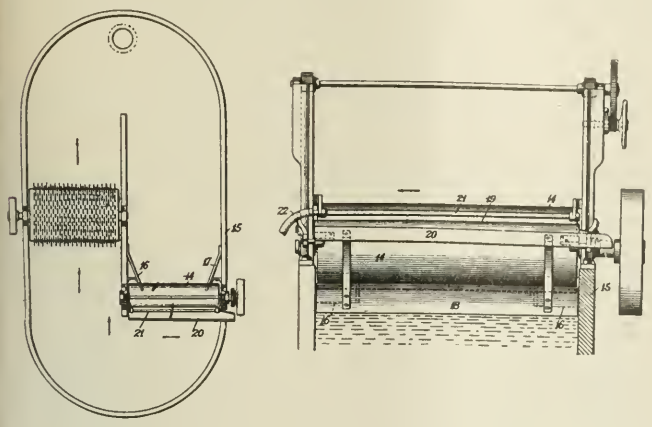
Method of Alloying.—Aladar Pacz, of Cleveland, Ohio, uses an intimate, very fine-grained mixture of alloying element and an oxide acidic to it to introduce the former into an alloy. For instance, he precipitates a mixture of tungstic acid and silicic acid, and reduces the mixture to tungsten impregnated with 2 per cent of silica. Twenty-one parts of this are melted with 150 parts of steel having the requisite amounts of carbon, chromium and other elements except tungsten required for high-speed steel, to produce tools having superior qualities. (1,402,088; assigned to General Electric Co. Jan. 3, 1922.)

De-inking of Paper.—In a recently patented method for removing printer's ink from paper, the waste paper (printed newspapers) is macerated in an ordinary beater or is shredded by other means and the stock then transferred to the beating engine. After heating to about 140 deg. F. and made up to a consistency of about 6 per cent, enough soda ash or other alkali is added to give the whole a decided alkalinity. After beating for a short time, say from 10 minutes to half an hour, sufficient ordinary laundry soap is added to form a saturated solution and the beating is continued until the oil of the ink is thoroughly emulsified.

At this stage sufficient cold water is added to bring the consistency down to about 3 per cent and to reduce the temperature to 100 deg. F. The effect of adding the cold water is not only to thin down the stock but also to throw more or less of the soap out of solution, with the result that as the agitation or beating continues, the emulsified soap, oil and pigment will rise to the top in the form of dark soapy bubbles. These may be removed from the surface of the stock as it flows around the beater by any convenient means, as for example by rotary washing screens but preferably by a rotary skimming mechanism devised by the patentees. This mechanism consists of a wooden roller 14 so arranged that its under side just touches or is but slightly above the surface of the stock. In front of the skimming roller are two inclined deflectors 16, 17, extending under the roller as indicated in the accompanying figure, for the purpose of concentrating the bubbles toward the center of the roller. Beyond the roller is a dam 18 extending transversely across the channel between the midfeather and the side wall, and preferably inclined, with its upper edge close to the roller 14. The dam extends down a short distance into the stock, so that its effect will be to cause the stock itself to flow down and under the dam, while the bubbles, trapped by the dam,

and brought into contact with the under side of the roller, may adhere to the latter and be carried upward.

Across the roller at a suitable point below the top thereof is a doctor 19 in close contact with the roller, so that the bubbles are scraped off by the doctor as the roller revolves. The doctor is inclined, as indicated, and at its lower edge is a backstrip 20 forming a trough. The trough thus provided



is slightly inclined so that the oil, pigment and other matters will tend to flow down the same and out over the side of the wall 15, where they can be discharged. To facilitate this flow of the material, a spray pipe 21 is provided, extending across the doctor at a slight distance about the same and connected at one end, as 22, with a source of water under pressure. The pipe has a series of perforations on its under side, so that the water is discharged in the form of jets upon the doctor to wash down the material scraped from the skimming roller.

After the stock has been cleansed by skimming and washing as described, it may be formed into standard pulp laps on an ordinary "wet machine," or it may have added to it in the beater such color and mordant as may be desirable, and may then be run directly to the paper machine. For some purposes it may be mixed with new pulp in any desired proportion. (1,406,222; Arthur F. Allen, and Alfred F. McCoy of New York City and Robert O. Sternberger of Newark, N. J., assignors to Tidewater Paper Mills Co., Brooklyn, N. Y., Feb. 14, 1922.)

Corrosion-Resisting Steel.—Aladar Pacz, of Cleveland Heights, Ohio, notes that the disadvantages of using ingot aluminum as a deoxidizer in steel making are removed if an aluminum-silicon alloy (10 to 40 per cent Al) is used instead. The reactions proceed more slowly and produce a fusible slag which separates easily. Furthermore, the alloy is brittle, so it may readily be pulverized and incorporated with the metal bath. If sufficient excess of the alloy is used so that from 1 to 18 per cent elemental Al (with a corresponding amount of Si) remains in the alloy, the resulting metal resists corrosion even at high temperatures. It also has a low magnetic hysteresis loss, and is therefore desirable for certain electrical apparatus. (1,396,276; Nov. 8, 1921.)

Contact Sulphuric Acid.—Specification covers the principle of drying the air supplied to the sulphur burner in order to prevent formation of acid mist in the burner and combustion chamber. It is said that this mist carries dust and other mechanical impurities and also impurities from the sulphur and from the action of sulphuric acid on the iron of the system. Molten sulphur is fed to the burner and the air necessary for its combustion is dried in two sulphuric acid scrubbing towers, followed by suitable spray catchers and filters to remove any acid spray carried over by the air. It is proposed that the air be dried in two stages, in the first using acid of moderate strength and of variable but controlled temperatures so that the air may have such predetermined humidity as may be required for the most efficient conversion reactions; in the second stage, using strong relatively cool acid in order to complete the drying to the extent required.

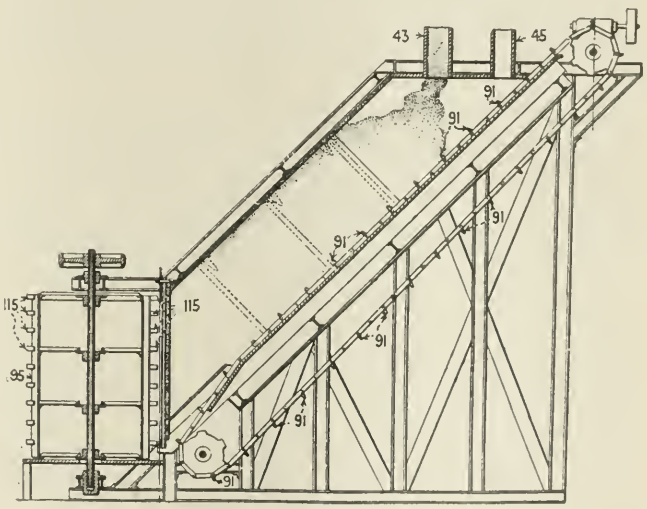
In order to introduce the proper amount of moisture for most efficient conversion, which is held to be 1 grain of water per cubic foot, the gas is passed through a humidifying tower over which is circulated 85 to 90 per cent sulphuric acid at 80 to 100 deg. C. By this means the humidity of the gas entering the converters is maintained constantly at the optimum for conversion. (1,405,669; M. F. Chase, Ardsley-on-Hudson, N. Y., and Frederick E. Pierce, New York, assignors to the COS Process Co. of New York City. Feb. 7, 1922.)

Aluminum Chloride.—The patent covers a process for the production of aluminum chloride from bauxite or other suitable alumina containing material by treatment with a mixture of chlorine and sulphur vapor. The reaction is said to proceed according to the equation:

$$2Al_2O_3 + 3S + 6Cl_2 = 4AlCl_3 + 3SO_2$$

The reaction is to be carried out either in a heated retort into which the sulphur is introduced as a liquid, or in a molten bath of bauxite dissolved in cryolite, through which the chlorine and sulphur gases are passed. The aluminum chloride is in any case evolved as a vapor and is collected or sublimed in any suitable manner. (1,405,115; Frank W. Hall, Port Arthur, Tex., assignor to the Texas Company of New York. Jan. 31, 1922.)

Apparatus for Superphosphate Manufacture.—Thomas J. Sturtevant of Wellesley, Mass., assignor to Sturtevant Mill Co., of Boston, has patented a continuous apparatus for the manufacture of acid phosphate in which the mixture of acid and rock is completely inclosed during the chemical reaction and in which the disintegration of the materials as well as the removal of the noxious fumes are accomplished automatically. A longitudinal section through the machine is shown in Fig. 1. It will be noted the den or chamber is inclined with respect to the floor and discharges directly into the disintegrator. In operation the mixture of ground phosphate rock and acid is introduced through the pipe 43 into the upper end of the chamber. The mixture is still in a



molten or semi-liquid condition and it is therefore necessary to close the door which slides across the lower end of the den. After the mixture has built up back of this door and has stood for a time, it changes from a molten to a solid or spongy form. This effectively plugs the end of the den and the door can then be removed.

The pitch or angle of the floor of the chamber is such that it will be barely sufficient to prevent the mass from sliding along the inclined floor. As a consequence, a slight amount of power transmitted through the sprocket chain and lugs 91 is required. In the disintegrator 95 the knives 115 act on the mass and completely disintegrate it. At the same time, by the fan-like action, the mass is aërated and the moisture permitted to escape in the form of steam. This steam as well as the noxious gases evolved by the chemical reaction are drawn off by an exhauster from the den through the pipe 45.

The process is of course continuous and is timed so that the chemical reaction may be completed and the materials changed from molten to solid form before reaching the disintegrator. (1,403,820; Jan. 17, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Vindication of Dye Industry Seems Imminent as King Charges Prove Blind Leads

As the dye investigation stretches into its fourth week it is becoming increasingly evident that the domestic dye industry will be given a clean bill of health. Chief interest now is centered in whether or not the committee will insist upon information as to the real source of the charges made.

Irenee du Pont expressed the belief, while testifying under oath before the Senate committee, that these charges had their origin in the German Cartel. To illustrate his point he cited a happening in the nursery of his home. Mrs. du Pont came into the room to find that the canary's cage had been thrown over and the bird badly mangled. She did not suspect the children. Her only thought was that the cat was responsible. Mr. du Pont suggested that the committee in this investigation examine the mouth of the cat and see if there are not some yellow feathers sticking to it. He emphasized the fact that the German Cartel must have an agent in this country, but he has not appeared before the committee and no one knows where he is. "I do not accuse Senator King," said Mr. du Pont, "because I think he believes honestly that the charges he makes are true." He emphasized, however, the necessity of ascertaining the source of Senator King's information. He asked why there should be any mystery about the quotations presented from out of the way newspapers. He told the committee that they should find out who furnished the material for those articles and who sent them to Senator King.

The consensus in Washington is that the domestic dye manufacturers have made a very convincing presentation of their side of the case. Despite the limited time to refute charges made by Senator King, there is indisputable evidence that the case against them is superficial to a degree that reflects very unfavorably upon Senator King and the unnamed persons who are holding up his hands.

Herty Answers King's Charges

Monday, March 13, was occupied by the testimony of Charles H. Herty, president of the Synthetic Organic Chemical Manufacturers' Association of the United States. Dr. Herty gave the committee a detailed account of his activities to obtain protection and development for the American organic chemical industry, which he declared is a matter of national necessity. Replying to the assertion by Senator King that the American Chemical Society, of which Dr. Herty was formerly president, was drawn into the campaign for protection for the industry by the Textile Alliance and the American Dyes Institute, Dr. Herty explained that the charge was ambiguous. The latter organization did not exist and the former was not interested in the distribution of dyestuffs when the American Chemical Society began its work for the development of the American industry.

Dr. Herty announced that he has never been a member of the American Dyes Institute and has no connection with the Chemical Foundation, although he is thoroughly sympathetic with its work. Moreover, King's charges that he is a member of the dye advisory committee of the Treasury Department is ridiculous in view of the fact that no such committee exists. The witness told in much detail of his trip to Paris in 1919 before the peace treaty was signed in order to obtain for American consumers necessary German dyes. He represented the State Department and his expenses were paid by the Chemical Foundation.

Dr. Herty added his corroboration to previous statements that there is no combination of any kind and no monopoly in the American industry. He expressed the belief that the embargo offered the only adequate means of protection and that the fear that a monopoly would be created by the embargo could be removed by giving the President power to remove it if any product should become controlled by a monopoly or if American industry failed to manufacture at least 60 per cent of the products needed in the United States. Given proper protection, he concluded, the American manufacturer can produce quantity enough for the American consumer and the American quality is and will be at least equal to that of competitive products.

Dye Business No Bed of Roses for du Ponts

Irenee du Pont, president of E. I. du Pont de Nemours & Co., declared that he sometimes thinks he is "a damned fool" to remain in the dye business in the United States, for the business as he has found it is without profits and the target of constant attack. His company has lost money in dyes during the last 3 years, but he was impelled to hold on because of the great benefits it would accrue to posterity should the American industry have the chance of proper development.

Taking up the ramifications of the business interests of the du Pont company, Mr. du Pont asserted that the size of a company does not make it a monopoly. The parent du Pont Co. is large, but does not have a monopoly on any of the products in which it is interested, he stated.

"There has never been anything nefarious about our operations," said Mr. du Pont. "There has been no agreement, written or unwritten, no gentlemen's agreement or agreement of any other kind to establish a monopoly or to restrain trade. There is no such animal. The only monopoly I know of in the dye industry is the German I. G., the German dye monopoly."

Shortridge Favorably Impressed by Manufacturers' Pleas

During an informal discussion following Mr. du Pont's, testimony Senator Shortridge declared himself in favor of adequate permanent protection of the American dye and organic chemical industry, "by an embargo, if necessary." "I think I may say that from the evidence so far gathered, the present or temporary embargo seems to have worked very well," he added.

It might well be, Senator Shortrige said, that the American dye industry, "a unique industry," needs special, even unusual protection. Some fear that under protection some sort of a monopoly will grow up. But I have no fears on that point. We can take care of our own monopolies by our laws; we would be able to rend them. But our laws do not apply to the foreign monopolies; we have no extraterritorial powers in that respect.

No Monopoly in Dyes Here

The National Aniline Co. is not a monopoly, has no connection with any monopoly in the American dye industry and has no agreement of any kind with any person or corporation for regulation of production or prices or division of prices or territory. This was the substance of the testimony of J. W. Newlean, president of the National Aniline & Chemical Co. "In fact," he went on, "there is nothing in the American dye and organic chemical industry even remotely approaching a monopoly."

"It seems to me that the maximum possible cost to the nation of surely keeping this industry, through a continuation of the selective embargo, is negligible compared with the risk of incalculable loss to the nation necessarily involved in any less certain measure of protection," declared Mr. Newlean. He added that there has been free competi-

tion, unrestricted in any way, under the selective embargo, with the result that the prices of American dyestuffs have steadily declined and are today lower than ever before.

Senator Shortridge announced at the close of Friday's session that John Nash McCullaugh, industrial manager for the National Association of Hosiery and Underwear Manufacturers, had disavowed authorship of or responsibility for the letter purporting to be signed for him and attacking the conduct of the hearing, which was left with the sub-committee recently by George Deming, who represented himself as counsel for the organization. Mr. McCullaugh asked that the letter be withdrawn from the records.

Tariff Commission Statistics

C. R. De Long, chief of the chemical division of the U. S. Tariff Commission, presented figures as to importations of dyestuffs in 1920. These showed that the total imports in that year, about 3,402,000 lb., constituted between 4 and 5 per cent of the total 1920 domestic production, which was approximately 88,000,000 lb.

Total domestic production of all coal-tar products in 1920 was 113,000,000 lb., and of this 88,000,000 lb. was dyes. Mr. De Long said that the total domestic production of all coal-tar products, including dyes, in 1921, estimated on the basis of incomplete reports, was from 40,000,000 to 50,000,000 lb. below the 113,000,000 lb. total of 1920. This decrease is due partly to overproduction in 1920 and partly to loss of export trade because of German competition.

Prompt Action in Granting Import Licenses

F. S. Dickson, chief of the dye and chemical section of the Treasury Department, declared that 90 per cent of the requests for import licenses received by his department are granted within 8 hours after they are received. The others are delayed in order to investigate the applicant's assertion that the American product will not meet his needs in point of price, quality or terms of delivery. About 5 per cent of the applications are refused.

The witness quoted specific examples where the consumers of dyes had requested licenses to import German dyes that are made in this country and the quality of which are such that the consumer actually did not know the difference. Asked his opinion as to existence of a monopoly, Mr. Dickson replied that he had seen no evidence of such thing.

Enamel Brick and Zirconium Refractories Discussed by Chicago Section, American Ceramic Society

Members of the Chicago Section, American Ceramic Society, met at the Hotel Morrison, Chicago, Tuesday evening, March 14. Ross C. Purdy, general secretary of the parent society, spoke informally of work being done by local sections and suggested the possibility of holding joint meetings with the Illinois Clay Manufacturers' Association.

D. F. Albery, of the Northwestern Terra Cotta Co., discussed the manufacture of wire-cut single-fire enamel brick. The brick are formed on an auger machine with a steam-lubricated die, wire-cut on an American down-cut board-delivery cutting table and dried on pallets holding twelve brick each. The dried brick are sprayed with enamel and burnt in the same car-type muffle tunnel kiln which is used for terra cotta.

H. T. Bellamy, of the Western Electric Co., told of his experience with zirconium silicate brick in the crown of a small surface combustion glass tank. No spalling occurred with these brick and there seemed to be practically no deterioration from the fumes. In fact, it was possible to tear down the crown brick by brick and build it up again. In discussing this paper, W. V. Knowles, of Buckman & Pritchard, was called upon to describe the unique deposits of zircon and related minerals found on the Florida coast.

Congressmen to Inspect Muscle Shoals

The Senate Committee on Agriculture, which is considering the offers for the lease of Muscle Shoals, will leave Washington March 25 for a 5-day inspection of the plants. About twenty Senators will comprise the party. The House Committee on Military Affairs, which is likewise considering the offers, will also inspect the plants, the House having passed a resolution authorizing the visit.

Metric System Hearings Close With Rebuttal of Opposition Testimony

Hearings on the Britton-Ladd metric system bill have been definitely closed with the final appearance of representatives of the American Metric Association to rebut the testimony given in opposition to the legislation.

Senator McNary, in the final hearing, asked Howard Richards, secretary of the American Metric Association, if he expected the bill to be reported out in its present form. To this Mr. Richards replied:

"I certainly believe it should be in view of all the evidence that has been brought out. We are ready to consider any modifications, but unless there is some far more important objection than has been suggested so far, we are sincerely of the opinion that the bill is a good bill." Mr. Richards submitted a brief in which he attempted to show that the estimates of the cost to various manufacturers of the compulsory adoption of the metric system which were presented in the testimony of the opposition were unfair.

Theodore H. Miller of the De Laval Separator Co. testified that his company's stand in favor of the metric system was not due to the fact that certain parts used in its machines are made abroad, as intimated in the discussion before the National Council of the Chamber of Commerce. He stated that all parts have been manufactured in this country for machines built in the last 20 years.

Referring to the compulsory adoption of the metric system, Mr. Miller said:

"It is contended that the metric system can be used alongside any other system and that it should not be compulsory. It is fair to compare the system of measurement with the monetary system. The decimal monetary system was of necessity made the only legal standard of values. It was necessary because it had to be used nation-wide or not at all. If it had been optional we still would be using pounds, shillings and pence. Any system which must of necessity be nation-wide in its use must be declared to be the only standard."

Heavy Cut Prescribed by Appropriations Committee Would Reduce Chemical Warfare to Skeleton

The appropriation for the Chemical Warfare Service for the next fiscal year was cut from $1,500,000, the amount carried in the budget, to $500,000 by the Appropriations Committee of the House of Representatives. This drastic reduction means that only a skeleton organization can be maintained and the appropriation bill specifically states that the great manufacturing plants at Edgewood Arsenal are to be held in stand-by condition. With this small appropriation, the work of the Service practically will be limited to research and experimentation. It will mean that the trained personnel which has been gathered together in such a painstaking way must be disbanded for the most part.

Representative Anthony of Kansas, who is in charge of the War Department appropriation bill, explains that this action was taken because of the agreement reached at the Arms Conference. There is a remote possibility that the Senate will increase the item, possibly on the ground that it is the duty of the nation to its soldiers to have on hand at all times a sufficient supply of gas masks to insure their protection in case a possible enemy resort to the use of gas.

The attitude of Secretary of War Weeks was given during his appearance before the Appropriations Committee.

"Personally, I wish that chemical warfare might be banished from the earth forever," he said. "I do not think it will be banished until every nation agrees to its banishment and does so in good faith. I think we ought to carry out the provisions of the treaty in good faith, but just to what extent we should carry on experimentations in connection with this matter is a subject which I think should be fairly and thoroughly discussed.

"Take, as an example, the barrage. There is nothing said about eliminating the barrage. You might develop a much more effective smoke screen than existed in the last war. Just what we should do with the Chemical Warfare Service, outside of manufacturing, which I would not do at all, is a debatable question."

Trade Associations and Department of Commerce to Confer on Dissemination of Statistics

The Secretary of Commerce will hold a conference in Washington with representatives of trade associations the activities of which are national or interstate in their scope on April 12, 1922. It is the purpose of the meeting to get a list of trade associations that will furnish voluntarily to the Department of Commerce the classes of statistical information outlined in the correspondence between the Department of Commerce and the Department of Justice, published on Feb. 16, 1922. Means and methods will be discussed best adapted for collecting and forwarding to the Secretary of Commerce, for dissemination, the classes of statistical information outlined in the correspondence referred to, including the forms of reports that will be most suitable, for associations that are willing to furnish such statistical information.

Meeting of New Jersey Chemical Society

A large and appreciative audience heard two entertaining talks at the meeting of the New Jersey Chemical Society on March 13, in Newark, N. J. C. E. Davis, director of the research laboratory of the National Biscuit Co., gave an outline of the work being done by his laboratory in adapting chemistry and scientific methods to the biscuit industry. Besides the analysis of a large amount of raw material and miscellaneous supplies, the laboratory has worked out methods for the measuring of shortening and has studied the fundamentals of this action and found that increased shortness is merely increased lubrication in the dough, there being no evidence of chemical action. Leavening is also being studied and Dr. Bacon discussed the different forms of bread and biscuits and the different leavens used in them. In this connection he discussed the modern quick leavens, particularly monocalcium phosphate. He also described the modern processes for the preparation of edible gelatine, large quantities of which are used in the biscuit industry. He stated that recent research work has standardized the manufacture to such an extent that any desired properties can be obtained by the scientific maker.

Ellwood Hendrick, Consulting Editor of CHEMICAL & METALLURGICAL ENGINEERING, spoke on the subject, "Out of Chemistry—and In Again." Dr. Hendrick told in a highly entertaining manner of his experience as a student in Germany and amusing incidents in his business career.

Meeting of Executive Board of Federated American Engineering Societies

Steady advancement of engineering ideals both here and abroad and a growing sense of the need and importance of professional unity were outstanding features of the meeting in Chicago, on March 10, of the executive board of the American Engineering Council of the Federated American Engineering Societies. The report of President Mortimer E. Cooley, and of the executive secretary, L. W. Wallace, presented highly encouraging evidence of the favor with which the idea of engineering federation is being received in this and other countries.

A wide range of topics was considered by the board, whose sessions, largely attended, were presided over by President Cooley and the first vice-president, Calvert Townley of New York.

The executive board received a long report from Rudolph P. Miller of New York, its representative on the National Board of Jurisdictional Awards, stating that the United Brotherhood of Carpenters and Joiners of America have not been observing the decisions of the Jurisdictional Board and that the attitude of the carpenters was causing serious embarrassment to owners, architects, engineers, contractors and workmen in the building industry as well as being detrimental to the public interest. As a consequence of this report, the executive board adopted a resolution urging "that the members of the American Institute of Architects and of the F.A.E.S. insert in all specifications and contracts for building operations a stipulation that the decisions of the Jurisdictional Board shall be observed."

One of the liveliest discussions of the meeting of the executive board arose from a resolution presented by Philip N. Moore of St. Louis "that the president of the F.A.E.S. be authorized to offer the Secretary of War the service of a committee of disinterested, distinguished and skillful engineers, to be selected by a committee of its executive board, for the purpose of making a thorough investigation of the geological, engineering and manufacturing possibilities of the Muscle Shoals power project; this committee to serve without compensation, save for necessary expense." The resolution was voted down.

Attention was called to the passage of the Lampert Patent Office bill and to the fact that much credit for the successful outcome of this legislation was due to the patent committee under the chairmanship of E. J. Prindle.

The Sterling bill for reclassification of federal employees was indorsed rather than the Lehlbach bill, since the salary schedules in the former are approximately 10 per cent higher than in the latter and conform more nearly with the report of the original reclassification committee.

Discussion of the proposed international federation of engineers to promote world peace centered on the details of effecting organization in the Americas. A committee was appointed to consider the whole situation as well as possible constitutional changes which would be necessary should the Canadian Institute of Engineers make application for membership.

Refractories Manufacturers' Association Holds Annual Meeting in Chicago

Departing somewhat from the custom of confining convention programs strictly to committee reports and other business matters, the Refractories Manufacturers' Association included a paper by W. A. Hull in the morning session, March 14, of its convention at the Drake Hotel, Chicago. Mr. Hull, who is chief of the refractories section, Bureau of Standards, spoke on the purchase of refractories with particular reference to government activities along these lines. It was found that the government system of purchasing left much to be desired. Through the energetic efforts of Mr. Hoover (who, he said, had taken the "secret" out of secretary) the Federal Specification Board had been formed. Conferences were held between producers and consumers—in the case of refractories the first conference discussed methods of testing, but the second was able to draw up a set of requirements for refractories for coal-fired boilers.

In his presidential address, J. D. Ramsay made a plea for a comprehensive industrial survey of the major operations in which refractory products are used. He suggested a committee of thirteen with a general chairman to consider service conditions in:

1. Blast furnaces, hot blast stoves.
2. Open-hearth furnaces, soaking pits.
3. Heating, puddling and forging furnaces.
4. All types of boilers.
5. Cement, lime and plaster kilns.
6. Window, plate, bottle and optical glass.
7. Annealing, malleableizing and air furnaces.
8. Water- and coal-gas generators, gas producers.
9. Cupolas and gray iron furnaces.
10. Oil refineries.
11. Zinc, lead and copper smelters.
12. All types of byproduct coke ovens.
13. All types of ceramic kilns.

Relations with the Mellon Institute of Industrial Research were brought out in the secretary's report and that of the committee on the Mellon Institute. Support of the fellowship has never been a serious drain on the association's resources because of an arrangement whereby research done for individual companies is paid for by the companies (at rates below those of independent laboratories, however). Thus in 5 years, over $46,000 has been paid for individual research while the association as a whole has had to contribute only about $7,000. In spite of business conditions during 1921, individual research for that year amounted to more than $16,000, as compared with about $13,000 in 1920.

Officers elected were: President, A. P. Taylor; vice-president, F. R. Valentine; treasurer, C. C. Edmonds.

Potash Producers Want Protection

A petition signed by forty-five American potash producers presenting their grievances has been received by Congress. The petition points out the serious effect of German competition on the American potash industry and appeals for relief in the form of moderate protection. Attention is called to the large investments that were made in potash developments during the war and which are now yielding no return because of the surplus of potash that is dumped on the market. It is claimed that German agents are conducting an extensive propaganda in this country to mislead Congress and the public about the needs of the American industry to the end that it may be denied the protection it seeks from foreign aggression.

Conservation of Supply and Continued Experiment Should Reduce Production Cost of Helium

Representative Anthony of Kansas, in discussing the army bill in the House, said that while it provides $400,000 for helium investigations by the army and that a similar fund would probably be authorized for the navy, the Committee on Appropriations was not convinced that with existing facilities helium can be produced commercially.

The cost of government experiments in helium production for the army air service has amounted to $8,016,000, according to testimony given before the Appropriations Committee by officers in charge of this work. When the work first started it cost $1,700 to produce a thousand cubic feet of helium, and this has been reduced to $83.71. The army has 2,400,000 cu.ft. of helium on hand. The government policy in regard to helium was announced to be one for scientific purposes and conservation for war purposes. The army authorities point out that it is desirable to establish continuous production to save the waste in the natural gas districts.

Advances have been made to the army by private interests for the development of helium production on a commercial scale, but no decision has been reached thereon. The army could provide storage facilities for 15 or 18 million cubic feet of helium. Army officers referred to a statement of the Bureau of Mines that the gas fields would probably be exhausted in 20 years. J. W. Davis, mechanical engineer of the Bureau of Mines, testified that with continued development, helium could be produced at a cost of $30 per thousand cubic feet.

Atomic Disintegration of Tungsten Interests Joint Meeting of Mid-West A.C.S. Sections

Members of all sections of the American Chemical Society co-operating in the publication of the *Chemical Bulletin* gathered at Northwestern University at Evanston, Ill., on March 11 for the purpose of participating in a well-balanced intersectional program of social as well as scientific appeal.

At the afternoon session, Harrison E. Howe, editor of the *Journal of Industrial and Engineering Chemistry*, spoke on "Chemistry's Publication Problem." Mr. Howe discussed the editorial and advertising phases of the *Journal*, the News Service, and then outlined some of the plans for enabling the *Journal* to render greater service to the members. Teams representing Milwaukee and Chicago furnished entertainment in the form of an indoor baseball game in the attractive Patten Gymnasium. A score of 11 to 10 in favor of Chicago made up in some measure for the defeat suffered by Chicago at the first intersectional meeting.

After supper the evening program was continued in Harris Hall. Prof. H. B. Lemon of the University of Chicago read a paper outlining preliminary results of some remarkable work by Dr. G. L. Wendt and C. E. Irion on "The Atomic Disintegration of Tungsten." The method employed was suggested by the astronomical researches of Dr. J. J. Anderson of the Mt. Wilson Observatory. If a condenser charged at 100,000 volts is discharged suddenly through a very fine wire, the wire explodes and an instantaneous temperature of between 20,000 and 30,000 deg. C. is obtained. A pure tungsten wire 0.0004 mm. in diameter was exploded in a vacuum tube which gave no spectroscopic lines prior to the explosion. After the destruction of the wire, however, the characteristic lines of helium, hydrogen and mercury were found, indicating atomic disintegration of the tungsten. It was voted unanimously to send a vote of congratulation to Dr. Wendt for this research.

Six group meetings provided ample variety of subject. Dr. H. I. Schlesinger demonstrated the application of absorption spectra methods to the study of the theory of the chamber process for sulphuric acid. Platinum black catalysis was considered by Dr. Roger Adams. Dr. E. J. Forbes spoke on the mineral metabolism of the milch cow; Prof. Edward Bartow on "Relation of High School and College Chemistry." The ladies and non-chemists witnessed a demonstration of the preparation of gelatine desserts and salads by Miss Alice Irwin.

John Arthur Wilson reviewed briefly the circumstances which had led to the development of his much-discussed method for tannin analysis. Attempts to check leather output against tannin input as indicated by the official method of analysis revealed that there was an apparent loss of about 50 per cent of the tannin. Further study showed that certain non-tans such as gallic acid which form hydrolyzable compounds with hide substance were included as tannin by the official method, the error varying with the amount of hide powder used. When the hide powder is washed free of these hydrolyzable substances, the results are constant regardless of the quantity of hide powder taken, and they check with the tannery yields. This forms the basis of Mr. Wilson's method, the washed, tanned hide powder being dried and weighed, giving a result strictly comparable with tannery practice.

Government Co-operating With Engineers in Standardization in Industries

At the request of Secretary of Commerce Hoover, the American Engineering Standards Committee has designated A. A. Stevenson, the retiring chairman of the committee, as a special representative to work with the department in the co-operation between the department's Division of Simplified Practice and the American Engineering Standards Committee. Mr. Stevenson, who is a past president of the American Society for Testing Materials and has had a most extensive experience in standardization work, is vice-president, in charge of manufacture, of the Standard Steel Works Co., which is a subsidiary of the Baldwin Locomotive Works.

The Division of Simplified Practice is a co-ordinating unit of the Department of Commerce assisting in those reductions of excessive variety and other simplifications which many industries are undertaking in order to decrease the cost of production and distribution of manufactured articles. The work of the division was organized in the latter part of 1921 and is now actively under way.

The American Engineering Standards Committee, which serves as a national clearing house for a broad field of engineering and industrial standardization, has offered Secretary Hoover the use of its machinery in carrying out the detailed work on technical projects initiated in the simplification program of the Department of Commerce. The committee has been actively at work somewhat over 2 years, during which time it has brought about a large measure of industry-wide co-operation. In this work more than a hundred national organizations are participating through representatives officially designated by them. The formulation of the standard for each specific project is in the hands of a working committee made up of representatives officially designated by the various bodies concerned. Eighteen standards have received formal approval as nationally recognized standards, and work on more than sixty other projects is in various stages of development. The American Engineering Standards Committee is maintained jointly by twenty-nine national organizations, including five departments of the federal government, nine national engineering societies, and fifteen national industrial associations.

There are now similar national industrial standardizing bodies in thirteen foreign countries, all but one of which were formed during or since the war. Of these the British and the German work is the most extensive, but active and important work is going forward in other countries.

Fish Commission Warns Against Drastic Pollution Prevention Measures

Congress has received a petition from the New Jersey Legislature urging passage of the Appleby bill to protect coastal waters from pollution by fuel oil and waste from chemical and industrial plants.

Warning was given Congress by the U. S. Fish Commission not to injure industry by proposed legislation to prohibit the discharge of oil and other acid wastes into navigable streams in an attempt to save fish from the effect of polluted waters. Officials of the fishery bureau point out that the pending bills before Congress against pollution would practically wipe out some industries on the theory that all pollution was injurious to fisheries, while as a matter of fact it was not known that they are so injurious. They admit that oil pollution is injurious to the fish but say that an attempt to protect fish by drastic legislation without fundamental information might work serious effects on the general business of the country. For example, it is known that the coal mines of western Pennsylvania cause pollution of the Ohio River to the injury of the fish, but obviously this is not sufficient ground for closing those mines. Authority to employ chemists to make a complete study of the effect of pollution on fish was requested.

Personal

R. I. BASHFORD, assistant general superintendent of the Grasselli Powder Co., who has been in charge of its high explosives plants for the past 2 years, has tendered his resignation to become effective April 1.

Dr. ERNEST B. BENGER, director of the Redpath Laboratory of E. I. du Pont de Nemours & Co., is making a brief trip to England in connection with the work of the laboratory on motion picture film.

A. NELSON CHASE, superintendent of the Forcite Works of the Atlas Powder Co., at Landing, N. J., has been transferred to the Darco Corporation's decolorizing carbon plant at Marshall, Tex., as superintendent. This plant is in process of construction and it is expected will be ready for operation about May 1.

Dr. EMIL COLLET of Christiania, Norway, is making a tour of the United States in the interest of Norwegian chemical companies.

R. D. COOKE, chief chemist at the plant of the Columbian Enameling & Stamping Co., Terre Haute, Ind., gave an interesting address before the members of the Indiana Section of the American Chemical Society at the Chamber of Commerce Building, Indianapolis, on March 10, on "Sheet Steel Enamels and Enameling."

JOHN A. ELLIOTT of Pittsburgh has been elected president of the Brinkley Producing & Refining Co. Headquarters of the company are being moved from New York City to Pittsburgh.

W. B. EMMERT, formerly president of the United Central Oil Co., now consolidated with the White Oil Corporation, 66 Broad St., New York, has been elected president of the latter company. He will succeed P. J. White, who becomes chairman of the board of directors.

JOHN R. FREEMAN, JR., returned recently to the Bureau of Standards from a 7 months' trip to Europe, where he visited, for the Bureau of Standards, the principal metallurgical laboratories of France, Germany and England. While in England he worked for about 2 months in the metallurgical department of the National Physical Laboratories under Dr. Walter Rosenhain.

W. A. GIBSON has been transferred from superintendent of foundry for the Owens Bottle Co. to master mechanic for the Libbey Owens Sheet Glass Co., at Charleston, W. Va.

WILLIAM R. HARRIS has been re-elected president of the Monroe Paper Products Co., Monroe, Mich.

H. T. HERRICK, formerly of the National Aniline & Chemical Co. at Buffalo, N. Y., and more recently with the American Aniline Products Co. at Lock Haven, Pa., is now operating chemist of the By-Products Steel Corporation at Weirton, W. Va.

A. C. LANSING has left his fellowship at the School of Mines at Golden, Col., to become chemist with the Lightfoot Schultz Co., soap manufacturer, of Hoboken, N. J.

Dr. W. LEE LEWIS of Northwestern University addressed a joint luncheon meeting of the Chicago Chemists Club and the City Club, Tuesday, March 7, on the subject "Is the Elimination of Gas Warfare Feasible?"

T. A. MITCHELL, chemical engineer, has just returned to the United States after spending 5 years abroad, where he was director of the French branch of the Norsk Aluminum Co. He is now at 30 Church St., New York City, associated with Rogers, Brown & Co.

ROSS C. PURDY, secretary of the American Ceramic Society, addressed the annual convention of Illinois Clay Manufacturers' Association at the LaSalle Hotel, Chicago, March 14, on "The Relation of State Associations to Local Sections of the American Ceramic Society."

CHARLES RUSS RICHARDS, dean of engineering and director of the experimental engineering department of the University of Illinois, has been elected president of Lehigh University. He succeeds Dr. Henry S. Drinker, now president emeritus at Lehigh. Mr. Richards is a graduate of Purdue University and a post-graduate of Cornell.

L. B. RIDDLE has been appointed manager of production for the Shaffer Oil & Refining Co., Chicago, Ill. He recently resigned as assistant manager of production for the Pure Oil Co. of the same city.

Dr. HUGO SCHLATTER, formerly chief of the chemical products division of the Hercules Powder Co., has recently returned from an extended visit to Europe and has opened an office as consulting engineer in the Stephen Girard Building, Philadelphia, Pa. He will specialize in the chemistry of cellulose and its products.

Dr. EDWIN E. SLOSSON spoke on "The Popularization of Science" at a luncheon forum of the City Club, Chicago, on March 14.

Prof. M. DEKAY THOMPSON of the Massachusetts Institute of Technology, Cambridge, Mass., addressed the Franklin Institute, March 5, on the subject "Recent Progress in Applied Electrochemistry."

Obituary

WILLIAM L. PRIZER, manager of the Vacuum Oil Co., New York City, died on March 6, at his residence in New York, at the age of 68 years.

CHARLES C. SPRINGER, managing director of the Mt. Tom Sulphite Pulp Co., Boston, Mass., and for many years identified with the pulp and paper industry, died at his apartments in the Hotel Vendome, on March 9.

Dr. CHARLES W. WAIDNER, chief physicist of the Bureau of Standards, died at his home in Washington, D. C., on March 10 after a protracted illness. He was born in Baltimore, March 6, 1873, and received his early education in the public and private schools there, after which he was graduated from Johns Hopkins University and later received the degree Ph.D. from that institution. He taught for several years, and in 1901 entered the Bureau of Standards, and was connected with that institution as organizer and chief of the work on heat measurements and thermometry practically since the establishment of the bureau. His work was mainly in the fields of temperature and heat measurements and apparatus for the study of thermal phenomena. During recent years his particular problem had been direction of the work on the determination of physical constants used in engineering, especially fireproofing of structural materials and refrigerating engineering. The work on automotive engines also was under his charge.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Wage Comparisons in the Chemical and Allied Industries

Manufacturers in every line of industry are impressed by the urgent need for lower costs of production. Naturally the problems of labor are among the first to absorb their attention, for in this direction lies the obvious, even though perhaps the most difficult, path to lower costs. Wages in most branches of business have already been reduced and in certain industries there is abundant evidence that further reductions are necessary if the manufacturer is to meet the competition which is developing with business revival. It is perhaps worth while, therefore, to give some consideration to the trend of employment and to wage levels both in this country and abroad.

Chemical and metallurgical manufacturers, unfortunately, can obtain relatively little published information regarding wage conditions outside of their own plants. To be sure, some compilations are made at infrequent intervals by the federal government and by labor departments in some of the states, but for the most part these data are not published soon enough to be of value or are too fragmentary to offer adequate basis for comparison. The monthly reports of the Industrial Commissioner of New York may, however, be regarded as an exception, for comprehensive statistics of employment and wages in New York State are now published fairly promptly.

In Table I are given some of the more recent figures for the number of employees and weekly wages in representative New York factories engaged in the production of chemicals and related products. It will be noted that the group "chemicals, oils and paints" exhibits the same general trend as the total for all industries, but has a noticeably higher wage level. However, maximum wages paid in December, 1920, averaged $28.04 for this group, as compared with $28.35 for all industries. The metals group appears to have received the highest wages most consistently, averaging $31.80 for December, 1920, while one subdivision, pig-iron and rolling mill products, reached as high as $36.65 per

TABLE I—EMPLOYEES AND AVERAGE WEEKLY EARNINGS IN REPRESENTATIVE NEW YORK STATE FACTORIES FOR CHEMICALS AND ALLIED PRODUCTS, FOR DECEMBER, 1914 TO 1921

(Compiled under direction of the Industrial Commissioner of New York State)

Chemical and Allied Industries	Number of Representative Establishments and Employees, December, 1921: Total State Establishments	Total State Employees‡	New York City Establishments	New York City Employees‡	Average Weekly Wages in New York State 1921	1920	1917	1915	1914	Average Weekly Wages in New York City 1921	1920	1917	1915	1914
Stone, clay and glass products					**$25.00**	**$30.98**	**$18.32**	**$14.08**	**$13.94**	**$30.14**	**$34.39**	**$18.55**	**$15 60**	**$16 53**
Miscellaneous stone and mineral products					27.78	33.02	19.64	16.54	18.47	38.73	41.76	22.45	20.50	21.44
Lime, cement and plaster	73	11,440	26	2,442	26.07	32.42	18.16	12.96	13.38	22.99	32.55	17.86	14.51	15.43
Brick, tile and pottery					21.99	29.07	16.19	11.72	11.53	25.95	31.44	18.42	13.21	10.18
Glass					25.73	29.96	18.53	14.99	14.23	28.82	30.24	20.18	14.40	15.30
Metals, Mchry. and Conveyances					**26.46**	**31.80**	**20.84**	**15.61**	**14.24**	**27.39**	**31.58**	**18 54**	**15.30**	**14 01**
Gold, silver and precious stones					27.14	33.46	18.99	16.56	14.24	31.46	31.62	18.91	17.72	16.98
Brass, copper, aluminum, etc					22.09	27.41	18.62	13.18	12.73	23.37	27.67	16.89	13.02	12.64
Pig iron and rolling mill products	346	142,606	96	30,172	24.53	36.65	27.70	18.01	16.63	.....	.....	.....	.....	.....
Structural and architectural iron wk.					30.12	33.10	20.50	16.62	15.31	33.26	34.34	20.09	16.96	5.99
Sheet metal work and hardware					24.65	27.77	17.24	13.03	12.20	24.33	27.41	16.23	12.08	10.33
Leather and Rubber Goods					**24.11**	**25.26**	**16.75**	**12.71**	**11.88**	**26.86**	**28.65**	**17.08**	**13.03**	**12.10**
Leather					21.05	25.49	18.21	12.26	11.04	.....	.....	.....	.....	.....
Misc. leather and canvas goods	141	40,663	75	13,578	24.08	23.87	14.57	11.66	10.99	28.74	28.75	15.20	11.80	11.29
Rubber and gutta percha goods					25.08	24.90	15.97	11.66	10.93	26.06	26.02	16.33	12.48	11.60
Pearl, horn, bone, celluloid, hair, etc.					21.38	22.39	13.79	10.31	9.62	23.49	25.06	13.59	10.20	9.27
Chemicals, Oils, Paints, Etc					**25.99**	**28.04**	**18.00**	**13.90**	**13.64**	**25.91**	**26.90**	**16.93**	**13 24**	**13 37**
Drugs and chemicals					23.82	26.09	16.68	13.69	14.57	20.35	21.19	13.52	11.39	12.88
Paints, dyes and colors	57	25,918	29	897	25.39	28.38	16.43	14.59	14.43	25.87	28.26	16.35	14.45	14.32
Animal and mineral oil products					26.30	28.17	19.03	13.69	13.35	28.11	28.99	19.09	13.57	13.32
Miscellaneous chemical products					27.17	29.37	17.96	14.25	13.17	27.78	31.76	19.20	13.52	11.55
Paper	167	48,719	92	29,897	**26.93**	**31.06**	**18.96**	**14.12**	**13.32**	*	*	*	*	*
Total for all industries	**1,648**	**471,431**	**780**	**177,855**	**$24.91**	**$28.35**	**$17.71**	**$13.49**	**$12.56**	**$26.56**	**$28.89**	**$16 61**	**$13 45**	**$12 81**

* Reports do not cover a sufficient number of employees to permit the publication of an average weekly earning.

‡ Includes all employees in both office and shop. It is commonly the case that office salaries are higher than the average weekly earnings of shop employees. However, the office employees form such a small percentage of the total number of workers that their effect, in the computation of the average earnings, is negligible.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.49
Last week	157.13
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

Of the twenty-five commodities included in this index number, the prices of five have advanced during the past week, two have declined and the others have remained unchanged. The rise in the prices of ammonium sulphate, barium chloride, caustic potash, caustic soda and soda ash more than offset the lower prices for linseed oil and citric acid.

TABLE IA—WAGES AND NUMBER OF EMPLOYEES IN THE DYE AND COAL-TAR CHEMICAL INDUSTRIES IN 1920

(From U. S. Tariff Commission Census of Dyes, etc.)

Wages per Week	Number of Employees at Each Specified Wage Engaged in Manufacturing Operations: Chemists and Technically Trained Men	Men Without Technical Training	All Employees	Percentage Receiving Each Specified Wage Of All Chemists and Technically Trained Men	Of All Men Without Technical Training
Under $10	3	30	33	0.12	0 15
$10, but under $15	15	303	318	0.59	1.54
$15, but under $20	55	618	673	2.15	3 15
$20, but under $25	72	2,038	2,110	2.82	10.38
$25, but under $30	118	3,837	3,955	4.63	19.55
$30, but under $35	201	5,564	5,765	7 88	28 34
$35, but under $40	242	3,431	3,673	9.49	17.47
$40, but under $45	431	1,813	2,244	16.90	9 23
$45, but under $50	214	1,049	1,263	8.39	5 34
$50, but under $75	670	907	1,577	26.25	4.62
$75 and over	530	46	576	20.78	0.23
Total	2,551	19,636	22,187	100 00	100 00

week. The leather group paid the lowest average wage in both 1920 and 1921, but the decrease was much less than in the case of any other group. The most striking wage reduction was in the ceramic industries, where the decrease of $5.98 per week in 1921 was equivalent to approximately 20 per cent of the 1920 wage and to 36 per cent of the 1914 figure.

Using the number of employees in June, 1914, as a basis of 100, the ratio in December, 1921, for the group "stone, clay and glass products" was 79; for the metals group, 95; for leather and rubber, 111; for chemicals, 102; and for paper, 93.

The most recent compilation of wages in the dye and coal-tar chemicals industry is contained in the United States Tariff Commission's "Census of Dyes and Coal-Tar Chemicals, 1920." These figures, reproduced in Table IA, are for the year 1920, and have therefore lost much of their value, for since that time there have been drastic reductions both in wages and number of employees.

International Wage Comparisons

The recent report of the Tariff Commission on "Depreciated Exchange and International Trade" contains a very interesting study of wages and living conditions within some of the countries whose exchanges have suffered depreciation. Commodity prices may be varied almost directly with the exchange, but wage rates shift more slowly and thus those countries whose currencies have depreciated most may derive a corresponding competitive advantage because of low wages as compared with the higher international value of their products. In this connection the Commission makes the following statement:

> The comparative wages in the chemical and metallurgical industries are especially significant. The standard wage in the United States appears to be about 50c. to 75c. per hour and from 30c. to 45c. per hour in England. Germany, on the other hand, shows a rate averaging about 10c. per hour at current exchange, about 18c. per hour in terms of the purchasing power over commodities at wholesale, and from 20c. to 25c. per hour in terms of the cost of living. Inasmuch as many chemical products in Germany are competing directly with similar ones produced in England and the United States, the wage rate at 10c. per hour at current exchange becomes an important factor.

It will be observed in Tables II and III that in the case of Germany, the wages paid in depreciated paper money are converted to American currency in three ways—viz., (1) at the current rate of exchange quoted in New York, (2) at a rate based on German and American wholesale price index numbers and therefore on the basis of relative purchasing power and, (3) at a rate based on the cost of living for an ordinary family in the two countries. In effect this is a translation of nominal to real wages.

These calculations are necessary because of two factors of peculiar significance in the German situation. These are low rents and food subsidies. The report points out that "because of governmental control, rents are only 50 to 60 per cent higher than they were in 1914, an item which holds down the cost of living to a great extent. The food subsidies take the form of government purchases, largely of imported commodities, at the world market price

TABLE II—INTERNATIONAL WAGE COMPARISONS IN THE CHEMICAL INDUSTRY*
(Rate per hour as of May, 1921.)

Occupation	United States[1]	Great Britain[2]	Germany[3]		
		At Current Exchange	At Current Exchange	Equivalent Purchasing Power[4]	Equivalent in Cost of Living[5]
Laborers:					
Male	$0.390	$0.271	$0.094	$0.155	$0.211
Female	.272	.172	.053	.088	.120
Foremen:					
Chemical operators	.674	.....	.097	.168	.228
Mech. operators	.557	.....	.096	.159	.216
Process men:					
Assistants	.500	.....	.....	.....	.....
Primary	.683	.312	.094	.155	.211
Secondary	.544	.....	.....	.....	.....

* Compiled and published by U. S. Tariff Commission.
[1] *Monthly Labor Review* for May, 1921.
[2] Ministry of Labor, "Rates and Hours of Wages," December, 1920. Amended by the *Labour Gazette*, May, 1921.
[3] German basic wages reported by *Statistischer Reichsamt* for February, 1920, readjusted to May, 1921, by application of the wage index number published by the *Frankfurter Zeitung* for the Frankfurt district.
[4] Equivalent purchasing power based on United States and German wholesale price indices.
[5] Equivalent purchasing power based on relative costs of living in United States and Germany.

TABLE III—INTERNATIONAL WAGE COMPARISONS IN METALLURGICAL INDUSTRY*
(Rate per hour as of May, 1921)

Occupation	United States[1]	Great Britain[2]	Germany[3]		
		At Current Exchange	At Current Exchange	Equivalent Purchasing Power[4]	Equivalent in Cost of Living[5]
Toolmakers	$0.880	$0.400	$0.109	$0.182	$0.246
Chargers for blast furnaces	.400	.350	.090	.150	.203
Other blast-furnace workers	.330	.270	.087	.145	.197
Stamped or pressed metal workers	.600	.200	.098	.162	.220
Borers	.550	.370	.099	.165	.230
Turners	.780	.458	.098	.163	.221
Millers	.650	.370	.107	.179	.242
Armature winders	.800	.458	.097	.160	.228
Pattern makers	.800	.479	.104	.174	.236
Boilersmiths	.800	.468	.106	.177	.239
Strikers	.500	.340	.090	.150	.203
Brass dressers	.550	.334	.116	.192	.261
Brass casters	.830	.413	.097	.161	.218
Brass polishers	.550	.354	.105	.165	.224
Brass molders	.880	.355	.096	.159	.215

* Compiled and published by U. S. Tariff Commission.
[1] Average estimate by experts of the Tariff Commission of wages paid in the chief commercial districts in the metallurgical industry.
[2] The *Labour Gazette* (British).
[3] German basic wages reported by *Statistischer Reischsamt* for February, 1920, readjusted to May, 1921, by application of the wage index number published by the *Frankfurter Zeitung* for the Frankfurt district.
[4] Equivalent purchasing power based on United States and German wholesale price indices.
[5] Equivalent purchasing power based on relative costs of living in United States and Germany.

TABLE IV—FOREIGN WAGES IN CHEMICAL INDUSTRIES COMPILED BY U. S. TARIFF COMMISSION FROM PRIVATE SOURCES OF INFORMATION, JANUARY-JULY, 1921

Occupation	France—Conversions Made at $0.074 Per Franc	Italy—Conversions Made at $0.042 Per Lire	Occupation	France—Conversions Made at $0.074 Per Franc	Italy—Conversions Made at $0.042 Per Lire
	Per Hour	Per Hour		Per Hour	Per Hour
Common laborers	$0.111	$0.121	Assistant chemists or aids	.185	.....
Do	.130	.....	Do	.315	.....
Do	.157	.089	Do	.370	.....
Do	.150	.....	Chemical engineers	.....	.210
Do	.130	.063	Do	.....	.263
Do	.143	.084	Pipe fitters	.222	.....
Skilled labor or process men	.....	.084	Do	.259	.....
Do	.139	.105	Machinists	.226	.....
Do	.167	.147	Do	.255	.....
Do	.173	.112	Blacksmiths	.200	.....
Do	.157	.....	Do	.255	.....
Do	.305	.....	Carpenters	.200	.....
Control or plant chemists	.....	.167	Do	.229	.....
Do	.231	.210	Firemen	.160	.....
Do	.444	.....	Do	.175	.....
Do	.694	.....	Plant operatives (unskilled)	.139	.....
Do	.207	.....	Do	.201	.....
Research chemists	.....	.167	Yardmen	.134	.....
Do	.370	.210	Do	.175	.....
Do	.781	.....	Plant foremen	.185	.....
			Do	.278	.....

TABLE V—WAGES IN THE GERMAN CHEMICAL INDUSTRY AND THE MINIMUM COST OF LIVING, 489 ESTABLISHMENTS

(Quoted from *Statistische Reichsamt* by Consul Maurice Parmelee in special report to the United States Bureau of Foreign and Domestic Commerce under date of May 22, 1921.)

	Skilled Workers				Unskilled Workers			
	1914		1920		1914		1920	
	Cost of Living*	Wages	Cost of Living*	Wages	Cost of Living*	Wages	Cost of Living*	Wages
Unmarried men	100	232	100	188	100	161	100	175
Married couple	100	174	100	131	100	121	100	122
Married couple with 1 child	100	162	100	113	100	106	100	107
Married couple with 2 children	100	135	100	103	100	94	100	97

* Includes food, fuel, light, and rent only.

and their resale to German consumers at a substantially lower figure."

In addition to the wages from official sources, the Tariff Commission has obtained some rates from American firms having definite knowledge of foreign conditions. From these data, which are reproduced in Table IV, it will be seen that wages in France and Italy at current rates of exchange were from 15c. to 25c. per hour for common labor and correspondingly more for skilled technicians. These rates appear to be about halfway between the rate for similar occupations in Germany and England and less than half the rates in the United States.

A special consular report to the Department of Commerce, under the date of May 22, 1921, gives some interesting information on the relation between the cost of living and wages in the German chemical industries in 1914 and 1921. This compilation, which includes data from 489 establishments, is shown in Table V. In commenting on this table Consul Parmelee says:

> These figures illustrate very pointedly that, while skilled workers in this industry were apparently not so well remunerated in 1920 as in 1914 in proportion to the cost of living, the unskilled workers were better remunerated in 1920 than in 1914 in proportion to the cost of living. In fact, by the year 1920 the unskilled workers had attained almost as high a level of remuneration as the skilled workers.

Imports and Exports of Chemicals in January

Figures covering imports and exports during January contain little of encouragement to the chemical industries. The total value of exports in January was $7,919,896. This compares with $16,833,454, the value of the exports in January of 1921. The imports in January of this year were valued at $7,517,817. This compares with $12,241,424 in January of last year.

The decrease in imports was confined entirely to the free list. Duitable chemicals increased slightly over the value of those brought into the country in January, 1921. Imports of coal-tar products were less in January by nearly one-half. The value of all coal-tar products imported in January was $720,908. There was only a slight falling off in the value of gums imported. The January figure was $7,272,280. There was a very material increase in imports of carbonate of and hydrate of potash. Increases in the imports of cyanide of soda and muriate of ammonia were noted, but the imports of calcium products fell to nearly one-third the volume of the January, 1921, imports.

Exports of benzene in January were 2,178,420 lb., double the exports of January, 1921. Exports of crude distillates of coal tar fell off decidedly. Exports of colors, dyes and stains of coal-tar origin fell to one-third of the volume in which they were exported in January, 1921. Sulphuric was the only acid moving in volume during January, but shipments were much smaller than in January of last year. The slump also affected in about the same proportion the shipment abroad of acetic, nitric, boric and lactic acids. Calcium carbide and chloride of lime moved in only one-half the rate at which shipments were made in January, 1921.

The New York Market

NEW YORK, March 20, 1922.

There has been a decided expansion in the volume of business transacted in the chemical market during the past week due to both foreign and domestic buying. Present low prices for caustic soda have noticeably improved export business in this chemical. Heavy sales were recorded to Italy, Germany, South America and Japan. There are some interests who expressed the opinion that caustic soda will touch 4c. per lb. before the close of the month. Although the market on soda ash of late is somewhat steadier, it is not showing much of a tendency to strengthen in sympathy with caustic soda. Nitrite of soda reached some new high levels on spot due to the very scant offerings. Yellow prussiate of soda was much easier. Quotations during the week recorded a net loss of ¾c. per lb. Prices opened at 18¼c. per lb. and closed the week at 17½c. Producers of carbon tetrachloride quote lower prices on round lots, but are sustaining recent levels on regular small-lot inquiries. Recent importations of glaubers salt have had a depressing effect on the market and prices on foreign material were generally below 1c. per lb. This is a fraction under prewar figures. The bromides were very much firmer and domestic producers have advanced prices considerably on potassium bromide, which is quoted at 23@24c. per lb. Imported material was very scarce and brought up to 16c. per lb. Barium chloride continued its rise. Sulphate of ammonia is exceedingly scarce in the resale market and prices showed a net advance to 3¼c. with the demand active. Tartaric acid has shown an advancing tendency and the market was very firm with offerings of imported material more restricted.

The Commodity Markets

Arsenic.—Continues very promising and the tone of the market is firm. Dealers are placing small-lot business at 7@7½c. per lb. In some directions 7½c. seems to be the prevailing figure, while others are even quoting as high as 8c. per lb.

Carbon Tetrachloride.—Leading manufacturers are offering carlots as low as 9½c. per lb. Small quantities command a premium and prices extend all the way up to 12c., according to seller and quantity.

Caustic Soda.—Prices for export remain firm and the market shows a tendency to advance among second-hand merchants. Quotations in these quarters are held at $3.70 per 100 lb. f.a.s., for March shipment, $3.60 for April and $3.50 for May-June. The export inquiry is very active and some sellers are sold up for April. Producers' contract prices are sustained at $2.50 per 100 lb., basis 60 per cent, f.o.b. works, in carload lots.

Epsom Salts.—Imported salts are offered at $2.60 per 100 lb. for the U.S.P. Some domestic material has been sold down to $2.50 at the works. The technical grade is not finding any ready market and goods are offered down to 1c. per lb.

Fluoride of Soda.—Leading factors in this commodity were not eager to quote below 10c. per lb., and stated that small consuming orders were being booked at 11c. Offerings are rather scarce and the tone of the market appears quite firm.

Glaubers Salt.—Imported material is offered at 95c. per 100 lb. in bags, on spot and 90c. to arrive. Barrels are quoted at 1.10@1.20, depending on quantity. Domestic goods are held at 1¼@1½c. per lb. Buyers are showing some additional interest of late.

Nickel Salts.—Spot material is not plentiful in the single or double grades and the general condition of the market is reported quite steady. Leading factors state that business in both varieties is going through at 11c. per lb.

Nitrite of Soda.—Scarcity in this chemical is very pronounced at present and holders are limiting their offerings. In first hand quarters it was stated that 9c. per lb. could be done on a firm order, while the majority of dealers are demanding 9½c. per lb. for spot goods. Some large holders of imported material have entirely withdrawn from the market, as they are convinced that higher prices will soon prevail.

Prussiate of Soda.—Lower prices are quoted for spot material and while 17⅜c. per lb. was quoted in some directions, it was intimated that 17½c. could be done on firm orders. The demand seems to have been temporarily satisfied so far as urgent requirements are concerned and a keener competition has developed.

Waxes

Beeswax.—Trading in crude beeswax was slow, but prices held up steady in sympathy with other markets. African crude on spot was available at 15c. per lb. Brazilian crude was quoted nominally at 21@24c. per lb., pure white on spot at 35@40c. per lb.

Montan Wax.—The shipment market held at 4¼@4½c. per lb., with spot material quoted at 4¾@5c. The demand was merely routine.

Paraffine Wax.—The general trend of the market showed

only a slight improvement. Leading producers did not attempt to force business, but tried to sustain current quotations. Match wax attracted some attention and with offerings rather light, prices ruled firm at 4¼@4½c. per lb. Fully refined wax of 125-127 deg. melting point sold at 3½c. per lb., with the 130-132 deg. at 4c. per lb.

Carnauba Wax.—Advices from primary markets indicated a firmer market but prices here did not change a great deal, for the demand has fallen off. No. 3 North Country was quoted at 15½@16c. per lb. No. 2 North Country was steady at 25@26c. pr. lb.

The St. Louis Market

St. Louis, March 16, 1922.

The activity in the local market for industrial chemicals continues and the prospects for the future are very promising. Furthermore, the market is much firmer and the demand for spot and future business is increasing steadily in volume. Many of the weak spots caused by the foreign competition are being eliminated, due to the continued rise of sterling exchange. The local market is very optimistic and producers are putting great confidence in the future.

Alkalis

There has been no change in *caustic* for some time and the present conditions would indicate firmness at prevailing price, one producer of *electrolytic caustic* having withdrawn from this market, being sold up for the time being. *Soda ash* continues to move steadily at prevailing market in less than carlots, and carlots can be purchased as low as $1.75 per 100 lb. in bags f.o.b. St. Louis. *Sodium bicarbonate* is being offered freely at $2.50 per 100 lb. in 1- to 5-bbl. lots. A new factor in the *sal soda* market is offering the regular case goods, 36 packages of 2½ lb. each, at $2.25 delivered buyer's door, with barrels at $1.75.

General and Special Chemicals

The heavy *commercial mineral acids* are still very active with no change in price and market firm. The disturbing element which existed some time ago is gradually coming into line with the present prices. *Citric acid* is moving somewhat better, but there is still lacking the real demand usually expected at this time of the year. Prices are firm. *Carbolic acid crystals, U.S.P.*, is one of the commodities which moves through regular channels and the demand remains practically the same from month to month. Owing to the scarcity of *white arsenic* the market is much stronger and spot lots are now being quoted at 6@7½c. f.o.b. producers' works. Domestic manufacturers of *bromides* have this week advanced their price on the *potash salts* 4c. per lb., other *bromides* remaining unchanged. There is quite a bit of activity in the *bromide* market and business of large volume is passing. There has been practically no cessation in the demand for *bismuth salts* and *iodide salts* for the past 12 months, and today the movement is of as large a volume as at any time. Producers report that they are favorably situated to meet the continued increase. *Carbon bisulphide* is in brisk demand. *Carbon tetrachloride* has not been active and prices are on the easy side. The *copperas* situation is not any easier today than it was several weeks ago. Producers are still unable to take care of business other than their regular customers. Quotations remain the same. *Glycerine* has not changed since our last report and is still being offered at 16c. in drums with a good demand. *Sulphur* has stiffened somewhat, as high as $2.10 being quoted in some instances. A steady demand for *zinc sulphate technical* is still evident and is being quoted at $2.95 in carlots f.o.b. St. Louis.

Vegetable Oils and Naval Stores

Castor oil remains firm and in good demand, the price of 13¾c. in drums prevailing. *Linseed oil* is being quoted today at 87c. basis raw oil, a drop of 2c. within the last 2 days. *Turpentine* offered today at 90c. in barrels, 87c. in drums, a drop of 1½c. since our last report.

Paint Materials

Our anticipated advance in price of *French ochre* stimulated buying in the paint trade recently, there being a rush to get under cover before the new price went into effect. Aside from this the paint trade is very slow at a period when it should be booming.

The Iron and Steel Market

Pittsburgh, March 17, 1922.

The chief point about the steel market now is whether demand will continue at its recent rate, not whether it will increase farther. The rate of steel ingot production in the past 3 weeks has ranged between 29,000,000 and 30,000,000 tons a year, while the two best pre-war years, 1912 and 1913, each showed a production of 30,275,000 tons. The decrease in exports is sufficient to cover the difference between these figures, so production for domestic consumption is now running at the average rate in the two best years before the war. As the general industrial or business situation in the country is regarded as unsatisfactory, rather than as measuring up to the highest standard before the war, there cannot be much complaint as to this item of the volume of steel demand, and the real market question is whether it will continue indefinitely, increasing as general and basic conditions improve.

Considering the time of year and the fears of not a few buyers that production and shipment of steel might be curtailed by the expected coal strike April 1, there is reason to suspect that a portion of the recent steel buying has been for stocking purposes.

There is no prospect that the coal strike will handicap the steel mills. It is unlikely, though it is not impossible, that production in the non-union fields, like the Connellsville region, will be interfered with by sympathetic strikes, and the non-union capacity is fairly large relative to the present rate of coal consumption. Consumers of coal are known to have been stocking coal and the weakness in the coal markets in most districts in the past fortnight, with definite declines in prices in some districts, including Pittsburgh, indicates that consumers are not being caught with smaller stocks than they think necessary.

With domestic demand for steel running at approximately the rate of 1912 and 1913 it is interesting to note the differences in distribution. Production of rails and plates is much less, while production of tin plates and sheets is much greater. In tubular goods there is more tonnage in standard pipe and less in oil country goods. In wire mill products there is less in fencing and probably more in nails. In bars and structural shapes there is probably little difference.

Steel Prices

As to prices, the steel market is probably a trifle stiffer, on the whole, than a week or two ago. There has been an effort to get bars, shapes and plates up to 1.50c. as a stabilized figure, and this has succeeded to the extent that quotations under 1.40c. are now relatively uncommon. Shading in tubular goods seems to be a trifle less extensive. Sheets show no change, as they have been rigid right along, at 3c. for black and 4c. for galvanized. Hoops are a shade stronger, with concessions under 1.80c. uncommon and 1.90c. well maintained on cut hoops. Nails, however, show more frequent concessions than formerly from the regular $2.40 price.

Pig Iron

Two sales of basic pig iron at $18 valley furnace re-established the market at that figure, after a spell in which $17.75 was the usual selling price. One of the sales was of 600 tons by a steel interest, the other being 1,000 tons by a merchant furnace interest. Foundry iron has sold so frequently at $19 valley, although in small lots, that this may be considered the market, against a range of $18.75@$19 formerly quoted. Bessemer remains at $19.50 valley in small lots, with a possibility of shading in case of a large tonnage.

Coke

Connellsville coke, which stiffened somewhat at the close of last week, is easier this week, with spot prices the same as quoted one week or two weeks ago, $3.25@$3.50 for furnace and $4.25@$4.75 for foundry. There is no decrease in demand to account for the easier tone, which is obviously due to the distinct decrease in late in demand for coal, a decrease that must be considered in the light of the fact that Connellsville operators expected an increase, or a last minute rush, as April 1 was approached, on account of the prospective suspension at the union mines.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 40 – $0 42
Acetone	lb.	$0 11½ – $0 12	12½ – 12½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	.11 – .11½	.11½ – .12
Boric, powder	lb.	.11¼ – .11½	.11¾ – 12½
Citric	lb.	..... –	.44 – .45
Hydrochloric	100 lb.	1.15 – 1 25	1.30 – 1 75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – 12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – 12
Lactic, 22 per cent tech	lb.	.04 – .04¼	.04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3.30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06¼ – .06½	.06¾ – .07
Nitric, 42 deg.	lb.	.06¼ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.12 – .12½	.13 – .14
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08¾ – .09½
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16 00 – 16 50	..... – .....
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.26 – .28
Tartaric acid, imported, powdered	lb.	..... –	.27 – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1 10
Alcohol, ethyl	gal.	..... –	4 75 – 5 50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¼ – .03½	.03¾ – .05
Alum, chrome lump	lb.	.07½ – 08	.08¼ – .08½
Aluminum sulphate, commercial	100 lb.	1 65 – 1.85	1.90 – 2.40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07¼ – .07¾
Amylacetate tech	gal.	..... –	2.00 – 2 40
Arsenic, white, powdered	lb.	.07¼ – 07½	.07¾ – .08
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	66.00 – 66.50	66 75 – 70.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07½ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55.00	..... – .....
Bleaching powder	100 lb.	1 75 – 2 00	2.05 – 3.00
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1.75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01¾ – 02	.02¼ – 02½
Calcium peroxide	lb.	..... –	1.40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.91 – .93
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – ....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.37 – 40
Cobalt oxide	lb.	..... –	2.00 – 2 10
Copperas	ton	15.00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	.19 – 20	.20¾ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.55 – 5 65	5 70 – 6 25
Cream of tartar	lb.	..... –	.23½ – 25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – 1 00
Formaldehyde, 40 per cent	lb.	.09 – .9½	.09¾ – 10½
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth-imported powdered	net ton	30 00 – 32 00	..... – .....
Fusel oil, ref.	gal.	..... –	2 50 – 3 00
Fusel oil, crude	gal.	..... –	1.40 – 1 75
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.16 – .17
Iodine, resublimed	lb.	..... –	4 05 – 4 15
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09 – 11½
Lead arsenate, powd	lb.	.15 – .15½	.15½ – 16½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2.60 – 2.65	2 70 – 3 00
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1 80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – 11½
Nickel salt, single	lb.	..... –	.11 – 11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	10½ – 10¾	10¾ – 10¾
Potassium bromide, granular	lb.	..... –	.18 – .24
Potassium carbonate, U. S. P.	lb.	12 – 12½	13 – .16
Potassium carbonate, 80–85%	lb.	04 – .04½	.04¾ – .05½
Potassium chlorate, crystals	lb.	05¼ – .06	06¼ – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5 75 – 5.85	5.90 – 6 50
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	07¼ – .07½	.08 – .09
Potassium permanganate	lb.	.16 – .17	.17½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	25½ – .26	.26½ – .26½
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb	.07 – .07½	.07½ – .08
Salsoda	100 lb.	1.60 – 1.70	1 75 – 2.00
Salt cake (bulk)	ton	17 00 –20 00	..... – .....
Soda ash, light	100 lb.	1 80 – 2 00	2.05 – 2.60
Soda ash, dense	100 lb.	1 85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	04½ – .04¾	.04¾ – 05
Sodium bicarbonate	100 lb.	1 90 – 2 00	2.05 – 2.40
Sodium bichromate	lb.	07¼ – 08	.08½ – .08½
Sodium bisulphate (nitre cake)	ton	4 50 – 4 60	4.65 – 5 50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12 00 – 13 00	..... – .....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.10 – .10½	.10½ – .11
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.75	3.80 – 4.30
Sodium hyposulphite	lb.	.03½ – .03¾	.03¾ – .04
Sodium nitrite	lb.	.09¼ – .09½	.09¾ – .10
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03 – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.17½ – .18	.18¼ – .18½
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2 50 – 2 60	2 65 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.10	1.15 – 1.50
Sodium sulphide, fused, 60–62 per cent (cone.)	lb.	.04⅛ – .04¼	.04¾ – .05
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11¼ – .15
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2 25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18 00 –25 00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09¼ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran.	lb.	.06 – .06½	.06¾ – .07
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 —	$1.05
Alpha-naphthol, refined	lb.	1.10 —	1.15
Alpha-naphthylamine	lb.	.30 —	.31
Aniline oil, drums extra	lb.	.16½ —	.17
Aniline salts	lb.	.24 —	.26
Anthracene, 80% in drums (100 lb.)	lb.	.75 —	1.00
Benzaldehyde U.S.P.	lb.	1.25 —	1.30
Benzidine, base	lb.	.85 —	.95
Benzidine sulphate	lb	.75 —	.85
Benzoic acid, U.S.P.	lb.	.60 —	.65
Benzoate of soda, U.S.P.	lb.	.55 —	.57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 —	.35
Benzene, 90%, in drums (100 gal.)	gal.	.27 —	.32
Benzyl chloride, 95-97%, refined	lb.	.25 —	.27
Benzyl chloride, tech	lb.	.20 —	.23
Beta-naphthol benzoate	lb.	3.75 —	4.00
Beta-naphthol, sublimed	lb.	.60 —	.65
Beta-naphthol, tech	lb.	.27 —	.30
Beta-naphthyla mine, sublimed	lb.	1.50 —	1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 —	.15
Ortho-cresol, in drums (100 lb.)	lb.	.16 —	.18
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 —	.52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 —	.47
Dichlorbenzene	lb.	.06 —	.09
Diethylaniline	lb.	1.10 —	1.15
Dimethylaniline	lb.	.38 —	.40
Dinitrobenzene	lb.	.22 —	25
Dinitroclorbenzene	lb.	.23 —	25
Dinitronaphthalene	lb.	.32 —	.35
Dinitrophenol	lb.	.35 —	38
Dinitrotoluene	lb.	.22 —	.24
Dip oil, 25% car lots, in drums	gal.	.24 —	26
Dipnenylamine	lb.	.59 —	.70
H-acid	lb.	.85 —	1.00
Meta-phenylenediamine	lb.	.90 —	1.00
Monochlorbenzene	lb.	.14 —	.15
Monoethylaniline	lb.	1.20 —	1.25
Naphthalene crushed, in bbls.	lb.	.06 —	.06½
Naphthalene, flake	lb.	.06½ —	.07
Naphthalene, balls	lb.	.08 —	.08½
Naphthionic acid, crude	lb.	.65 —	.70
Nitrobenzene	lb.	.10 —	.12
Nitro-naphthalene	lb.	.30 —	.35
Nitro-toluene	lb.	.15 —	.17½
Ortho-amidophenol	lb.	2.75 —	2 80
Ortho-dichlor-benzene	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.75 —	80
Ortho-nitro-toluene	lb.	.15 —	.20
Ortho-toluidine	lb.	.20 —	.25
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.15 —	18
Paranitroaniline	lb.	.75 —	.77
Para-nitrotoluene	lb.	.70 —	.75
Para-phenylenediamine	lb.	1.50 —	1.55
Para-toluidine	lb.	1.10 —	1.15
Phthalic anhydride	lb.	.35 —	.38

Phenol, U. S. P., drums	lb.	.11½ —	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.25 —	1.30
Resorcinol, pure	lb.	1.80 —	1.95
Salicylic acid, tech., in bbls.	lb.	.20 —	.21
Salicylic acid, U. S. P.	lb.	.22 —	.23
Salol	lb.	.80 —	.82
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.12 —	.14
Sulphanilic acid, crude	lb.	.25 —	.27
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.25 —	.28
Beeswax, refined, light	lb.	.30 —	.32
Beeswax, white pure	lb.	.35 —	.40
Candellila, wax	lb.	.25 —	.26
Carnauba, No. 1	lb.	.45 —	.46
Carnauba No. 2, North Country	lb.	.25 —	.26
Carnauba, No. 3, North Country	lb.	.15½ —	.16
Japan	lb.	.18 —	.18½
Montan, crude	lb.	.04¾ —	.05
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ —	.03⅝
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04¾ —	.05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05¼ —	.05½
Stearic acid, single pressed	lb.	.08¾ —	.09
Stearic acid, double pressed	lb.	.09¼ —	.09½
Stearic acid, triple pressed	lb.	.10¼ —	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.15 —	5.20
Rosin E-I	280 lb.	5.25 —	5.30
Rosin K-N	280 lb.	5.90 —	6.65
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.85 —	....
Wood turpentine, steam dist.	gal.	.82 —	....
Wood turpentine, dest. dist.	gal.	.68 —	.70
Pine tar pitch, bbl.	200 lb.	.... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	9.50
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, bulk and double bags	100 lb.	3.25 —	....
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	2.90 —	3.00
Nitrate soda	100 lb.	2.85 —	2.95
Tankage, high grade, f.o.b. Chicago	unit	3.60 —	....
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	3.75
Tennessee, 78-80%	ton	6.00 —	7.50
Potassium muriate, 80%	ton	34.00 —	35.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Prices remain same as previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10 —	$0.10¼
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.14 —	.14½
Coconut oil, Ceylon grade, in bbls	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls.	lb.	.09½ —	.10
Corn oil, crude, in bbls.	lb.	.11¼ —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	.10 —	.10⅛
Cottonseed oil, summer yellow	lb.	.11¾ —	.12
Cottonseed oil, winter yellow	lb.	.13¼ —	.13½
Linseed oil, raw, car lots (domestic)	gal.	.81 —	.82
Linseed oil, raw, tank cars (domestic)	gal.	.77 —	.78
Linseed oil, in 5-bbl lots (domestic)	gal.	.84 —	.85
Olive oil, denatured	gal.	1.15 —	1.20
Palm, Lagos	lb.	.08 —	.08½
Palm, Niger	lb.	.06⅜ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls.	lb.	.13 —	.13¼
Rapeseed oil, refined in bbls.	gal.	.85 —	.86
Rapeseed oil, blown, in bbls.	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11 —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¼ —	....

FISH

Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Shellac, orange fine	lb.	.86 —	.87
Shellac, orange superfine	lb.	.88 —	.89
Shellac, A. C. garnet	lb.	.70 —	.71
Shellac, T. N.	lb.	.83 —	.84

All other prices remain unchanged.

Refractories

Prices remain quotably unchanged.

Ferro-Alloys

Ferromanganese, 76-80% Mn, Domestic, gross ton $62.50. All other prices remain the same as previous report.

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19.00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.75
Coke, furnace, f.o.b. ovens	net ton	3.25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01⅝
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.24½ —	25
Manganese ore, chemical (MnO_2)	net ton	55.00 —	60.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.40 —	.43
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport.	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13¼

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75–13.00
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	29.125
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.40–4.45
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.70

OTHER METALS

Silver (commercial)	oz.	$0.63⅝
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	51.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.63	$2.38
Soft steel bars	2.53	2.28
Soft steel bar shapes	2.53	2.28
Soft steel bands	3.13	2.88
Plates, ¼ to 1 in. thick	2.63	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Water Works Co. will install new filtration and purification equipment at its plant in connection with general improvements and extensions. The company is arranging for an increase in capital from $2,529,700 to $3,039,700, and more than one-half of the proceeds will be used for the work.

California

MOJAVE—The Jo Rand Smelting Co., Bakersfield, Cal., recently organized, is planning for the erection of a new smelting plant on site selected at Mojave. R. L. Gilmore, Bakersfield, is secretary and treasurer.

BOALINGA—The Council has called a special election, April 10, to vote bonds for the erection of a 100,000 cu.ft. gas plant and holder for municipal service.

Delaware

WILMINGTON—The Martin Leather Co., 703 East 5th St., has filed plans for the erection of a 2-story addition to its tanning plant, with wings, 47 x 126 ft. and 36 x 48 ft.

Idaho

COEUR D'ALENE — Idaho Clays, Inc., recently organized, is perfecting plans for the erection of a new plant on site selected in the Hayden Lake section in the eastern district of the city. The plant will consist of a number of buildings for the manufacture of a general line of burned clay products, estimated to cost about $500,000, including machinery. The works will include a power plant for operation.

Indiana

VALPARAISO—Frank W. Lesch, superintendent at the plant of the Pitkin & Brooks Glass Co., has acquired the plant and property of the company and will take possession on May 1. It is purposed to discontinue operations at the local factory and remove the machinery to another location, where increased manufacture will be provided. The local Chamber of Commerce is interested in the project.

Kentucky

LEACH—The Great Eastern Refining Co. is planning for the erection of a new oil refinery on local site to cost about $250,000, including equipment. Plans will be drawn at an early date.

Maryland

BALTIMORE—The Patuxent Clay Products Co., 210 Equitable Trust Bldg., has selected a site at Patuxent, Md., for the erection of a new plant for the manufacture of a line of burned clay products. It will consist of a number of buildings, estimated to cost about $100,000, including equipment. I. P. Mills is in charge.

BALTIMORE — The Colloidal Process Paint Co. has work in progress on a new local plant, to be used primarily for the processing of bitumens.

BALTIMORE—The Prudential Oil Co., Keyser Bldg., has acquired a tract of land adjoining its plant on 7th St., East Brooklyn, totaling about 6⅛ acres, to be used for extensions. The property was obtained for a consideration of $22,000.

BALTIMORE—Gilpin, Langdon & Co., Inc., 300 West Lombard St., manufacturer of chemicals, drugs, etc., has broken ground for the erection of a 1-story plant, 65 x 211 ft., at Smallwood and Eagle Sts., estimated to cost about $55,000. Frainie Bros. & Haigley, 19 Clay St., are the building contractors.

BALTIMORE—The Atlas Chemical Laboratories, Inc., 1717 Mosher St., recently organized with a capital of $50,000, has plans under way for the establishment of a local plant for the manufacture of chemical sanitation specialties. It is planned to commence operations at an early date. John E. Auld, Jr., is president, and John E. Auld, Sr., treasurer.

Massachusetts

EVERETT—A portion of the works of the Merrimac Chemical Co., located on the banks of the Mystic River, including three buildings, was destroyed by fire, March 7, with loss estimated at about $20,000.

LEOMINSTER—The Atlantic Refining Co., Hospital Trust Bldg., Providence, R. I., will commerce work at once on a new oil-distributing plant on North Main St., Leominster.

Michigan

DETROIT—The Detroit Sand Lime Brick Co., 507 Vinton Bldg., is completing plans for the erection of its proposed new plant on property recently acquired at River Rouge, Mich., to consist of a number of buildings. It is expected to call for bids at an early date.

BAY CITY—The local Chamber of Commerce has announced that the Andrews Steel Co., Newport, Ky., affiliated with the Kentucky Rolling Mills Co., of the same place, has taken an option on Bay City property, totaling about 150 acres, to be used as a site for the construction of a new blast furnace and steel works.

Missouri

ST. LOUIS—Fire, March 6, destroyed a portion of the plant of the Perfection Enamel Corp., 4528 Page Ave. The fire started in one of the drying ovens. An official estimate of loss has not been announced, but is said to be heavy.

Montana

GREAT FALLS—The American Zinc, Lead & Smelting Co., 120 Broadway, New York, N. Y., has acquired a controlling interest in the Silver Dike Mining Co., operating in the Great Falls district, for a consideration said to be $125,000. The production is silver-lead-copper ores, and the new owner plans for extensive development and production.

New Jersey

TRENTON—The Star Porcelain Co., Muirheid Ave., has awarded a contract to the Karno-Smith Co., Trenton, for the construction of a new 1-story building at its plant, 71 x 101 ft.

NEWARK—The United Color & Pigment Co., Evergreen and McClellan Aves., has filed plans for the erection of an addition to its plant to cost about $22,000. Work will be commenced at once.

BLOOMFIELD—A water-softening and filtration plant will be installed at the new local bleaching plant to be erected by the Clark Thread Co., 260 Ogden St., Newark, estimated to cost about $200,000.

New York

HUDSON—The Hudson City Steel Co., 233 Broadway, New York, N. Y., has plans nearing completion for the erection of its proposed new plant at Hudson, to comprise six 1-story buildings, equipped for general steel products manufacture, estimated to cost close to $900,000, with machinery. The work will be commenced at an early date. Dwight P. Robinson & Co., 125 East 46th St., New York, are engineers.

NEW YORK—The Rose Novelty Mirror Works has leased space in the building at 65-69 Varick St., for a new factory for the manufacture of mirrors and other kindred glass products.

TONAWANDA—The Beaver Board Co. has closed down its local works for extensive improvements and repairs. It is expected to have the plant ready for service in August. In the meantime, the company will concentrate on the manufacture of its composition wallboard products at its works at Thorold, Ont.; it is planned to install new equipment at this plant, and to increase the working force by at least 100 men.

BUFFALO—The Water Bureau, George G. Andrews, Water Commissioner, City Hall, has plans in progress for the construction of a new filtration plant for the local waterworks, to be located at the Col. F. G. Wood Pumping Station. It is estimated to cost in excess of $3,500,000, and the city has appropriated funds greater than this amount to carry out all details of installation. Clark D. Parsons, Fort Porter Ave., is engineer.

North Dakota

WILLISTON—F. J. Wilkinson, vice-president of the Williams County Bank, and associates are organizing a new company to construct and operate a local leather tannery. It will be 2-story and basement, 60 x 125 ft. and estimated to cost approximately $30,000. George E. Ellinger, Havre, Mont., is architect.

Ohio

UTICA—The Licking Window Glass Co. is planning for the rebuilding of the portion of its plant, destroyed by fire, March 5, with loss estimated in excess of $100,000, including equipment. Harry McCann is president.

CINCINNATI — The Ultra-Marine Co., Huntington, W. Va., will soon take bids for the erection of a new 1-, 2- and 3-story plant in the vicinity of Cincinnati, estimated to cost in excess of $60,000. U. S. G. Anderson is president; E. C. Baugher, 539 22nd St., Huntington, is in charge of the project.

LIMA—The Lisbon Agricultural Lime Co., recently organized, has taken over the plant and business of the Lisbon Lime Co., and will operate the works in the future. Plans are under way for enlargements in the plant, with the installation of new equipment in different departments.

Oregon

PORTLAND — The Portland Vegetable Oil Mills Co., care of W. H. Curtis and L. R. Russe, engineers, Portland, will build a new local plant for the production of turpentine, rosin and kindred wood byproducts, to be extracted from Douglas fir pitch. Plans will be drawn at an early date. H. H. Ward is one of the heads of the company.

SCAPPOOSE—The Oregon Charcoal-Iron Co., A. W. Martin, head, has plans under way for the erection of a new plant, with furnace, etc., on local site. It will be used for pig-iron production and work will be placed under way at an early date. The complete plant is estimated to cost about $200,000.

Pennsylvania

BRADFORD—The Interstate Glass Co., Bradford, has commenced work on extensions and improvements at its plant at Clarksburg, W. Va., estimated to cost about $70,000. L. E. Stewart, Bradford, is engineer, H. J. Walters is president.

PITTSBURGH—Fire March 8 destroyed a portion of the plant of S. Struntz & Son, 702-716 Bingham St., manufacturers of soaps and kindred products, with loss estimated at about 40,000.

KANE—The Interstate Window Glass Co., Kane, is dismantling its plant at Smethport, Pa., including blowing machines, etc., and at a later date will install new and improved equipment to replace the machinery. Operations have been discontinued during the change.

Texas

NEW BOSTON—Fire Feb. 28 destroyed a portion of the plant of the New Boston Cotton Oil Co., with loss estimated at about $75,000, including equipment. It is planned to rebuild.

THREE RIVERS — The Three Rivers Glass Co., recently organized, will establish a local plant for the manufacture of glass bottles and other glass products. H. L. Warrick is general manager.

West Virginia

CASS—The West Virginia Pulp & Paper Co., 200 Fifth Ave., New York, is said to be planning for the rebuilding of the portion of its pulp and wood plant at Cass, recently destroyed by fire with loss estimated at about $200,000, including equipment.

Washington

SPOKANE—The Western Materials Co. is planning for the erection of a new magnesite mill on local site, to handle production from its quarry at Springdale, Wash. F. M. Handy is manager in charge.

Capital Increases, etc.

THE WHITE OIL CORP., 66 Broad St., New York, N. Y., has filed notice of increase in capital from $100,000,000 to $201,500,000.

THE HOME OIL & GAS Co., El Dorado, Ark., petroleum products, has filed notice of increase in capital to $45,000.

THE THERASSE GLASS CORP., Marion, Ind., has filed notice of increase in capital from $15,000 to $50,000.

THE ROLLER OIL & REFINING Co., recently organized under Delaware laws, has filed notice of intention to operate at Mexia, Tex., with capital of $3,000,000. H. C. Roller, Mexia, represents the company.

THE PURE OIL Co., 74 Broadway, New York, N. Y., is arranging for a new stock issue to total $14,000,000, for general operations, financing, etc.

Jesse W. Ehrich, receiver for the WORLD RUBBER PRODUCTS Co., INC., 518 West 58th St., New York N. Y., is arranging for the sale of the property of the company.

THE VIRGINIA ALBERENE CORP., 1511 Walnut St., Philadelphia, Pa., manufacturer of soapstone products, has disposed of a bond issue of $750,000, the proceeds to be used for general operations and financing, including the recently acquired property of the Soapstone Products Co.

H. W. Holland has been appointed receiver for the EL DORADO PETROLEUM Co., El Dorado, Ark. The company's liabilities are stated at $720,000, and assets $348,000.

THE STANDARD CHEMICAL WORKS, Reading Pa., with branch plant at Wormlsdorf, Pa., has arranged for an increase in capital from $200,000 to $500,000.

Elliot Frederick has been appointed ancillary receiver for the ENGLE PAINT & VARNISH Co., Pittsburgh, Pa.

THE NATIONAL ENAMELING & STAMPING Co., 411 Fifth Ave., New York, N. Y., is considering a new note issue of $15,000,000, for financing and general operations.

New Companies

THE IRONITE CORPORATION OF AMERICA, New York, N. Y., has been incorporated with a capital of $300,000, to manufacture powders for welding service and kindred products. The incorporators are H. H. Drysen, H. Schulze and O. Hackeman. The company is represented by Charles A. Oberwager, 233 Broadway, New York.

THE ATLANTIC TAR & CHEMICAL WORKS, LTD., Jersey City, N. J., has been incorporated with a capital of $300,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co., 15 Exchange Pl., Jersey City.

THE WHALEBACK OIL Co., Oklahoma City, Okla., has been incorporated with a capital of $50,000, to manufacture petroleum products. G. D. Samuell, 606 Francis Ave., Houston, Tex., is president.

THE HERMO Co., 542 East 63rd St., Chicago, Ill., has been incorporated with a capital of $300,000, to manufacture oils, colors, etc. The incorporators are Ernest A. Hoerich, Frederick W. Modersohn and Lowell F. Booton.

THE INDUSTRIAL LABORATORIES, INC., 640 Chestnut St., Grand Rapids, Mich., has been chartered under state laws to operate a chemical testing laboratory and research business. The incorporators are Elmer F. and Bert A. Way, and Walter K. Schmidt.

THE FRISKOPF COLOR & CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals, colors and affiliated products. The incorporators are A. and W. Friskopf. The company is represented by J. C. Wechsler, 261 Broadway.

THE BERTSMITH CHEMICAL Co., INC., Boston, Mass., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. Thomas H. Smith, Dorchester, Mass., is president and treasurer.

THE O'NEAL LIME WORKS, INC., Wilmington, Del., has been incorporated under state laws with capital of $2,000,000, to manufacture lime and affiliated products. The company is represented by the Corporation Service Co., Wilmington.

THE VERM-O-SPRAY PRODUCTS, INC., West Haven, Conn., has been incorporated with a capital of $50,000, to manufacture insecticides, chemical products, etc. The incorporators are Charles Vincent, A. G. Sargent and Maurice Sulzbach, 78 East Ave., West Haven.

THE DIAMOND CANDLE Co., Brooklyn, N. Y., has been incorporated with a capital of $40,000, to manufacture candles, wax products and affiliated specialties. The incorporators are C. and G. F. Schisano, and H. T. Rosenfeld. The company is represented by Samuel Stark, 280 Broadway, New York.

THE MECHLING BROTHERS CHEMICAL Co., Camden, N. J., has been incorporated with a capital of $1,000,000, to manufacture chemicals and chemical byproducts. The incorporators are William H., Edward A. and Benjamin S. Mechling, Line St. and Cooper's Creek, Camden.

THE C. H. WOLFELT Co., New York, N. Y., has been incorporated with a capital of $400,000, under Delaware laws, to manufacture leather and rubber products. The incorporators are C. Irving Brown, James L. Watson and Tracy S. Buckingham, New York. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ROSMIL FIBRE Co., Boston, Mass., has been incorporated with 1,000 shares of stock, no par value, to manufacture fiber products. William R. Rogers is president; and M. F. McGrath, 293 Washington St., Boston, treasurer.

THE SUNSET TILE Co., 947 Elden Ave., Los Angeles, Cal., has filed notice of organization to manufacture ceramic tile products. The company is headed by G. S. Sinclair and C. S. Wallace.

MCCALVIN & Co., Jacksonville, Fla., has been incorporated with a capital of $10,000, to manufacture soaps and kindred products. W. W. Parker is president and treasurer; and S. A. Logan, secretary, both of Jacksonville.

THE AMERICAN B. F. R. MFG. Co., 848 Noble St., Chicago, Ill., has been incorporated with a capital of $15,000, to manufacture leather products. The incorporators are Isaac F. Potter, Peter P. Reisenhus and Baldwin S. Benton.

THE FLUID CHEMICAL Co., 149 High St., Newark, N. J., has filed notice of organization to manufacture washing fluids and other kindred chemical products. The company is headed by Frank Salvato.

THE ENDYNE CHEMICAL Co., Wilkinsburg, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are H. G. Hurney, Pittsburgh, Pa.; George L. and B. B. Ayres, Wilkinsburg. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE LARKUM-WALD Co., Mt. Vernon, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are E. S. and I. C. Larkum, and M. Wald. The company is represented by H. D. Lent, Mt. Vernon.

THE PADUCAH CLAY Co., Paducah, Ky., has been incorporated with a capital of $25,000, to manufacture clay products of various kinds. The incorporators are James S. Escott, E. I. Milburn and Elmer C. Ries, all of Paducah.

THE R. J. SPROUT LEATHER Co., INC., Boston, Mass., has been incorporated with a capital of $5,000, to manufacture leather products. Robert J. Sprout, Everett, Mass., is president and treasurer.

THE KE-TOY MFG. Co., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture soaps and kindred products. The incorporators are R. L. Gordon and J. Margolis. The company is represented by Benjamin Marvin, 386 Fulton St., Jamaica, L. I.

THE REITER OIL CORP., Wilmington, Del., has been incorporated under state laws with a capital of $1,000,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE SILVER REDUCTION Co., 2426 Clybourn Ave., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture chemical solutions, metal reduction products, etc. The incorporators are Charles E. Johnson, Emerson B. Stoddard and Ralph E. Rich.

THE FLORIDA NOLENE PAINT Co., Lemon City, Fla., has been incorporated with a capital of $25,000, to manufacture paints, varnishes, etc. I. B. Padgett is president; and W. D. Many, vice-president, both of Lemon City.

THE PALMER PRESSED BRICK WORKS, INC., Palmer, Ellis County, Tex., has been incorporated with a capital of $21,000, to manufacture bricks and other burned clay products. The incorporators are J. R. Beck, Y. Barron and L. B. Griffith, all of Palmer.

H. P. DANIELSON, INC., 300 West Lake St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture leather products. The incorporators are Leo P. Wall, H. P. Danielson and Harold M. Pine.

THE GRUBER VARNISH CORP., New York, N. Y., has been incorporated with a capital of $500,000, to manufacture paints, varnishes, etc. The incorporators are L. H. and F. R. Gruber, and L. Estander. The company is represented by Henry Hoelljes, 95 Madison Ave.

THE CONTINENTAL COLOR & CHEMICAL Co., Boston, Mass., has filed notice of organization to manufacture chemicals, colors, etc. The company is headed by Tracy L. Evans, 34 Merchants Row, Boston.

THE JOHN B. HEDIAN Co., 809 Hillen St., Baltimore, Md., has been incorporated with a capital of $20,000, to manufacture salt products and affiliated specialties. The incorporators are John B. Hedian and Charles B. Hoffman.

THE COOPER Co., Elwood, Ind., has been incorporated with a capital of $50,000, to manufacture steel and other metal castings. The incorporators are Clayton C. Cooper and William T. McNamara, both of Elwood.

THE PENINSULAR PHOSPHATE CORP., Wilmington, Del., has been incorporated under state laws with a capital of $1,500,000, to operate phosphate properties, manufacture fertilizers, etc. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

F. HOUT & Co., New York, have been incorporated with a capital of $5,000, to manufacture soaps and kindred products. The incorporators are R. P. Bramley and A. Henderson. The company is represented by H. A. Richards, 56 Pine St., New York.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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Measuring Ideas

"IT IS difficult to measure ideas in terms of specific or ad valorem duties. . . . The dye industry involves more than the mere producing of commodities. . . . This industry is unique and it may require unique forms of protection."

These very significant and highly encouraging statements are almost verbatim remarks by Senator SHORTRIDGE, who has been conducting the hearing regarding activities of the dye industry and of dye importers. The remarks occurred just before the Senator made a preliminary informal report to the Finance Committee of the Senate, which is drafting the tariff bill.

Chemical industry can well take encouragement from these comments. Its case has been forcefully and fairly presented thus far. Criticism of the industry has been vitriolic, but based upon false assumptions and misapprehension. The truth regarding the situation is being most satisfactorily brought out by the proceedings and the truth certainly promises to be helpful to the cause of the industry, as might have been known in advance by anyone who took the pains to find out how meritorious and patriotic has been the effort of those who have labored for the establishment of an organic chemical industry in the United States.

The Price of an American Potash Industry

OUR potash people are petitioning Congress for what they consider a moderate scale of protective duties and we are inclined to think that their demands are not exorbitant. Somehow or other we have been steeped in German propaganda for so long and the idea has become so prevalent that the Creator appointed Germany the custodian of the world's potash that it appears almost irreverent to defend an industry elsewhere than in der Vaterland. That is just what we intend to do, however, for a close study of the facts regarding the American potash industry has convinced us that it is deserving of the sink-or-swim chance which the proposed tariff will afford it. Given this protection for 5 years, it is our firm opinion that the nucleus of a potash industry can be developed that will stand on its own feet and justify its existence in competition with the foreign industry. The crux of the situation lies in the successful development of Searles Lake and the lowering of transportation costs by a water route through the Canal and around to the Atlantic seaboard.

In the first place, just to get it off our chest, we want to admit that the domestic industry has many shortcomings and that many acts of its own have stood in the way of its best development. The producers themselves have been responsible for much of the misinformation about the American potash industry. They have met the propaganda we referred to in our opening sentences with similar propaganda, and we are not prepared to say which has been the worse. Stock-selling schemes, wildcat projects and engineering monstrosities have been too common and have caused many potential friends of the industry to lose faith in its future. Another and in our opinion a most serious handicap has been the lack of unity in the ranks of potash producers. The reason, of course, is that our output has come from a dozen widely different sources, representing so many varying costs of production and so many clashing interests that there could be no single voice to speak for the industry. To be sure, the Potash Producers Association in Washington has met this need to some extent, especially as far as legislative activities are concerned, but it is in the industry's business relations that the lack of unity has been most evident. Negotiations with the grouped buyers of the fertilizer industry and the attempts to meet the organized competition of the German and Alsatian potash syndicates called for unified action, but unfortunately resulted in friction and discord.

The tariff for which the industry is petitioning is the sliding scale of duties contained in the bill which passed the House last summer. Under this arrangement the potash producers claim that they can resume operations and build up their production to a basis on which they can meet foreign competition without further aid from the government. They ask for but a fighting chance to go ahead and, sink or swim, they are willing to abide by the results. Obviously not all the producers can compete, even with the benefit of the duty, but many of the plants can continue in business if they have the assurance that they will receive a fair price for their product. As these plants enlarge operations, they will lower their costs and thus become better prepared to meet the inevitable competition. Expansion in a going concern usually means only a multiplication of present units, with consequent savings not only in construction costs but in distribution of overhead charges.

The brief of the potash producers, which is reviewed in the news pages of this issue, holds a lesson for other of our chemical industries which are suffering from foreign competition and are half-heartedly awaiting the relief promised them by Congress. The devastation in the dye industry, for example, is not so complete as among the potash producers, but it is evident that the same agencies are at work.

But sizing up the problem from the broad national viewpoint, there are certain outstanding facts about the potash situation which we must not forget. The war taught us the value of several key industries, and a surprising proportion of these were our basic chemical industries. Potash proved to be one of those essential commodities the supply of which we suddenly found was lacking from our industrial make-up. Now, by long and

tedious experimenting and costly research, we have developed the makings of a creditable potash industry. If we permit it to thrive in this country, it will mean that in case of another emergency we will have the nucleus around which we can build up an industry to take care of our entire demands. If, on the other hand, we permit the industry to die, we return to the hands of the foreign producers and the price we must pay for our future supply of this essential element will be dictated by the syndicates in Berlin and Paris.

It is scarcely necessary to urge the chemical industries to lend their support to the potash tariff. The price to be paid for this domestic industry is insignificant in comparison with its value to chemistry in America. If our entire chemical independence could but be purchased by the adoption of such moderate rates of duty, we would indeed have cause for rejoicing.

Lowering Costs and Increasing Production Efficiency

THE necessity of lowering production costs is now generally acknowledged if prices are to be such as to encourage sales and meet foreign competition. Unquestionably costs have been lowered by some manufacturers as far as circumstances will permit, with the result that their business is generally in a better condition than the average. But there still are too many plants where the costs have not been reduced as they should be. Many are trying to carry on with the methods established before the war, and made perhaps more inefficient under the pressure of war production. Conditions in such cases are capable of improvement; but those responsible are beset with conflicting advice, and fear that the expenditures necessary to put their plants in condition to compete are beyond their means. Also, sometimes the inertia of old ways is too strong.

What course, then, should be followed by those who must lower costs and are willing to make the attempt? Is there any definite plan that can be used in all cases to attain this end? We think not. But in spite of the general discredit thrown by the panacea peddlers on those who give advice, there is a counsel of common sense which if applied with fair judgment should do much to bring about the desired ends.

The problem should be studied with a view to applying sound principles that have led to efficient results for others, together with such other measures as the special case may require. All preventable waste must be eliminated. Processes must be arranged to flow continuously in the straightest possible line. Sufficient auxiliary equipment must be added to bring the existing machinery of production to its highest efficiency. Steps must be taken to organize so that the inventory of goods in process is at all times at a minimum. Everything possible must be done to heighten the morale of the workers and to keep the labor turnover at the lowest figure obtainable. The burden of management must be lessened by the elimination of all unnecessary employees and the reduction of the product and its process of manufacture to the simplest terms.

These principles form the framework upon which a comprehensive plan of improvement can be hung. Each must study out his own problem. But, taking these principles as a basis of action, if a definite program is formed and put into effect, the result for that plant can scarcely fail to be lower costs and increased production efficiency.

Furniture For Firewood

CONGRESS is making kindling out of our national furniture with a vengeance. This conclusion seems inevitable when we witness the procedure of the House of Representatives Appropriations Committee ruthlessly hacking at the organization of the executive departments. One of the latest evidences to confirm this idea is the cut which was made in the appropriation for the U. S. Geological Survey. In this case, not content with cutting off the increases which even the hard-headed business men of the budget bureau had approved, the committee slashes still further and makes actual decreases below current funds in several important items for the support of geologic and engineering work.

It takes years to build up a smoothly working efficient scientific organization of any sort in a field of complicated endeavor in research or exploration. In this respect the U. S. Geological Survey is no exception. Its high standing and high standards of performance are the result of years of development and training of its personnel. To cut down such an organization below its pitifully inadequate strength of this year is worse than foolish. It is nationally and economically criminal.

We suggest that our national legislators chop wood on an appropriate woodpile and not hack up the national scientific furnishings of the government in this fashion.

Is It "Exportable Surplus"?

THERE has been a general tendency during recent months to assume that the ammonium sulphate produced in the United States which does not find ready market here is exportable surplus. On the basis of this assumption, Mr. MACDOWELL, president of the National Fertilizer Association, recently estimated that 150,000 to 200,000 tons of ammonium sulphate is produced which will not find market in the United States. He, therefore, has characterized this as a "normal exportable surplus."

It is a demonstrated fact that fertilization of even relatively new soils is a paying proposition. Improvement in economic conditions of the country demands such fertilization. Moreover, the farmer is beginning to realize these facts, and one is not unduly optimistic in assuming that the use of fertilizers is going to increase rapidly in the next few years, even to the extent of doubling the demand within 5 or 10 years. Of course the pace at which increase will come will be determined more largely by economic conditions—that is, the ability of the farmer to buy—than by any other factor. However, it seems likely that this increase in demand will outstrip the increase in production of ammonium sulphate from existing agencies, even though the metallurgical industries demand coke production up practically to the capacity of the coke ovens of the country and thereby increase materially the byproduct ammonia output. The increase in use of fertilizers may therefore be more than enough to absorb all of what we now call "exportable surplus."

There will be continuous readjustment of the relationships of nitrogen production and nitrogen utilization during the coming years. Even a resumption of active purchasing by farmers, a normal operation of metallurgical coke plants for byproduct ammonia output, and the settlement of the question of Muscle Shoals, large as that question now looms on our political horizon,

will not decide the whole situation. The readjustment of relationships will be largely affected also by the new technology of nitrogen fixation, now a demonstrated commercial success. Any interest in the nitrogen industries which neglects this factor, or fails to take account of the latest technology in its own branch of the business, is doomed to disappointment. The country will demand, and undoubtedly will have the benefit of, the best in technology for production of fixed nitrogen at a minimum cost; and moreover the country will see to it that the use of fixed nitrogen in agriculture is extended to the point of maximum efficiency. The laggard in technical affairs is the one who will suffer.

The Annual Report of The Steel Corporation

AS THE United States Steel Corporation reports its earnings quarterly, the 1921 profits have been known for a couple of months, but the annual report, which has just been issued, offers a better opportunity for their study. After allowance for federal income and all other taxes, subsidiary company depreciation charges and general administrative expenses, but before payment of either subsidiary company or Steel Corporation bond interest, the corporation's total earnings amounted to $100,791,279 in 1921, as against $185,095,359 in 1920. The shipments of rolled steel, etc., decreased 43.5 per cent in tonnage, and realized prices decreased greatly, while the reported earnings decreased 45.6 per cent.

This decrease in earnings by comparison with reports made by the majority of independent steel companies is considerably less than would be expected. In some quarters the impression has grown up that "the independents" are at a great "disadvantage" as compared with the Steel Corporation, this alleged disparity accounting for the Steel Corporation reporting earnings while most of the independents report losses. That impression is incorrect. There are several ways by which this can be shown. Perhaps the most interesting is to note that in 1912 and 1913, years in which the Steel Corporation and the independents alike had satisfactory profits, the Steel Corporation's earnings were about $10 per ton of steel shipped. If the typical independent was at a disadvantage as compared with the corporation, the disadvantage could have been no more than a very few dollars a ton. The same number of dollars per ton would not account for the disparities shown in 1921 earnings, while of course there has been no great change since 1912 in the relative positions, as to manufacturing processes used or character of physical equipment.

The divergences are due almost wholly to two things —to a difference in accounting methods and to the Steel Corporation having acquired certain good will in 1920 by holding down its prices, whereby it operated to better advantage in 1921 than did the majority of the independents.

As to accounting methods, it may be remarked that if the Steel Corporation desired the general public to be in ignorance of its financial affairs, as used to be the case with nearly all large corporations, its practice of publishing a full report annually would be a noteworthy application of practical psychology. The Steel Corporation reports are studied by only a very few. As to difference in accounting methods, many corporations, whether in the steel business or not, considered their profits for several high price years, through 1920, as real profits, and in 1921 they were forced to make extensive inventory readjustments, whereby the profits of the good years were left unduly swelled and the profits of a lean year were diminished, sometimes beyond the vanishing point. The Steel Corporation's reserves against inventory were as follows at the ends of the years named:

1916.....	$13,524,794	1919.....	$90,000,000
1917.....	30,270,670	1920.....	95,000,000
1918.....	51,289,603	1921.....	60,710,255

This reserve is of course a continuous fund, rising or falling. When it rose, the corporation was refraining from declaring profits the existence of which it doubted. When the reserve fell $34,000,000 in 1921 this did not represent a padding of profits. The actual profits were simply permitted to stand. If inventory values had never fallen, after Dec. 31, 1920, the corporation would have been forced some day to declare that in the past it had earned $95,000,000 more than it thought it was earning. As it is, the corporation does not need to report that it made any such mistake.

The Mental "Feel" Of the Nature of Matter

ON ANOTHER page of this issue a member of our staff presents a digest of some current thought about the structure of atoms and their occasional isotopes. As in an earlier exposition of the Langmuir postulates, Dr. HENDRICK has not attempted to depict the intricacies of the heavier elements. They are still in that realm of supercomplexity for which the art of exposition seems not yet developed. Even in considering the elementary details there are dicta which seem likely to need an appetizer for the processes of mental digestion, such as the decrease in the weight of protons by a "packing effect" and the nature of the mass of electrons.

In a late number of our excellent contemporary *The Chemical Age* of London (vol. 6, p. 136, Jan. 21, 1922), Dr. STEPHEN MIALL in his "Notes on Some Recent Chemical Theories" says:

> It is not clear . . . why iron, with eight external electrons, should be chemically active while argon and xenon, with eight external electrons, should be inert. LANGMUIR has put forward an ingenious theorem to account for this and some other anomalies, but I will not try to explain it here. When I read his own words I think I understand and I accept his hypothesis, but when I try to put it into plain language I am not sure whether I understand it at all. It may be that future researches will make it easier for us ordinary people to grasp the difficult features, and until then the only way to cover up our lack of intelligence is to assume that we and our readers understand it and that we could put it into simple language if we took the trouble. The Athanasian Creed requires intellect with a similar attitude.

Our author calls a halt somewhat earlier in the game than does Dr. MIALL. He knows that we are strictly undenominational in religion, so that creeds are forbidden subjects, while as for the structure of atoms and isotopes of the higher atomic numbers, he declares he would need weeks of work by LEFFERT LEFFERTS in the preparation of his illuminating atomic models and then many hours of patient instruction from Dr. LANGMUIR himself.

What the author has tried to set forth in the present essay is something to give old chemists and engineers who have not followed the modern literature of physical chemistry the feel of the thing in their minds.

Readers' Views and Comments

Utility of Recrystallization Studies

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the very interesting paper by Jeffries and Archer on "Grain Growth and Recrystallization in Metals" and particularly to the diagrams showing the effect of annealing on grain size of cold-worked material,[1] I wish to call attention to the fact that it is very useful to show such "recrystallization diagrams" in three dimensions: One to express the percentage of deformation in previous cold work, the second to show annealing temperatures and the third to show grain size.

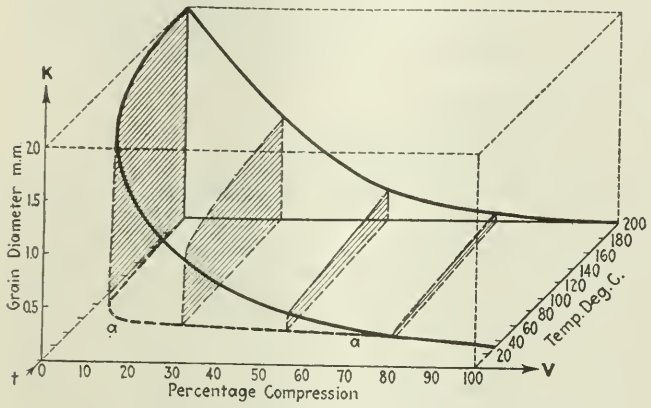

FIG. 1—RECRYSTALLIZATION DIAGRAM FOR TIN, ACCORDING TO CZOCHRALSKI, 1916

This form of diagram, worked out for tin by Czochralski,[2] is shown in Fig. 1.

In this diagram the principal horizontal axis represents the degree of cold work which the material has undergone (for instance, the percentage of reduction of height of a cylinder under compression), the secondary horizontal axis represents the temperature to which the sample was then heated, while the ordinate is the diameter of the grain after recrystallization. If the sample is reheated to a temperature below the curve *a-a*, no change in the grain size takes place.

[1] CHEM. & MET. ENG., March 1, 1922, vol. 26, pp. 405-408.

[2] Czochralski, Grundprinzipien der technologischen Kornverfeinerung; Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, August, 1919.

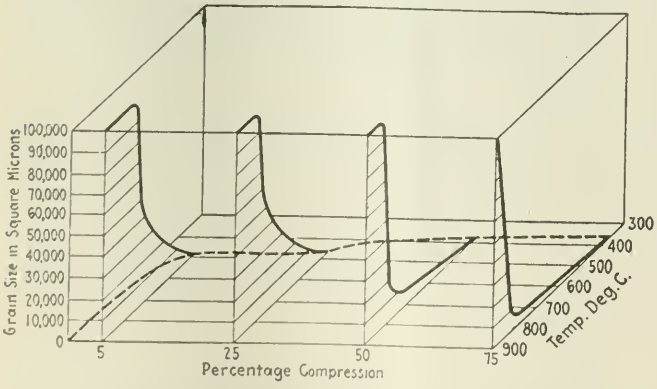

FIG. 2—RECRYSTALLIZATION DIAGRAM FOR ELECTROLYTIC IRON, ACCORDING TO OBERHOFFER AND OERTEL, 1919

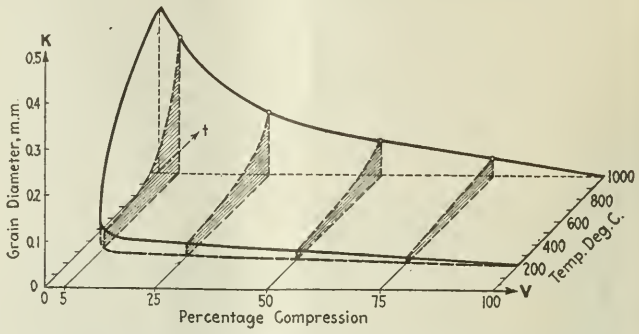

FIG. 3—RECRYSTALLIZATION DIAGRAM FOR COPPER, ACCORDING TO RASSOW AND VELDE, 1920

Above this lower temperature limit, however, the grain soon acquires the average size indicated. As will be seen from the other diagrams, the "body" of the diagram always flattens out with increased degree of cold work—i.e., the grain size of cold-worked metal increases with increasing the recrystallization temperature, but decreases with the degree of cold work.

The phenomena and laws of recrystallization will be of increasing importance to metallurgical investigation, and they are also bound to be of great practical value to future workers.

After the recrystallization diagram of a metal or alloy is once worked out, it is possible to determine the degree of cold work a material had previously undergone, by heating it to a certain temperature and measuring the grain size. The diagram will then reveal the desired information. In a similar way the grain size can

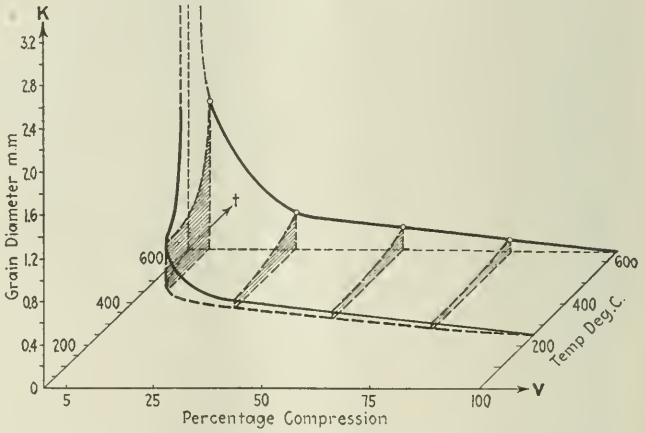

FIG. 4—RECRYSTALLIZATION DIAGRAM FOR COMPRESSED ALUMINUM (98.5 PER CENT), ACCORDING TO RASSOW AND VELDE, 1921

be utilized as criterion of the temperature at which cold-worked metal has been annealed. To do this, the metal is subjected to increasing temperatures until the grain size increases. This temperature must necessarily be higher than the previous annealing temperature. By measuring the grain size produced by the final treatment we can find from the diagram the degree of cold working, and by considering the grain size of the material as delivered we can then ascertain the original

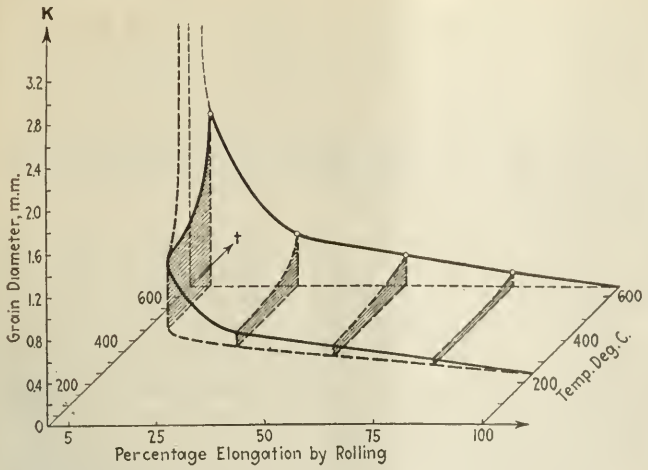

FIG. 5—RECRYSTALLIZATION DIAGRAM FOR ROLLED ALUMINUM (98.5 PER CENT), ACCORDING TO RASSOW, 1921

annealing temperature. By choosing a suitable degree of cold work and a suitable anneal we would be able to produce any desired grain size—in other words, we are enabled to put the metal systematically into a definite physical and mechanical state.

The practical application of these important theoretical considerations is limited mainly by the small number of such recrystallization diagrams which have been worked out so far. As far as I know, they have been published only for tin (Fig. 1), electrolytic iron (Fig. 2), copper (Fig. 3) and aluminum (Figs. 4 and 5). The difference between Figs. 4 and 5, although small, shows that it is advisable to control the manner in which deformation by cold work was produced.

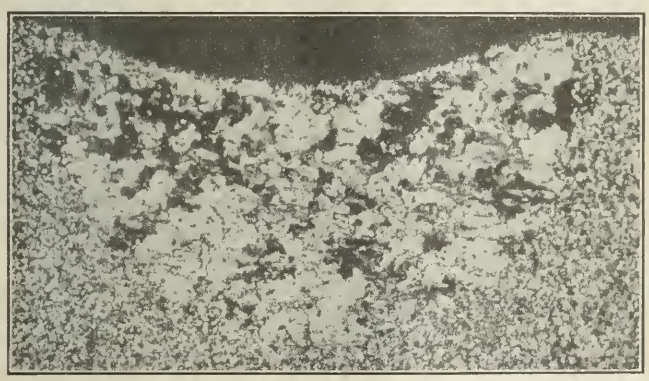

FIG. 6—BRINELL TEST, STATIC LOAD; ANNEALED AT 750 DEG. C. × 15

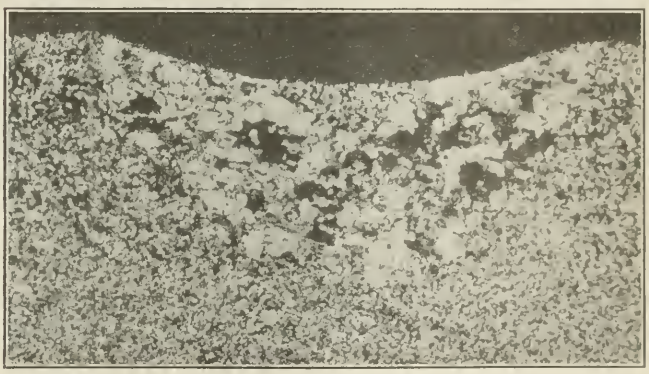

FIG. 7—SAME IMPRESSION AS IN FIG. 6, PRODUCED BY IMPACT; ANNEALED AT 750 DEG. C. × 15

The recrystallization diagram of iron differs from that of tin in one point: Heavy cold work does not increase the grain size with increasing annealing temperature first quickly and then slowly, but in opposite manner.[3]

It will be extremely valuable, both from a scientific and technical point of view, to have such recrystallization diagrams carefully worked out for the most important metals and alloys, especially for those used to a large extent in the industries. Further development along this line will help make the science of metallography available for "quantitative" work, a movement which was originated years ago by Dr. Jeffries and for which much credit is due.

Furthermore, recrystallization studies can doubtless be applied to advantage when investigating strains produced in specimens that have undergone tensile, bending and other mechanical tests. Or, in the diagnosis of failures, recrystallization upon annealing will give the clue as to whether fracture was due to the application of excessive static forces, impact or to faults in chemical composition. For instance, in a recent investigation of the comparative resistance of metals to ball indentations under static and kinetic forces, Wüst and Bardenheuer[4] utilized the recrystallization of strained metal to excellent advantage. They produced ball impressions of equal depth in low-carbon steel by static pressure and by impact; the specimens were then annealed for 1 hour at 750 deg. C. In this way recrystallization was obtained in that zone of the metal in which the cold work had reached a critical degree. Fig. 6 shows a static ball impression (Brinell), while Fig. 7 represents an impression of equal size obtained by impact of a 10-mm. ball.

As will be seen from these illustrations, the zone of coarse grain is much deeper in the impressions produced by static pressure than in those produced by impact.

New York City. HERMAN A. HOLZ.

[3]Oberhoffer, Das schmiedbare Eisen; J. Springer, Berlin, 1920.

[4]Wüst u. Bardenheuer; Härteprüfung durch die Kugelfallprobe; Mitt. a.d. Kaiser Wilhelm Inst. für Eisenforschung, 1920.

Relation Between the Composition of Vapor and Liquor in Distillation

To the Editor of Chemical & Metallurgical Engineering

Sir:—In the number of your paper dated Feb. 15, 1922, there appears an article by Emil Piron on the fundamental laws of distillation. This article is open to serious criticism.

All of the material on page 317 except Table I was developed by Lord Rayleigh and published in the *Philosophical Magazine*, series 6, vol. 4 (1902), p. 521. It was later published in another form by W. K. Lewis in the *Journal of Industrial and Engineering Chemistry*, vol. 1, p. 522 (1909). It has also been discussed by me in my recent book on Distillation (McGraw-Hill, 1922).

The first column of page 318 is taught to the students of most universities in their courses in physical chemistry in the third or fourth year, the first part being due to Francis Marie Raoult, professor of chemistry at Grenoble, France, who published it in 1881, and the second to John Dalton in 1808 (Moore's History of Chemistry, McGraw-Hill, 1918).

I have no criticism of the remainder of pages 318 and 319, except that like all empirical relations its value is doubtful. The final material on page 320 will be

found, except for the specific application, in Lewis' article and in my book.

The reason I object to the publication of such an article is because the average young chemist or chemical engineer who has had a hard time mastering such fundamental laws as those of Raoult and Dalton while in college has discarded them as soon as he gets into the industries as being things impracticable for everyday use. And when such an article appears with those laws in perhaps an unfamiliar form and without the originators' names attached, so that they appear to be original with the writer, the former student infers that something new and also impracticable has been evolved, and hastily crosses over to the other side.

If, on the other hand, the writer had referred to the "well-known laws of Raoult and Dalton with which every one is familiar," and to the "fundamental work of Lord Rayleigh, known to all interested in distillation," he would have struck a responsive chord in the young man's mind, and stimulated the idea that perhaps there was something worth while after all in these old laws.

CLARK S. ROBINSON.

Massachusetts Institute of Technology.
Cambridge, Mass.

Transparent Films of Metal

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have noted at the bottom of p. 204 of the article "Colloidal State in Metals and Alloys" a statement about thin films of metal, which at once reminded me of A. E. Outerbridge's experiments, the results of which I saw in part in 1884, which were reported by him to the Franklin Institute on Feb. 27, 1877. Your readers would probably be glad to have the matter summarized from details Mr. Outerbridge will probably be glad to give or refer you to on Transparent Films of Metal. Instead of dissolving gold leaf, as did Faraday, he produced perfect and far thinner films of gold, silver, platinum and copper by electrodeposition and then solution of the metal receiving the deposit. I tried to get a film of iron to look through by deposition on fused AgCl (horn silver) and solution by NH_4OH, but it would not work and I have little chance for such interesting "things that don't pay" at once except in pleasure.

Bristol, Tenn. ASA W. WHITNEY.

To the Editor of Chemical & Metallurgical Engineering

Sir:—I have not had time to hunt up numerous old publications and notes requested by you covering my early investigations on extremely thin films of metal, but a communication dated April 5, 1895 (vol. 34, p. 67) to the American Philosophical Society by the late Patterson Du Bois refers to several early notices of the process and product. I quote:

"*Transparent Gold.*—In the course of a lecture on gold, delivered before the Franklin Institute on Feb. 27, 1877, A. E. Outerbridge, Jr., of the assay department of the Mint in this city, gave an account of some experiments he has made with the view of ascertaining how thin a film of gold was necessary to produce a fine gold color.

"The plan adopted was as follows: From a sheet of copper rolled down to a thickness of 0.005 in. he cut a strip 2½ x 4 in. This strip, containing 20 sq.in. of surface, after being carefully cleaned and burnished, was weighed on a delicate assay balance. Sufficient gold to produce a fine gold color was then deposited on it by means of the battery; the strip was then dried without rubbing, and reweighed, and found to have gained 0.1 grain, thus showing that 1 grain of gold can by this method be made to cover 200 sq.in., as compared to 75 sq.in. by beating.

"By calculation, based on the weight of a cubic inch of pure gold, the thickness of the deposited film was ascertained to be 1/980,400 in., as against 1/369,650 for the beaten film.

"An examination under the microscope showed the film to be continuous and not deposited in spots, the whole surface presenting the appearance of pure gold.

"Not being satisfied, however, with this proof, and desiring to examine the film by transmitted light, Mr. Outerbridge has since tried several methods for separating the film from the copper, and the following one has proved entirely successful.

"The gold plating was removed from one side of the copper strip, and by immersing small pieces in weak nitric acid for several days the copper was entirely dissolved, leaving the films of gold intact, floating on the surface of the liquid. These were collected on strips of glass, to which they adhered on drying, and the image of one of them is here projected on the screen by means of the gas microscope.

"You will observe that it is entirely continuous, of the characteristic bright green color, and very transparent, as is shown by placing this slide of diatoms behind the film. By changing the position of the instrument, and throwing the image of the film on the screen by means of reflected light, as is here done, you will see its true gold color.

"Mr. Outerbridge has continued his experiments, and, by the same processes, has succeeded in producing continuous films, which he determined to be as little as 1/2,798,000 in. thick, or 10,584 times thinner than an ordinary sheet of printing paper, or 60 times less than a single undulation of green light. The weight of gold covering 20 sq.in. is, in this case, 0.035 grain; one grain being sufficient to cover nearly 4 sq.ft. of copper."

In 1876 I furnished transparent gold films on glass for lantern projection to several universities and possess a note from Prof. Eggleston of Columbia dated Feb. 21, 1876, acknowledging receipt of one such specimen.

In one of my papers I referred particularly to Faraday's thin gold films, made by floating beaten gold leaf on a bath of potassium cyanide. I reproduced those, but found that all beaten gold leaf is full of holes and humps, as might be expected; my films were all continuous and of uniform thickness, as shown by their transparencies and faint green tint by transmitted light.

I never attempted to commercialize the patent (No. 198,209, granted Dec. 18, 1877), though I made a lot of gold foil, some thicker than gold leaf, and used these for various purposes.

One of the most interesting to me was a request from Prof. S. P. Langley for a gold strip to make the first "grill" or resistance bridge for an experimental instrument for measuring infinitesimal variations of heat from stars. This he called a "bolometer." I think the gold film or foil was too good a conductor for his purpose and I remember making one, or trying to, of palladium. All this was so long ago that I have forgotten most of it, but we had several talks and I visited him at his observatory outside of Pittsburgh on a spur of the Alleghanies.

Philadelphia, Pa. ALEX. E. OUTERBRIDGE, JR.

Atoms and Isotopes

A Record of Present-Day Conclusions as to the Structure of Atoms or Atomic Architecture and of the Nature of Isotopes, Including a Short Note on the Leading Contributions of Dr. F. W. Aston, Who Is Now Visiting America

By Ellwood Hendrick, Sc.D.
Consulting Editor, Chemical & Metallurgical Engineering

SOMEWHAT over a hundred years ago we—that is to say, we chemists of earlier date and personality—were discussing whether John Dalton was philosophically justified in his theory and whether an indivisible atom were possible or not. We were then, however, as we are today, leaders in pragmatism, and we welcomed then, as we do now, any theory that works. In this respect chemists differ from most physicists who have less urge to be practical, and thus occasionally there arise cleavages between them in habits of thought. The author of a text-book on physics, for instance, would hesitate long before presenting his readers with a two-dimensional exposition of the benzene ring. In chemistry we don't mind a little incongruity like that—so long as it works. And while the earlier generations of us continued to discuss the atomic theory in the abstract, we accepted it for the same pragmatic reason that we accept the benzene ring.

Dr. Prout and His Idea

Between 1815 and 1817 a London physician, Dr. William Prout, ventured the belief that the atomic weights of the different elements were whole numbers and that, hydrogen being 1, all the elements were aggregates of the atoms of primordial hydrogen. "Many tried to reconcile Prout's hypothesis with facts," says J. W. Mellor,[1] "by changing the standard of reference to something equivalent to half an atom of hydrogen, and then to a quarter of an atom of hydrogen. But having once begun to divide the hydrogen atom, there was no limit to the process of subdivision, and the hypothesis could then be made to fit any conceivable set of atomic weights. This tinkering with Prout's hypothesis brought it for a time into disfavor."

Stas of Ghent, a generation and more later, preceded our own Theodore W. Richards in the meticulously exact determination of atomic weights, and he found so many fractions, contradictory to the whole number hypothesis, that he said: "I have arrived at the absolute conviction, the complete certainty, so far as is possible for a human being to attain to certainty in such matters, that the law of Prout is nothing but an illusion, a mere speculation definitely contradicted by experience."

The Faith of Dr. Richards

Stas held the floor, and poor Prout was in limbo for many years after his death, languishing in that purgatory of chemistry to which all those are consigned who propound theories which are not accepted. Richards was not so drastic in his conclusions as was Stas. He took up the work where the Belgian left it off, and proceeded to record his findings, despite the fact that they did not seem to lead anywhere or suggest anything but to add more decimals. The writer remembers an evening about a dozen years ago when Dr. Richards was speaking in an informal manner to a meeting of chemists on the work being done in the Harvard laboratory. He said in substance: "Sometimes we are asked why we devote so much time to work that seems dull and that does not lead more directly to discovery. Our answer to that is that we are gleaning facts, which are duly recorded and made available to others. And in so doing we have in mind that what we do may become useful under greater enlightenment than ours. As yet these records are only so many figures, but under the illumination of a greater intelligence, of a master mind, probably with a mathematical background and a great capacity for co-ordination, they may be so arranged as to reveal what is still unknown. We are getting out stones against the time when the master builder shall come to build the temple."

It was something to that effect which he said in the vein of his usual modesty.

Chlorine's Short Career as an Oxide

Now we shall not go over the ground in reference to the theory that atoms were indivisible units of matter, except to say that most of us held in the backs of our heads reservations in regard to it. We claimed that atoms were the ultimate grains of matter—and then we were not so sure after all. The writer recalls also an evening at Zurich back in 1879 when Victor Meyer brought out his vapor density apparatus and explained his curious experience with chlorine at high temperatures; that not only did he find singular irregularities in the vapor density of chlorine, but on opening the apparatus, there developed unmistakable signs of oxygen where theretofore only chlorine was contained. There was scarcely a man present who was not willing to believe that the halogens were oxides of some primary or more nearly primary element. Later it was demonstrated that the oxygen came from rubber connections in the apparatus, but the incident is given to show how lightly chemists more than a generation ago held to the belief of the final integrity of atoms.

Persistence of the Higher Criticism

This question would not down. Most atomic weights constantly approximated whole numbers. In the International Table of Atomic Weights for 1912 there are 82 elements, and of these 39 are integers within one-tenth of a unit. Or, "If we consider only the elements whose atomic weights were determined by Stas, we find that two-thirds of them have atomic weights diverging

[1] "Modern Inorganic Chemistry," London, 1914, p. 816.

by less than one-tenth from whole numbers."[2] The approximation to whole numbers is greater if we consider oxygen as 16 than hydrogen as unity, but we shall not discuss that subject now.

Another disturbing feature was the family relationships exhibited in such elements as the alkali metals, the alkaline earths, the halogens, etc., and the similarity of their relationships to those among known organic bodies, such as methane, ethane, propane, butane, etc., with regular increases in molecular weights.

Again, if elements are independent entities, enduring from everlasting to everlasting without beginning and without end, why are close relatives so often associated with each other in nature? Why is silver found with lead and gold, selenium with the sulphur of pyrites, cadmium with zinc; and why do the rare earths and the platinum family almost always appear to be having a thanksgiving feast, with all branches united? Of course we can overlook or forget, but we cannot cut from the records old J. W. Doebereiner and his triads, even though he has been dead for nearly a hundred years—and the triads are definite groups. It was easy enough for London chemists to chortle and pooh-pooh Newlands into silence when he offered his theory of octaves, but after a while Mendeléef and Lothair Mayer took it up, and they built the periodic table; and then we couldn't throw it out of the house. The blamed thing was there. Prof. G. C. Foster had all sorts of fun with Newlands when he asked him if he discovered any coincidences by arranging the elements according to their initial letters, but in spite of all that it is just possible that Irving Langmuir's octet theory in regard to electrons in the presence of positive charges may light another candle at the shrine of Newlands, while Foster's acerbity loses its sharpness. More evidences of the unsoundness of the infinite and eternal theory of elements were developed from "the grouping of spectral lines, the perturbation of spectral lines, the phosphorescent spectra of the meta elements, stellar observations, electric discharges in attenuated gases, and radioactivity"[3]—more particularly in radioactivity.

The Wages of Modesty

Prof. Richards' modesty was excessive, because he himself within a few years helped to show deviations in atomic weights that finally upset the complacency of chemists whose faith still clung to the integrity of the atom. We must note also the contributions in this respect from Professors Soddy and Honingschmidt. It was the demonstration that the atomic weight of lead varies according to the source of its origin. "Radioactive lead" (which is not appreciably more radioactive than any other kind) from thorium differs from that from uranium, and both differ from ordinary lead.

Eventually, then, we had the disintegration of the radioactive elements on the one hand, and various kinds of lead with identical chemical properties, but different atomic weights, on the other. And so the great research as to the constitution of the atom began in many places. There was Sir J. J. Thomson, who discovered positive ray analysis, and Sir Ernest Rutherford, who, among many other things, drove hydrogen atoms from an atmosphere of nitrogen. Prof. W. D. Harkins of Chicago University propounded the theory that all other atoms than hydrogen and helium were made up of aggregates of atoms of hydrogen and helium, and the brilliant young Moseley of Cambridge University pointed out shortly before his death at Gallipoli that the atomic number of elements is of more fundamental importance than the atomic weight, and that the atomic number indicates the number of free positive charges on the nucleus, and consequently also the number of electrons held about it.

With such tunneling into the very foundations of our faith in the inviolability and invulnerability and immutability of the atom, it is high time to look around and take stock of what principles we have left over.

The Requirements of Faith

Some things we must take for granted. For instance, we must agree that the hydrogen ion is one single, positively charged particle. It is the universal positive charge. Its mass is 1. When this engages an electron, which it invariably does whenever it can, it becomes a hydrogen atom. The negative particle has about one eighteen-hundredth of the mass of the whole atom. The two parts are held in leash by their opposing electric charges, but they are not in contact. The nucleus is the positive charge and the electron whirls around or about it in some manner. The atom of every other element differs from the hydrogen atom only in the number of positive charges in the center or nucleus and the corresponding number and the arrangement of electrons outside of the nucleus, with more pairs of positive and negative charges packed in between them, as we shall describe later. Please accept as the workable theory and without further explanatory introduction, that all atoms are composed of a nucleus where the positive charges are concentrated and that around and about this nucleus there are an equal number of electrons or negative charges held in leash by these positive charges. The arrangement of electrons we have previously discussed in an introductory chapter called "The Langmuir Postulates," published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 21, No. 2, July 15, 1919, and the study has since been greatly augmented and developed in various publications by Dr. Langmuir himself. This theory of place rather than of orbit for the external electrons finds favor with chemists because, chemically speaking, it works. The theory of Bohr, in which the electrons revolve as planets about a sun, is in favor with many physicists, but it does not make so clear to chemists the operation of chemical phenomena. We call these electrons external or free, and the positive charges in the nucleus free for reasons that we shall take up shortly. They are nevertheless in opposition and are held together by their opposing forces.

Please take for granted also the work of Moseley and admit that the atomic number represents the number of free positive charges in the nucleus and also that of the free electrons which rotate or are held about it. With few exceptions this atomic number indicates the place occupied by each element in the order of increasing atomic weights. Thus the atomic number of hydrogen is 1, helium 2, lithium 3, and so on up to uranium, the atomic number of which is 92, and which has the highest number as well as the greatest atomic weight of all the elements.

Then if hydrogen consists of one positive charge (or proton, as John Mills calls it) and one electron, and its atomic number is 1 and its atomic weight is 1, why are

[2] James Walker, "Introduction to Physical Chemistry," 1919, p. 19.
[3] Mellor, p. 817.

not all atomic weights and numbers the same, after all? Well they're not. We have a list of atomic numbers given before and approximate atomic weights given afterward as follows: 1 hydrogen 1; 2 helium 4, 3 lithium 7, 4 glucinum 9, 5 boron 11, 6 carbon 12, 7 nitrogen 14, 8 oxygen 16, 9 fluorine 19, 10 neon 20, 11 sodium 25, 12 magnesium 24, and we can go on until we find that the rule—which, according to the Sunday School hymn, "we may almost discover"—that the combining weights are approximately double the atomic number, is not a rule at all. We have, for instance, 50 tin 119, 78 platinum 195, 79 gold 197—indeed, the higher we go the more the atomic weights run away from us. So our only safety is to disabuse our minds of this conclusion. A positive and a negative charge together represent 1. Never mind the observation that the atomic weight of many elements represents about double the respective atomic number.

No, the atomic weight, we say, is made up of the atomic number, which is the number of positive charges or protons in the nucleus plus an equal number of electrons held in leash or revolving about the nucleus (the mass of the electrons being negligible)—and then something else. The atomic number would be the atomic weight if it were not for this something else.

Atoms Not Grains

Before approaching this feature let us make a few notes about these positive and negative charges in atoms —these protons and electrons. An atom is not a compact, tight grain. The actual space or displacement of the nucleus and several electrons of an atom, compared with the space inclosed by the orbits or positions of the outer electrons, is almost negligible. One evening at the Chemists' Club Dr. Irving Langmuir said (according to the writer's recollection, and he records his apologies if his memory is at fault or if Dr. Langmuir has since revised his opinion): "If we were to magnify the diameter of an atom to the length of a mile, the electrons would have a diameter of 5 ft. each and the nucleus would be the size of a walnut." This was merely an incidental remark, and the kind of atom referred to is not remembered, but it is given to indicate how much of energy and how little of substance we have in matter, as matter. Again, it is the positive charge that has weight or mass. We read that the electron has one eighteen-hundredth the weight of a hydrogen atom. Then if a hydrogen atom consists of one proton and one electron, it is the proton that furnishes the weight, not the electron. The electron of itself is without definite mass; its mass or weight is a function of the velocity of the electron and it is always negligibly small in comparison with the proton.

Atomic Numbers and Atomic Weights

Now let us approach the reason why the atomic weight is greater than the atomic number in connection with all other atoms besides those of hydrogen.

We have been agreed for a considerable time that there must be something else besides these free protons and electrons in the atom. Atomic weight demands it. Now it is held that the excess weight is due to exactly the same elemental stuff, to some more positive charges bound to electrons somewhere within the atom, and there has been considerable discussion as to the elemental forms in which they are bound. That is, what kind of small atoms are there within larger atoms to make up the difference between the atomic weight and the atomic number of each? In this connection opinion has followed the voluminous and persuasive arguments of Prof. Harkins of Chicago in support of the belief that the excess mass consists generally of helium and hydrogen atoms. The subject has an important bearing on the cosmic history of matter. From the study of the spectrum and the rotational velocities of certain nebulas, particularly the one in Orion, it is probable that a substance of elemental nature discovered there and which appears to have an atomic weight of 3 is the original material from which creation makes its start. It is called nebulium. It appears also that the next step in the cosmic order is the development of helium and hydrogen from nebulium, and that the synthesis of all other elements proceeds from hydrogen and helium. It opens up a vast field for study and speculation, but it will do no harm to reserve decision on this until we know more than we do now.

Atomic Architecture

As to the place within the atom where this excess of helium and hydrogen is held, theory has usually packed it within the nucleus along with the free positive charges, which are present in number equal to the atomic number of the element. But lately Sir Ernest Rutherford has proposed a three-stage atom, which is a more orderly arrangement and for which he makes an excellent argument in the light of certain phases of research. This excess weight, consisting of positive and negative charges, is packed more or less closely about the nucleus and is held there as satellites, much nearer than the outer free electrons which offset the free protons within the nucleus. This makes an atom of three stages, consisting of the nucleus of free protons at the center, next the satellites as bound protons and electrons (or as helium and hydrogen), and the free electrons beyond them. The free electrons on the outer shell are those which wander to and fro and which produce all chemical reactions.

As an example of the force needed to drive satellites of hydrogen from nitrogen atoms as achieved in Rutherford's experiment by the impact of alpha particles from radium C upon the nuclei of nitrogen atoms, it is computed that if the base of each impact were magnified to 1 cm. square, there would be a blow of 10^{27} in kilograms. That's a billion times a billion times a billion times 2.2 lb. and then a lot more, on something the size of a child's thumb nail.

Summary of the Atom

What we need to get into our minds now is that, in addition to the nucleus of every atom that holds as many free positive charges as are indicated by the atomic number, there are packed about the nucleus as many hydrogen and helium atoms as will make up the difference between the atomic weight and the atomic number. And beyond these are the free electrons of the atom that are held there by the force of the free positive charges in the nucleus. We must also remember that a positive charge counts as 1 in the atomic weight. Never mind about the fractions for the present. Also that the mass of an electron is relative to its velocity and that this is also, as mass, negligible. And finally that every atom contains the same number of electrons as it does of positive charges.

As an example let us consider an atom of tin as a

three-stage atom. Its atomic number is 50 and its atomic weight 119. Then there will be 50 free protons in the nucleus, what amounts to 69 hydrogen atoms packed about it, irrespective whether as hydrogen or as hydrogen and helium, to make up the atomic weight of 119, and 50 more electrons arranged in concentric shells on the outside, the mass of which we do not count.

The Obstreperousness of Hydrogen

Right here, however, we meet a difficulty. We have a mass of 16 for oxygen, but a little more than 1 for hydrogen. Or if hydrogen is unity, then we have a little less than 16 for oxygen. There isn't any getting around this discrepancy, either. If oxygen is 16, then hydrogen is 1.008. And since atomic weights approximate whole numbers more nearly with oxygen as 16 than with hydrogen as 1, we take oxygen as 16 and hydrogen as 1.008. That means that hydrogen atoms packed in or about a nucleus are 1 each, whereas by itself the mass of the atom is 0.008 greater. It is suggested that the increase in the single hydrogen atom is due to the lack of a "packing effect" of hydrogen and helium atoms squeezed together with great force within the nucleus or as satellites to it; that the same mass, under the packing effect of bound positive and negative charges, is 1, whereas free it is slightly more.

It is not very appealing, this theory that hydrogen and helium atoms or those positive and negative charges packed together about the nucleus of every atom should be 1, and 1.008 if free as in hydrogen itself, but let's accept it. It works out mathematically. And Mr. Aston said in his lecture at Columbia on March 15, according to the writer's notes, "By the conversion of hydrogen into helium the hydrogen loses mass of 0.008, but in doing so it generates energy. This is such that if one-tenth of the hydrogen of the sun were converted into helium it would provide for the sun's heat and light for 1,000.000,000 years."

Let's hope that no one will discover a method to accomplish this transformation for a long time to come. We are not good enough to wield such power. Indeed, if we started it we might not be able to stop it—and then where should we be? As Dr. Aston says, the result would probably be signified to the universe as a new and very bright star.

Dr. Prout's Ghost

It is well to bear in mind that the nucleus is the less studied and less familiar part of the atom, and therefore it is the more abundant field for theory, for empiricism and for the joyful art of postulation. It may be indeed that we are dealing with entities over in the realm to which Sir Evelyn de la Rue refers as "beyond numbers"; like the velocity of light, which remains constant from an approaching and from a retreating body. Sir Evelyn intimates that we might call this realm infinity, being not only beyond numbers but beyond us as well. There are Hottentots who can count up to 20, but 21 and all numbers beyond that are "many." It may be that the velocity of light and the mass of the electron will be our limit, our 21, our many, our infinity.

Now, leaving that difficulty aside, with hydrogen composed of one proton and one electron and with helium composed of two protons, two electrons and two hydrogen atoms packed inside, and with everything else made up of just such protons and electrons and hydrogen atoms, can't you see the shade of old Dr. Prout looming up again in the offing?

Isotopes Explain the Fractions

Nothing yet mentioned, however, even if we leave hydrogen out of consideration, will explain the persistent fractions in atomic weights, small though most of them are. We are postulating integral numbers for atomic weights—and they are not there. But the greater illumination which Dr. Richards was waiting for comes in good part from himself. These isotopic forms of lead point the way. If different atoms of the same element have different atomic weights but similar chemical reactions, they are isotopes. Thus we have lead atoms with the same number of free positive charges within and of electrons without the nucleus, but with a varying number of these bound sub-atomic couples or positive and negative charges packed about the nucleus. Isotopes are atoms which have the same atomic number—that is, the same number of free positive charges within the nucleus and opposed electrons outside it—but not the same number of hydrogen or helium atoms packed about the nucleus. Therefore the atomic weights of isotopes differ. And while each atom is integral, mixtures of isotopes give fractional weights. Even if we had equal portions of actinium lead 206, common lead 207, thorium lead 208 and radium lead 210, we should have an atomic weight of the mixtures of 207.5 and there is nothing to make the proportions of the different isotopes either constant or equal. So we generalize by saying that fractions in atomic weights are due to mixtures of isotopes—and then set out to prove it.

We must beware not to confuse isotopes with allotropic modifications such as is shown in the various forms of phosphorus and sulphur. There we have different geometrical arrangements of atoms within the molecules or crystals. In isotopes the differences are confined to the packing about the nuclei of the atoms. And we must not confuse the presence of isotopes with processes of radioactivity. When free positive charges and entrained electrons are thrown from a radium atom, for instance, the atomic number is reduced, and we have the transmutation of an element, the new element ceasing to be isotopic with the first.

It stands to reason that all the various isotopic forms of lead have the same chemical properties, because chemical properties are on the outside of the atom. We have in chemical activity exchanges of electrons on the outer shells of atoms, the holding of pairs of electrons in common by combined atoms and the wandering of electrons from one atom to another, thus producing ions, but in chemical processes the free positive charges in the nucleus and the H and He atoms packed within or about it are not disturbed. In radioactivity they are shot off, but not in chemical processes. So it is generally agreed, and it would seem fair to say, that the chemical properties of all the isotopic variations of an element are the same.

The Bell Rings

Having written the foregoing, the bell rang for luncheon. On the dining-room table I found my weekly copy of *Science*, vol. 4, No. 141, of Jan. 13, 1922, and there on page 42, under the head of "Scientific Events," I read that among the grants made by the Heckscher Research Foundation at Cornell University was one to

"Prof. L. M. Dennis for carrying on an investigation on the 'Separation of the Isotopes of Lead by Chemical Processes.'"

Right here is the text of as pretty a sermon in science as one could want to preach. Suppose there were a hierarchy of chemistry and we wore our academic vestments—on our minds as well as on our bodies—every day, and were insistent that we maintain unity in all the essentials of belief, restricting liberality to what we determine to be non-essentials. Then we should proceed to try Dr. Dennis for heresy and make things as uncomfortable for him as we could. But this will not do within the realm of science. If we maintain that the isotopes of an element are chemically the same, and he undertakes to separate them by chemical means, the worst we can do to him is to wait until he comes out with his findings, and then argue with him if we do not agree with his conclusions. It is a good thing for us that this is so. In the meantime let us cling to the dictum that the isotopic varieties of lead are, chemically speaking, the same, until he disproves it. We need the foundations of faith, even if they are frail.

There is no reason why atoms of different elements should not have the same mass or atomic weight, and indeed this is so, especially among the heavier elements. For instance, radium D, actinium C and polonium all have the atomic weight of 210, but have as atomic numbers respectively 82, 83 and 84. These are not isotopes. They are called isobares.

Aston's Great Work

Very important in the field of isotopes is the work of Prof. F. W. Aston of Cambridge University. He tried in 1914 to break up a gaseous element that shows a considerable deviation from an integral number in its atomic weight, and began with neon, using diffusion methods. He believed it consisted of mixed isotopes of atomic weights 20 and 22, and his experiments confirmed him in this belief. The method of diffusion is very slow, and he followed this work by the use of Sir J. J. Thomson's method of positive ray analysis, and he then brought out the amazing conclusions that no fewer than twenty elements consist of mixed isotopes the mass of each of which is invariably a whole number. A memorandum of these may be of interest.

Element	Atomic No.	Atomic Wt.	Minimum Number of Isotopes*	Masses of Isotopes in Order of Their Intensity*
H	1	1.008	1	1.008
He	2	3.99	1	4
B	5	10.9	2	11, 10
C	6	12	1	12
N	7	14.01	1	14
O	8	16	1	16
F	9	19	1	19
Ne	10	20.2	2	20, 22, (21)
Si	14	28.3	2	28, 29, (30)
P	15	31.04	1	31
S	16	32.06	1	32
Cl	17	35.46	2	35, 37, (39)
A	18	39.88	(2)	40, 36
As	33	74.96	1	75
Br	35	79.92	2	79, 81
Kr	36	82.92	6	84, 86, 82, 83, 80, 78
I	53	126.92	1	127
Xe	54	130.2	5 (7)	129, 132, 131, 134, 136, (128, 130?)
Hg	80	200.6	(6)	(197 to 200), 202, 204

*Numbers in brackets are provisional only.

Lithium proved to be a mixture of isotopes 6 and 7. Sodium is simple, apparently only of 23. Potassium shows a strong line at 39, and a weak one at 41. Rubidium shows two, at 85 and 87 respectively. Although the atomic weight of caesium, 132.81, indicates complexity, no line except that at 133 has been distinguished.

Prof. W. D. Harkins undertook the search for isotopes of chlorine, the atomic weight of which remains persistently around 35.5 and has always stood in the way of any hypothesis of integral weights. He used the diffusion method, and described it in the *Journal of the American Chemical Society*, vol. 43, No. 8, August, 1921. Since the speed of diffusion varies inversely as the square root of the density, it stands to reason that by shooting Cl, for instance, through a porous material, the lighter isotopes, if present, will tend to pass through more rapidly than the heavier. And the fruit of 7 years' labor is confirmatory of this. Repeated experiments showed the remaining chlorine which did not pass through the porous material to increase in atomic weight in the measure of 0.0318.

His first effort at separation was by means of a centrifugal machine, which was unsuccessful, but by employing diffusion apparatus, using churchwarden pipe stems and special tubes of clay, a separation of chlorine into heavier and lighter fractions was accomplished. He calculated the proportion of isotopic chlorine having the atomic weight of 37 derived from the pure HCl which he put through the apparatus to be 23 per cent.

Another lead of research has been contributed by Brönsted of Copenhagen, who evaporated mercury in vacuo upon a surface cooled by liquid air. It stands to reason that the lighter atoms which are single in mercury vapor would evaporate more readily and condense on the cool surface, and he actually found that the density of the condensed fraction was slightly less than the residue.

Present-Day Conclusions

The theoretical conclusions of today in regard to atoms and isotopes are:

1. A positive charge of proton with or without an associated electron has an atomic weight of 1, excepting hydrogen, which is slightly above unity.

2. Counting oxygen as 16, every other atom after hydrogen has approximately an integral atomic weight.

3. In the nucleus of every atom are free positive charges in number equal to the atomic number of the element. These hold in leash, either as planets revolving or within circumscribed spaces in relation to the nucleus but exterior to it, an equal number of electrons.

4. Just outside the nucleus, according to the theory of Sir Ernest Rutherford, or within it, according to the earlier theory, of each atom of elements of higher atomic number than hydrogen is the packing. This consists of bound positive and negative charges probably in the form of helium and hydrogen atoms, which affect the atomic weight, but do not affect the chemical reactions of the atom. The presence of the packing explains the excess of the combining weight of atoms above their respective atomic numbers. It also explains the presence of isotopes.

5. Fractions in atomic weights are due to the presence of isotopes in varying proportions.

In the preparation of the foregoing essay I have drawn indiscriminately on the work of Rutherford, Langmuir, G. N. Lewis, Aston, Harkins and others, without attempting in every instance to ascribe credit to the respective authors according to the contribution of each. And I desire to acknowledge the clear illumination and kindly criticism of Prof. James Kendall of Columbia University, without whose aid I should have been unable to make the present contribution.

Contributions to the Study of Ammonia Catalysts—III

Description of the Apparatus Developed by the Fixed Nitrogen Research Laboratory for the Moderate-Scale Testing of Ammonia Catalysts at One Hundred Atmospheres Pressure*

By R. S. TOUR

IN A preliminary study of substances likely to be effective in catalyzing the formation of ammonia from nitrogen and hydrogen, much information can be secured by simple tests carried out at atmospheric pressure, as described in the first article of this series. Much more exhaustive tests can be carried out satisfactorily on a small scale at higher pressures by the use of such an apparatus as that previously described in the second article of this series.

However, in order to be able to decide finally on the selection of a catalyst for actual plant operation, it is essential that tests be also carried out in an apparatus of reasonably large capacity, capable of operating under conditions similar to those apt to prevail in the plant. From an apparatus of this type information may be obtained which is much more directly applicable to plant operation than that obtainable from a smaller apparatus.

Since the effective life of a catalyst is an important item in plant operation, especially in a high-pressure system where renewals are apt to be inconvenient and expensive, and since the reliability of catalyst tests depends greatly on their continuity, it is important that the testing apparatus be capable of continuous operation over long periods of time.

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*For Parts I and II, see CHEM. & MET., vol. 26, Nos. 11 and 12, pp. 493 and 555, March 15 and 22, 1922.

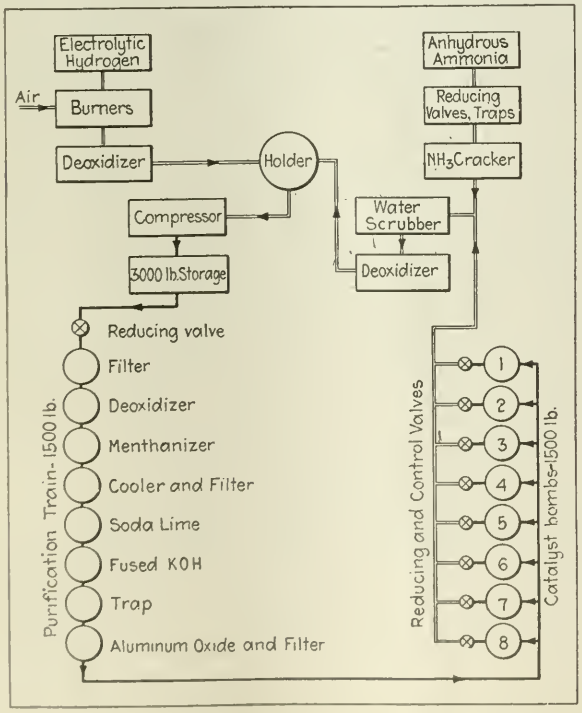


FIG. 1—FLOW SHEET OF CATALYST-TESTING PLANT

This report discusses a testing plant of the type indicated above, operated at the Fixed Nitrogen Research Laboratory. Such a plant presents many difficulties in design, construction and operation, and in its development it is inevitable that changes should be made from time to time in many items. In the main the description of apparatus is confined to the present installation and operation of the testing plant, although reference is made to apparatus and practices once employed but later modified or abandoned.

A critical study of the problem as a whole is not attempted, and therefore criticism of or comparison with other methods of achieving the same end is not included. It may be noted that the plant has to all intents and purposes operated continuously for over a year.

Early in 1916 the Bureau of Soils of the Department of Agriculture began a study of the ammonia synthesis problem and by 1917 the installation of a catalyst-testing plant was under way at Arlington, Va. In 1918 this testing plant was taken over by the Nitrate Division of the Ordnance Department, U. S. Army, and operated and developed through funds of the War Department in co-operation with the Bureau of Soils. In August, 1919, shortly after the creation of the Fixed Nitrogen Research Laboratory by the Nitrate Division, all the Arlington equipment was transferred to that laboratory.

Outline of Complete Installation

Since the detailed discussion of individual units may make difficult the visualization of the plant as a whole, a brief preliminary description of the complete set-up will be given, illustrated by flow sheets (Fig. 1) to which reference should be made in conjunction with the text.

The mixture of nitrogen and hydrogen (1:3) for testing is obtained from cylinders of liquid NH_3 which is decomposed after expansion to atmospheric pressure by being passed through a "cracker" containing electrically heated steel wool, then through a water scrubber and then through a deoxidizer of heated copper, from which it passes into the low-pressure gas holders.

From the gas holders the gas goes to compressors and is compressed to 3,000 lb. into high-pressure storage cylinders. From these cylinders it passes through an automatic reducing valve into the purification system, maintained at 100 atmospheres and consisting of a filter of glass-wool; a deoxidizer of copper, maintained at 300 to 400 deg. C.; a nickel catalyst maintained at 250 to 300 deg. C.; a water-cooled condenser and glass-wool filter; a soda-lime drier; a fused KOH drier; a dust trap; an Al_2O_3 absorber and glass-wool filter combined.

From the purification system the gas passes to the

electrically heated catalyst bombs, from which, after reduction to atmospheric pressure by appropriate valves, it passes through flowmeters, at which point samples for analysis are taken. The catalyzed gas issuing from the flowmeters passes through water scrubbers to remove the ammonia and thence back to the low-pressure gas holders for recirculation through the system.

The construction and operation of each of these items is discussed below.

Sources of Nitrogen: Hydrogen Mixtures for Testing

Up to the present the two gases have always been obtained together in the proportions desired for testing by decomposing ammonia. This is readily accomplished and yields a gas comparatively free from many impurities. Furthermore, it obviates the necessity of measuring and mixing the two gases independently.

As a future development, fifteen Electrolab cells are being installed to supply electrolytic hydrogen into which air will be injected in the proper proportion to form any desired ratio of hydrogen to nitrogen after deoxidation in a suitable apparatus.

Ammonia Cracker

Ammonia gas at atmospheric pressure obtained by expansion from standard liquid ammonia in cylinders is passed through the cracker, the final design of which

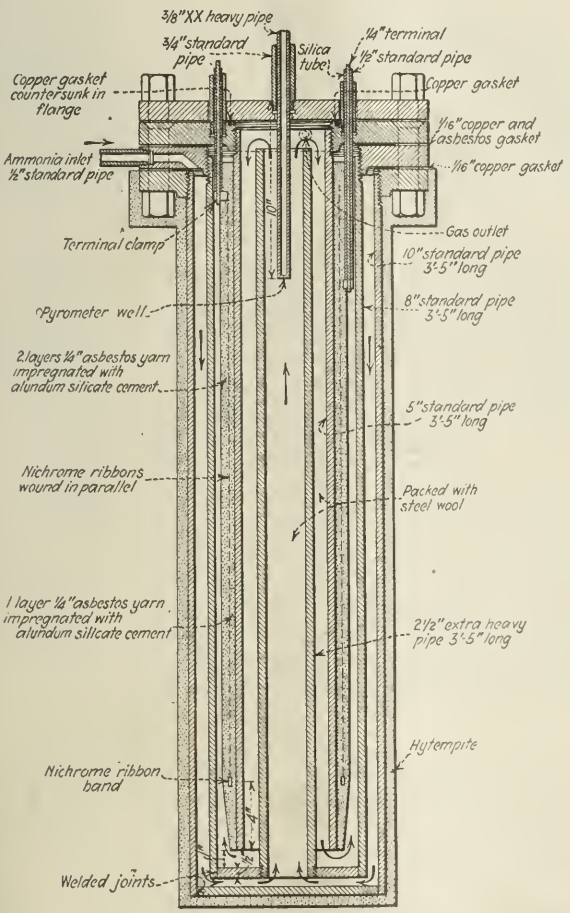


FIG. 2—THE AMMONIA CRACKER FOR EXPERIMENTS AT 100 ATMOSPHERES PRESSURE

is shown in Fig. 2. It is similar in principle to that described for small-scale testing in the first article of this series and consists essentially of four concentric steel cylinders, 10, 8, 5 and 2½ in. in diameter, arranged as shown in the figure, and all imbedded within a sheet-iron container 3 ft. in diameter, filled with 85 per cent magnesia. Around the 5-in. cylinder a heating coil of nichrome ribbon is wound, imbedded in alundum cement. The 5-in. and 2½-in. cylinders are packed with steel-wool and a pyrometer well of ⅜-in. XX heavy pipe extends into the 2½-in. cylinder. The whole apparatus is constructed of standard pipe fittings and so arranged that the heating element can be removed for repair without completely dismantling the outer shell. The ammonia gas enters at the top, passes down between the 10-in. and 8-in. cylinders for heat interchange, then up through the 2½-in. cylinder, where cracking begins, then down between the 5-in. and 2½-in. cylinders, where cracking is completed and last up and out between the 5-in. and 8-in. cylinders. The cracker operates at 600 to 700 deg. C., the heating coil taking 25 to 40 volts alternating current. The capacity is about 3 cu.ft. of cracked gas per minute. Two such crackers are maintained, one for continuous use, the other as a spare. The exit gas, containing about 0.1 per cent undecomposed ammonia, is scrubbed with water in a tower 8 in. in diameter by 6 ft. tall, packed with broken rock, the water flowing downward and the gas upward through the packing, finally leaving the tower with no ammonia remaining.

The Deoxidizer

From the scrubbers the gas may be passed when desirable through a low-pressure deoxidizer. This is essentially a piece of 4-in. standard iron pipe, filled with copper shavings and heated by a nichrome coil wound on the outside of the pipe and imbedded in alundum cement. This pipe is inclosed within the same heat-insulating shell with the cracker. The copper is kept at 300 to 400 deg. C., which suffices to reduce the oxygen content of the gas to traces.

Low-Pressure Storage

The nitrogen: hydrogen mixture, free from ammonia and practically so from oxygen, is metered by standard dry meters and a friction tube flowmeter for control purposes and goes to the holders. There are three single-lift, water-sealed, commercial gas holders, located just outside the building and fitted with heating coils to prevent the water from freezing. Two of these holders have a capacity of 500 cu.ft. each, and the third has a capacity of 250 cu.ft. All of the low-pressure gas lines to and from the holders and manifolds are of standard 2-in. and 1½-in. pipe and fittings, provided with traps, drips and drains, and tested for leaks at 30 lb. pressure.

Compression of Gases

The compressing system consists of three motor-driven standard four-stage, 4,000-lb. Norwalk compressors, two of them having 8 cu.ft. displacement per minute and one having 28 cu.ft. displacement. On the suction line to each compressor is a 10 cu.ft. tank which acts as a buffer and which is provided with an automatic vacuum alarm, warning the operator when the inlet line is under vacuum, with the attendant possibility of air being sucked into the line. The compressors, after some initial difficulties, have operated fairly satisfactorily, though requiring very careful attention and maintenance.

On its way to the storage system the compressed gas passes through a trap built up of a heavy steel cylinder

about 20 in. long by 5½ in. external and 4 in. internal diameter, fitted at each end with square forged flanges and with special internal construction to separate oil and water which is periodically blown out through a valve at the bottom.

High-Pressure Storage

The high-pressure storage system consists of twelve steel cylinders, 1.6 cu.ft. capacity. Eight of these are connected into the same manifold, which in turn is connected through standard stop valves with two auxiliary manifolds, to each of which two cylinders are connected. The piping is so arranged that two, four, eight, ten or twelve cylinders may be intermittently filled to 3,000 lb. pressure. The automatic reducing valves, one of which is used continuously, the other being reserved as a spare, are so connected to the storage that gas may be delivered from any of the above combinations of the storage system directly to the purification system at 100 atmospheres, or when desired two of the twelve storage cylinders may be used on the low-pressure side of the reducing valve as part of the purification system to increase the capacity, thereby minimizing fluctuations in the pressure. The system is fitted with gages, oil traps, safety valves and the like to insure continuous dependable operation.

It may be noted that the high-pressure manifold and the pipes which carry the gas throughout the high-pressure system are made of special double extra heavy ⅜-in. welded pipe and many of the connections, tees, unions, etc., are specially made, although standard hydraulic fittings are used where possible.

Purification of the Gas

The most important feature of the plant, other than the actual testing of the catalyst, is the purification of the nitrogen:hydrogen mixture. In order to be able to

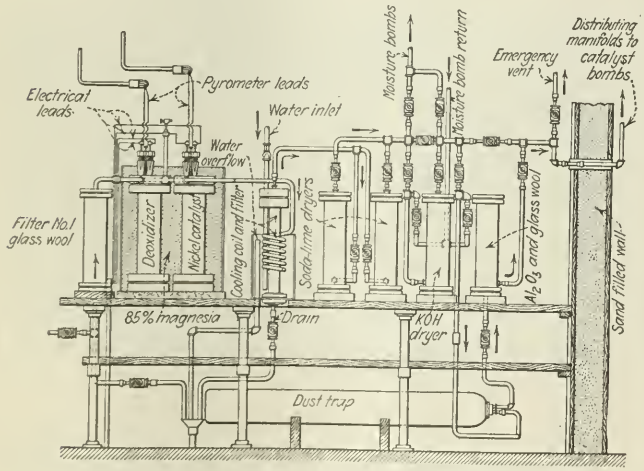


FIG. 3—PURIFICATION SYSTEM FOR EXPERIMENTS AT 100 ATMOSPHERES PRESSURE

draw intelligent conclusions concerning the behavior of the catalyst, it is essential either that the gas should be as pure as possible or that it should contain definite and known quantities of certain impurities when such are desired. The chief impurities likely to be present in gas cracked from commercial ammonia and scrubbed with water are traces of carbon compounds, moisture and oxygen, although removal of acidic constituents is provided for in the purification system. Carbon monoxide can scarcely be present in appreciable amounts, but the nickel catalyst provides for its removal.

The arrangements and connections of the various items of the purification system are shown in elevation in Fig. 3. Individual items will be discussed in more detail below.

Glass-Wool Filter

The gas from the storage cylinders passes at 100 atmospheres pressure into filter No. 1. This consists of a steel cylinder 5 in. outside diameter by 2 ft. long, fitted with flange heads and packed with glass-wool. The filter removes dust and oil which may have come over from the oil traps after the compressors.

Deoxidizer

From the first filter the gas passes to the deoxidizer, built up of a 2-ft. length of 5-in. double extra heavy chromium-vanadium seamless pipe and flanged at both ends with chromium-vanadium forged flanges. The joint used at the heads is a specially shaped tongue and groove fitted with copper gaskets. Within the deoxidizer is inclosed a steel tube carrying around it a nichrome heating element wound on alundum and incased in alundum cement. The tube is fastened to the head, which also carries the inlet and outlet connections and the electrical high-pressure terminals. The gas passes in through the head, down around the heating element and up through the steel tube, which is filled with copper turnings and maintained at 300 to 400 deg. C. The gas passes out through the steel tube through the head and to the next step of purification. Indications are that the oxygen escaping this deoxidizer is of the order of one part in one million. The deoxidizer is imbedded in 85 per cent magnesia inclosed within a sheet-iron casing. This same casing also incloses the next item of the purification train, the nickel catalyst.

Nickel Catalyst

The apparatus for the hydrogenation of carbon compounds is practically a duplicate of the deoxidizer above excepting that the inner tube carries a catalyst of reduced nickel on nonpareil brick and is maintained at 250 to 300 deg. C. The preparation of this catalyst was described in the first article of this series.

Cooler, Condenser and Filter

The hot gases pass from the nickel catalyst through a cooling coil of double extra heavy ⅜-in. pipe wrapped around a small cylindrical tower packed with glass-wool, the whole being immersed in a bath of cooling water. The gas passes down through the coil and up through the filter. The water formed in the deoxidizer is thus condensed and may be discharged through a drain at the bottom of the filter.

Driers

The gas next passes to a cylinder identical in design with the first filter of this train, filled with hard, granulated soda-lime. Two of these cylinders are arranged in parallel, but only one is in use at a time, the other being reserved as a spare. Removal of moisture as well as possible acidic impurities occurs at this point.

From the soda-lime drier the gas passes to a cylinder of similar construction, packed with lumps of fused KOH. Further removal of moisture and acidic impurities takes place in this cylinder.

From the KOH drier the gas passes into an empty steel cylinder of the type used in the storage system,

to serve as a settling chamber and to increase the capacity of the purification system to balance pressure changes.

Al_2C_3 Absorber

From the dust trap the gas passes into a cylinder similar in construction to those used as filters but containing a steel tube 2½ in. outside diameter by about 18 in. long, fastened gas-tight to the bottom head and open at the top. This tube is filled with granular colloidal Al_2O_3, which serves to remove moisture and any other readily condensible vapors, while the annular space around the tube is packed with glass-wool to act as a final filter, the gas passage being up through the Al_2O_3, down through the glass-wool and then directly to the catalyst bombs.

The arrangement of valves and pipes is so devised as to permit bypassing the gas around any unit of the purifying train when desired, and also taking off samples of gas for analysis at any point. As a matter of routine test a portion of the gas is bypassed from time to time, after the soda-lime driers and the KOH drier, through a special high-pressure bomb containing a weighed P_2O_5 tube by which moisture determinations are effected. This serves to determine the effectiveness of the preliminary drying and to indicate a need of replacing the soda-lime and KOH.

The Catalyst Bomb

The catalyst bomb represents the most important single item of the apparatus and the one whose construction and design present the greatest difficulties for successful operation. The assembled bomb, together with its heating element, is shown in cross-section in Fig. 4. Eight of these bombs are operated simultaneously.

The bomb proper is a chromium-vanadium steel cylinder, about 26 in. long by 5½ in. external and 4 in. internal diameter, fitted at each end with square chromium-vanadium flanges. The flange joints are made up with a specially shaped tongue and groove, copper gasketed joint that has proved very successful for high pressures and continually varying temperatures. The whole bomb is fastened securely to the floor for ease in assembly and is all incased in a sheet-iron container 16 in. in diameter, filled with 85 per cent magnesia.

The bottom flange is solid, while the top flange-head carries the three electrical leads to the heating elements and the catalyst tube through the center. The gas enters through the catalyst tube, which projects through the bomb head. The gas outlet from the bomb is through a passage drilled in the side of the head. On the under side of the head within the bomb is suspended the special heating element surrounding the catalyst tube.

The catalyst tube is a removable part of the bomb, permitting charging and recharging without disassembling. The portion of the tube extending above the bomb head carries a "T" connection for the gas inlet in the side and for the pyrometer well through the top. The pyrometer well consists of ⅛-in. steel tubing, which extends the full length of the catalyst tube within the bomb and permits the measurement of temperature throughout the full length of the catalyst. The catalyst tube within the bomb consists essentially of two parts, the upper portion being of steel packed with copper turnings to act as a "preheater" for the incoming gas before contact with the catalyst, and the lower portion a heavy-walled copper tube about 1 in. inside diameter which is charged with the catalyst. The copper casing aids in maintaining uniform temperature throughout the length of the catalyst.

The heating element consists essentially of a nichrome winding around a Pyrex glass tube of 1¼ in. outside diameter. The whole Pyrex tube and heating element is imbedded in alundum cement in a sheet-iron casing, which in turn is supported from the bomb head and held concentric with the catalyst tube which it surrounds. The gas passage is, therefore, down through the preheater, then through the catalyst, then up around the catalyst tube within the heating element and out through the bomb head.

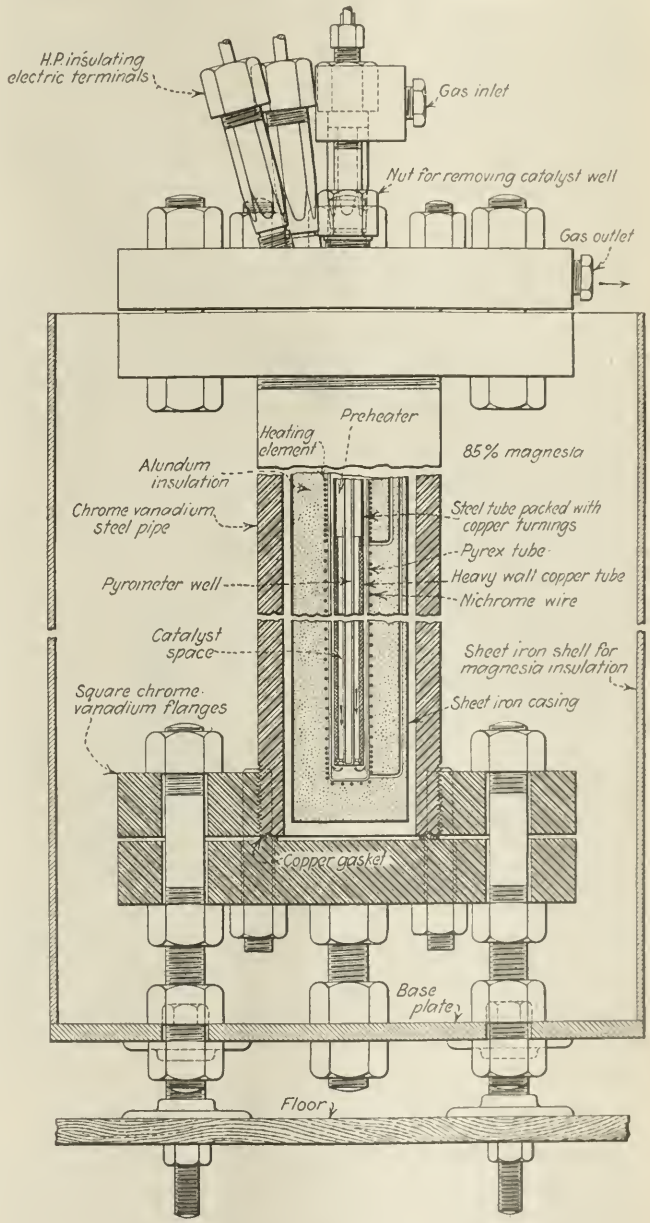


FIG. 4—CATALYST BOMB USED FOR TESTING AT 100 ATMOSPHERES PRESSURE

The design of the catalyst tube, determination of the direction of the flow of the gases and the winding and construction of the heating coil represent the results of extensive investigations whose object has been to cut down as far as possible the temperature gradient through different parts of the catalyst. Earlier designs of heating element, especially those with uniform wind-

ing and no preheater, proved on investigation to have temperature gradients as high as 200 deg. C., due partly to uneven heating and radiation and partly to localized evolution of the heat of reaction. Since the ammonia equilibrium varies rapidly with the temperature, no conclusions can be drawn as to the efficiency of a catalyst when part of its mass is 200 deg. higher in temperature than another. The method finally adopted consisted of a double winding of nichrome wire, closely wound at the top where the tube jackets the preheater, coarsely wound in the center at the location of the catalyst, and closely wound again at the bottom, where the radiation to the bottom flange of the bomb is large, has minimized this serious difficulty. Leads at top, bottom and middle are provided and with proper adjustment of resistances it becomes possible to introduce variations in the current supplied to the different portions of the tube and thus adjust the temperature as the temperature explorations in the pyrometer well may indicate. Even with widely varying rates of flow of gas it is possible with this arrangement to make the entire temperature gradient less than 10 deg. C.

Control and Measurement of Gas Flow

In the high-pressure system proper the control of gas flow is effected by the use of high-pressure valves, the design of which is given in Fig. 5. These valves are introduced between all the items of the system and are arranged to permit bypassing gas at different points in the line and also withdrawing samples for test analysis. For reduction of the pressure of the system after the gas has passed the catalyst bomb the gas passes through one of the larger high-pressure valves, then through a smaller valve[1] and finally through a section of high-pressure capillary tubing, 0.014 in. in diameter. The small valve is used for the control of the rate of gas flow. The expanded gas is measured through a calibrated friction tube flowmeter. The type of flowmeter used is a modification of the usual manometer type so much used by the Chemical Warfare Service at the American University Experiment Station.[2] The main features are that it is single reading and nonblowable. The manometer liquid is Nujol colored a deep red by a small amount of National Oil Red O.

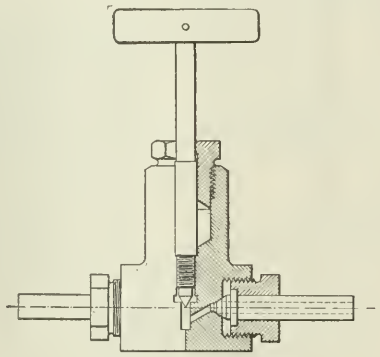


FIG. 5—STANDARD TYPE OF HIGH-PRESSURE VALVE

Control and Measurement of Pressure

Control of pressure is effected as indicated above by reduction of pressure from the high-pressure storage cylinders (3,000 to 1,800 lb.) to the desired pressure of 100 atmospheres by means of an automatic high-pressure reducing valve. The valve used is a modification of the A. W. Cash standard high-pressure piston type reducing valve. With the arrangement of storage cylinders indicated above it is possible to maintain 100 atmospheres pressure in the purification and catalyst system within 5 or 10 lb. with but occasional slight adjustment of the valve, even though the inlet pressure may vary from 3,000 to 1,800 lb. Pressure measurement is effected by Bourdon tube gages, placed on the main instrument board with the pyrometer and other measuring instruments. These gages are calibrated in place and under conditions of operation. Two Crosby recording pressure gages record continuously the pressure of the high-pressure storage and the catalyst bombs.

Control and Measurement of Temperature

Temperature control is needed in the ammonia cracker, the deoxidizers, the nickel catalyst and the catalyst chamber. Only approximate temperature control is required in the cracker and low-pressure deoxidizer, and heating there is effected by the use of a 15-kva. transformer as a source of current. The low-tension windings give a maximum of 40 volts with intermediate leads taken off to give 5-volt steps. The current through the heating elements can be thus varied by varying the impressed voltage across its terminals without the use of rheostats.

In the case of the catalyst chamber, the high-pressure deoxidizer and the nickel catalyst, this method cannot be used, because of the need of more accurate temperature control. The current used in this case is 110 volt d.c. from a 20-kw. motor generator set with a 25-kw. gasoline-driven generator for use in case of breakdown of the normal current. Plate type rheostats in series with the windings serve to control the current input and so the temperature. An ammeter and voltmeter in the circuit aid in controlling the temperature, which is finally adjusted and measured by the pyrometer.

Temperature measurement is effected in all cases by a No. 28 gage iron-constantan thermocouple, inserted into the pyrometer well. In the case of the catalyst bomb the pyrometer well extends through the entire mass of the catalyst and it is thus possible to explore the catalyst from end to end for temperature gradient.

Temperature readings are made with a Leeds & Northrup potentiometer. Two Leeds & Northrup recording potentiometers are auxiliary and maintain a continuous record of all temperatures about the plant. The couples are standardized from time to time against boiling sulphur.

Analytical Control

The ratio of ammonia formed to residual nitrogen: hydrogen constitutes the only necessary analytical determination. This is accomplished by drawing a sample of the gas through a quantity of boric acid in a bubbler to absorb the NH_3 and measuring the residual gas by a compensometer.[3] The solution is titrated with standard H_2SO_4, using bromphenol blue (tetrabromphenolsulphonephthalein) as indicator.

Introduction of Poisons Into the Gas When Desired

As previously mentioned, the two catalyst poisons removed with greatest difficulty from commercial nitrogen: hydrogen mixtures are moisture and carbon monoxide, and it is therefore desirable to study the effect of known quantities of these substances upon catalysts.

[1] See Fig. 5 in Part II of this series. CHEM. & MET. ENG., vol. 26, p. 559, 1922.

[2] See Benton, *J. Ind. Eng. Chem.*, vol. 11, p. 623 (1919).

[3] R. S. Tour, CHEM. & MET. ENG., vol. 23, No. 23, Dec. 8, 1920, p. 1104.

Moisture is introduced into the system when desired by mixing known amounts of oxygen with the nitrogen: hydrogen gas prior to compression and then passing the gas into the catalyst bomb with the deoxidizer and nickel catalyst bypassed. The oxygen reacts with the hydrogen to form water in the copper preheater of the catalyst chamber.

Carbon monoxide, prepared by passing carbon dioxide over heated carbon and then scrubbing with alkali, is introduced into the system prior to compression, the nickel catalyst being bypassed to prevent removal of CO during the operation.

Both the oxygen and the carbon monoxide are stored in a small reserve gas holder and are introduced by means of suitable flowmeters into the gas stream after it has passed the catalyst bombs and the scrubber and is on its way to the low-pressure storage.

In normal operation of the plant all readings are taken each hour and are recorded on suitable data sheets.

Conclusion

The testing plant has been used for the study of the behavior of ammonia catalysts under varying conditions of temperature, space velocity and purity of gas. These studies include consideration of the effective life of catalysts; their reproducibility; sensitiveness to and recovery from poisoning; and other factors of importance in determining the selection of a commercial catalyst.

In the fourth article of this series the results obtained with certain typical catalysts in the apparatus described in this and the preceding articles will be discussed.

World Production of Coal in 1921

The world's production of coal in 1921 dropped back to the level of 1909. From reports so far received, the United States Geological Survey estimates the total output at approximately 1,100,000,000 metric tons. This figure is subject to material revision as more complete returns are available.

In comparison with the feverish year 1920, the year just closed shows a decrease of more than 200,000,000 tons. The chief factors in the decrease were the British miners' strike, which lasted from April to June, and—more important—a world-wide industrial depression. Prices collapsed early in the year, and the seaborne coal trade of the world fell off sharply. The consequent reduction in the volume of business offered to the shipping of the world has been an important element in the decline in ocean freight rates, so keenly felt by the American merchant marine.

Of the major coal-producing nations, France and Germany were the only ones to show an increase. Progress in restoring the ruined mines of France is indicated by the steady increase in output of the past 3 years. In 1919, 22,000,000 tons was produced; in 1920, 25,000,000; in 1921, approximately 29,000,000. A further increase of 12,000,000 tons, however, would be necessary to bring French production up to the level of 1913. German production of bituminous coal is also still far below the pre-war level, although an increase was effected in 1921 as against 1920. German production of lignite in 1921 reached the highest point ever attained. The estimated output of 120,000,000 tons is an increase of 33,000,000 tons over the last year before the war.

The proportion contributed by the United States was 40.9 per cent, a larger share than in the years before the European war, but the smallest in any year since 1916.

The following table presents the information received by the Geological Survey up to Feb. 15, 1922. The tonnage of the countries not yet heard from ordinarily amounts to 12 or 15 per cent of the total. Receipt of data for these missing countries, estimates for which are included in the total, may raise or lower the final figure by some millions of tons. The unit used is the metric ton of 2,205 lb., the approximate equivalent of the long or gross ton. It is not, however, exactly the same, and the translation from net or gross tons to metric tons gives many of the figures an unfamiliar look.

PRELIMINARY ESTIMATE OF THE WORLD'S COAL PRODUCTION

(In metric tons of 2,204.622 lb.)

Country	1919	1920	1921
Australia	10,736,321	13,176,426	(*a*)
Belgium	18,342,950	22,388,770	21,807,160
British India	22,991,217	17,356,889	(*a*)
Canada	12,411,328	15,088,175	13,300,000
China	23,000,000	19,500,000	(*a*)
Czechoslovakia	26,946,813	31,086,479	(*a*)
France	22,341,000	25,300,000	29,000,000
Germany—Coal	(*b*) 116,500,000	(*b*) 140,757,433	(*b*) 145,400,000
Lignite	93,800,000	111,634,000	120,000,000
Japan	31,461,386	29,245,384	(*a*)
Union of South Africa	9,313,232	11,181,846	(*c*) 9,400,000
United Kingdom	233,467,478	233,216,071	166,992,000
United States	502,534,410	586,000,000	448,600,000
Other countries	46,553,865	49,068,527	(*a*)
Totals	1,170,400,000	1,305,000,000	1,100,000,000

(*a*) Estimate included in total. (*b*) Includes Saar and Upper Silesia.
(*c*) Estimated from 11 months' production

Neither 'Nor Nor 'Noxide

A product resulting from a number of processes applied to an ore is not to be classed as an ore. A decision to the foregoing effect has been handed down by the United States Court of Customs Appeals in the case of Tower & Sons versus the United States. The question arose over an importation which was assessed by the Collector of Customs as oxide of cobalt. The importer contended that it should be admitted free as "cobalt and cobalt ore." The importation was in the form of a heavy grayish black powder. It was admitted that the product was a residuum after the natural ore had been subjected to various treatments. The ore had been roasted, it was testified, to eliminate the arsenic. It then had been treated with an acid to concentrate its soluble components. A part of the residuum was precipitated, filtered, dried and ground. The court held that the product could not be classed as an ore after these treatments. Incidentally the testimony developed that it could not be classed as oxide of cobalt, since the analysis disclosed that it contained 28 per cent of oxide of nickel.

Preheating High-Speed Tools

The Bureau of Standards is testing a number of ½-in. lathe tools made of several brands of high-speed steel. One interesting point brought out in the early work is the apparent influence of preheating before hardening. Using the average of four tools, made, heat-treated and tested under the same conditions, except for preheating temperature, the results were as follows:

Preheated 20 Min. at	Hardening Heat (5 Min.)	Quenching Medium	Pounds of Metal Cut
1,400 deg. F.	2,417 deg. F.	Oil	9.1
1,500 deg. F.	2,417 deg. F.	Oil	10.1
1,600 deg. F.	2,417 deg. F.	Oil	5.1
1,600 deg. F.	2,417 deg. F.	Water	5.1

The steel in question analyzed 0.6 per cent C, 3.5 per cent Cr, 15.5 per cent W and 1.6 per cent Va.

The Control of Tuberculosis in Industries

By James A. Aupperle

THIS article covers the disease of pulmonary tuberculosis as found among the employees of our industries. A change of environment is suggested which will mitigate this disease and increase the worker's efficiency. It is an established fact that the occupation one follows has a decided effect upon pulmonary tuberculosis. In some occupations the workers are immune from this disease and in other occupations the death rate from tuberculosis is very high.

The purpose of this paper is to present the facts as we find them in the hope that tuberculosis will be mitigated by a change of environment.

It is an established fact that tuberculosis is nonexistent in certain occupations and an analysis will be made of these occupations in order to arrive at conclusions for combating this disease.

Nieszytka[1] reports that 76.5 per cent of all deaths among the sandstone workers in Hanover are due to tuberculosis. This is ten times as many deaths from tuberculosis as occur among workers in limestone. The difference is due to the fact that sandstone is siliceous and does not dissolve, while the limestone is readily dissolved by the carbonic acid present in the lungs. The particles of sandstone are sharp and irritate the tissues, which then present a fertile field for the entrance and growth of tubercle bacilli. The chances of contracting the malady are hastened by a run-down, weakened condition of the human system due to disease, vice or alcoholism.

Rotation of Work a Remedy

Many of the large trusts control so many industries that the efficiency of the tuberculous workmen can be increased by a scientific rotation of work. If an employee, on account of occupation or predisposition to pulmonary tuberculosis, can have a change of occupation, the disease will not only be arrested but the employee will get well and be of more economic value to the employer and the community.

Dampness is conductive to tuberculosis, as is evidenced by the fact that in the Philippine Islands and seacoast cities the mortality from tuberculosis is extremely high, while it is very low in dry states like Arizona, Colorado and New Mexico. The effect of dampness is counteracted by other agencies, so that if there is present a germ-destroying sulphur gas, such as hydrogen sulphide, sulphurous acid or sulphuric acid, the danger of contracting tuberculosis is reduced to a minimum. Various sulphur gases are found in coal mines, and although damp and at times dusty, the coal miner is practically immune from the disease, and those employed in coal mines have the lowest death rate from tuberculosis. Their average age at death is 51.3 years, while in all other occupations the average age at death is 47.9 years.

There is an abundance of sulphur dioxide and sulphur trioxide gases in the Pittsburgh atmosphere—in fact, there is so much that these compounds in the air cause the rusting of steel sheets to such an extent that iron sulphate forms on the metal. On the other hand, the death rate from tuberculosis in Pittsburgh is lower than any other large city in the United States. Pittsburgh is a smoky city where the large consumption of coal containing sulphur produces the germicidal sulphur gases.

Immunization by Sulphur Gases

Plaster of paris—calcium sulphate—is a combination of lime and sulphuric anhydride. This compound, when breathed into the lungs, ionizes to lime and sulphuric anhydride, the lime as bicarbonate is absorbed by the tissues and rendered harmless, while the sulphuric anhydride in the presence of water and carbon breaks up into carbonic acid gas and hydrogen sulphide gas, and is thus eliminated from the system. Calcium sulphate has such germicidal properties that in one German plaster of paris establishment there have been no cases of tuberculosis in 17 years. In another plaster of paris establishment in France tuberculosis is practically non-existent.

Selkirk[2] tells us that no workers around limekilns have died from tuberculosis. The probable reason is that coal which contains sulphur is used in limekilns and the production of germicidal sulphur gases is responsible for the non-existence of tuberculosis in this industry.

The smelter fumes in Colorado and Arizona contain large amounts of sulphur gases. In some cities the sulphur dioxide can be tasted in the air breathed. Tuberculosis is practically unknown in these districts, except in those who have contracted the disease elsewhere and who have gone to these districts to get well.

Furnace tenders are practically immune from tuberculosis, and here again we trace the beneficial effect of sulphur gases which are derived from sulphur in the coal.

In the manufacture of sulphuric acid the employees are practically immune from tuberculosis.

A sailors' and soldiers' health camp has been established at Hilo on the Island of Hawaii. It is located on the brink of one of the world's wonders, the ever-active volcano of Kilauea. The wonderful results obtained at this health resort are of world-wide renown. Tubercular patients show immediate improvement when sent to this resort. The volcano is continually giving off gas containing a large percentage of sulphur dioxide gases which is responsible for the mitigation of tuberculosis.

Large Organizations Can Help

The virtual trusts now being formed will be very useful in helping to stamp out tuberculosis. A careful survey of occupations in a large steel trust will give a good idea as to how the men with tuberculosis can be given employment where there is a possibility of curing the disease and increasing the worker's efficiency.

The following are among the jobs which should be given to men with tubercular tendencies:

Coal mining, furnace tending, cement manufacture, lime burning, manufacture of sulphuric acid, manufacture of gypsum, galvanizing where sulphur is burned, roasting of sulphide ores or wherever a small amount of sulphur gases are present from the burning of sulphur.

With the well-organized medical departments, employment and mutual interest departments, our large industries should find it an easy matter to follow the health of employees who may be given employment in departments which may mitigate tuberculosis.

Middletown, Ohio.

[1] Vrtljschr. f. gerichtl. Med., Berlin, 1912.

[2] *J. Am. Med. Assn.*, Dec. 12, 1908.

Effects of Impurities on Electrolytic Zinc

Photographs of Cathodes Made in Commercial Cells After the Addition to the Electrolyte of One or Two Parts Per Million of Arsenic, Antimony, Cobalt, Copper, Nickel and Glue —Severe Action Commences Several Hours After Addition

By GUILFORD DARBY SCHOLL

THE Keokuk, Iowa, plant of the River Smelting & Refining Co. was built in 1915 and started operating in 1916, treating the zinc "fume" produced at a plant in Florence, Col., from the complex zinc-lead-copper-silver sulphides of the Colorado district when smelted by a process of roasting and reverberatory smelting.

Naturally ores of the nature treated contained impurities in varying amounts and as the Keokuk plant was entirely an experimental unit, it took several years in which to work out a successful refining process to recover the zinc as "Grade A Electrolytic." Satisfactory results were finally obtained, but not until after the close of the World War, when the zinc market had become completely demoralized.

During the 3 years of operation there were periods when production was seriously threatened by the action of impurities in the solutions. A number of tests carried out in the commercial cells were run during the closing months of operation to determine, if possible, the characteristic effects of foreign elements in the electrolyte.

Fig. 1 illustrates the arrangement of the electrodes in the cells in which the tests were made. The neutral solution entered the top cell of a cascade of four, but this flow was supplemented by an auxiliary feed into each of the three lower cells to maintain zinc concentration as constant as possible in all the cells. Fig. 1 also shows the position of the cooling coils, rubber connections and iron water and waste pipes.

In conducting the tests, the electrodes as well as the cells were thoroughly cleaned and then cut into service for an hour or two before the impurity was added. At the start sufficient "dope" solution, as it was called, was poured into the cell to give the volume of cell solution a certain predetermined content in the element under consideration. Thereafter at hourly intervals enough impurity was added to maintain this concentration. Doubtless a better plan would have been to add the impurity continuously, especially in the case of elements that deposited out with the zinc, as opposed to those that acted as catalytes.

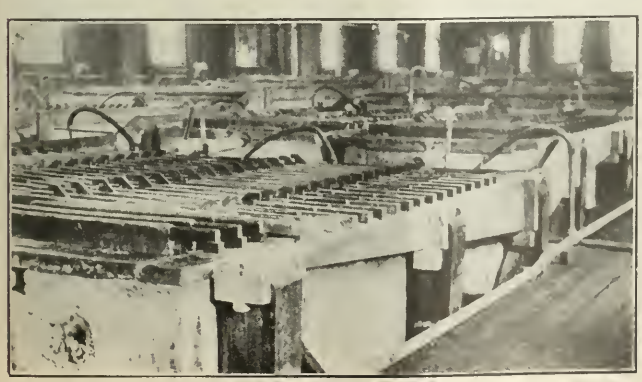


FIG. 1—CELL IN WHICH TESTS WERE MADE

The duration of a test was 48 hours—the regular stripping interval—but in numerous cases the deposit had to be stripped before this time, owing to the violent action of the impurity in redissolving the zinc faster than it was being plated. Individual cathodes, however, were removed and the zinc was stripped from time to time to obtain samples representative of the stages in the action of the impurity. From these sheets of zinc and from others taken at the end of the tests, 8-in. squares were cut and photographed. They are reproduced in this article at about one-quarter size to illustrate the effects of foreign elements upon the electrolytic deposition of zinc.

The electrolyte employed in the cells was as pure a zinc sulphate solution as it was possible to make. In fact it was a great deal purer than the so-called c.p. zinc sulphate of commerce. It ran between 70 and 80 g. per liter in zinc and varied from zero to 6 per cent in free sulphuric acid. In this article is treated only one phase of the varied and interesting experience encountered at Keokuk.

Arsenic

Sufficient arsenic solution was added to the bottom cell of a cascade to bring the content in arsenic up to one part per million. This ratio was then maintained by hourly additions. After 20 hours of deposition a cathode was removed and stripped; Fig. 2 represents the incoming solution side of the zinc deposit. Although this sheet shows nothing distinctive, yet a close examination with a magnifying glass reveals characteristics which appear more definite in succeeding photographs.

A second test followed directly upon the first and in the same cell, but the content in arsenic was increased to two parts per million. This ratio was maintained by hourly additions. After 26 hours of deposition sheet Fig. 3 was taken out. In this sheet the typical arsenic effect, as interpreted, is evidenced by the shattering of the carrot-like bamboo structure which in itself appears to indicate too much antimony in the electrolyte. Arsenic eats holes through the deposit, not only in the bottom of the recesses between the rough bamboo structure but also through the joints of this formation. The rear of arsenic-affected sheets is black around each corrosion center, with a corresponding black residue opposite on the cathode. This is in striking contrast to antimony-affected deposits.

A third test followed immediately upon the second and also in the same cell and with the same proportion of arsenic. A sheet pulled out 33 hours after the start of deposition is shown in Fig. 4. This illustrates more clearly the character of deposit yielded by arsenic. Note the similarity between this sheet and that of Fig. 3, only the effect has been intensified.

Another sheet, shown in Fig. 5, was taken out after 37 hours run and Fig. 6 shortly thereafter. Fig. 7 was

withdrawn 43 hours after the start of the test. The last three illustrate the progressive steps in the corrosion as the deposits grow older. The sheets are shot full of holes and show in a more positive degree the presence of too much arsenic in the electrolyte. Deposits of this kind naturally dross heavily in the melting furnace.

Efforts were made to detect arsine (AsH_3) in the faint sulphuric acid vapor arising from the cell, but while one trial, using a conical hood with a small vent in the top, indicated what might have been taken as a faint trace, yet it was not conclusive enough to warrant the statement that arsine is given off from a cell having arsenic as an impurity in excess of a harmless quantity.

Tests made in experimental cells by Dr. Mighill indicated that arsenic up to one part in a hundred thousand caused a serious loss in current efficiency.

Antimony

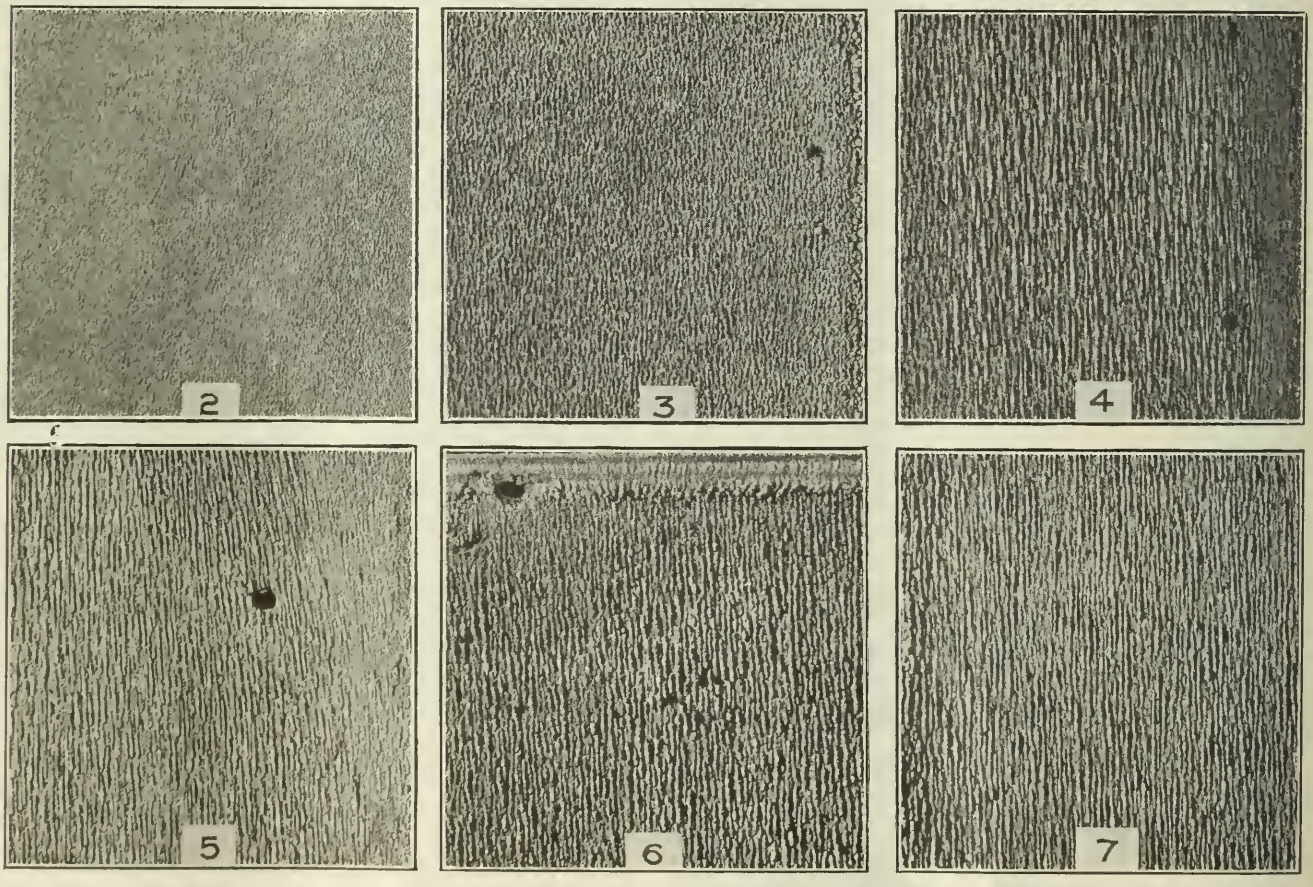
The effects of antimony are striking and distinctive. The zinc deposit is characterized by an imperfect carrot-like bamboo structure in sheets from 23 to 30 hours old and by a cauliflower-mushroom deposit in sheets 48 hours and older.

Into the bottom cell of a cascade enough antimony solution was poured to bring the content in antimony to one part per million, and thereafter enough fresh solution was added hourly to maintain this ratio.

Four hours after the first addition of antimony solution a sheet was stripped and found to weigh 179 g. per square foot, while a sheet of the same age from a regular cell weighed 237 g. per square foot. A piece of zinc from both samples was placed in the ordinary plant electrolyte and the rate of solution observed. The piece from the antimony cell dissolved just six times as fast. The surface of the antimony sheet was granular, while that of the sheet from the regular cell was smooth and of a bluish cast of color.

FIG. 8—FULL-SIZED CATHODE; POROUS AND LACY FROM RE-SOLUTION INDUCED BY ANTIMONY

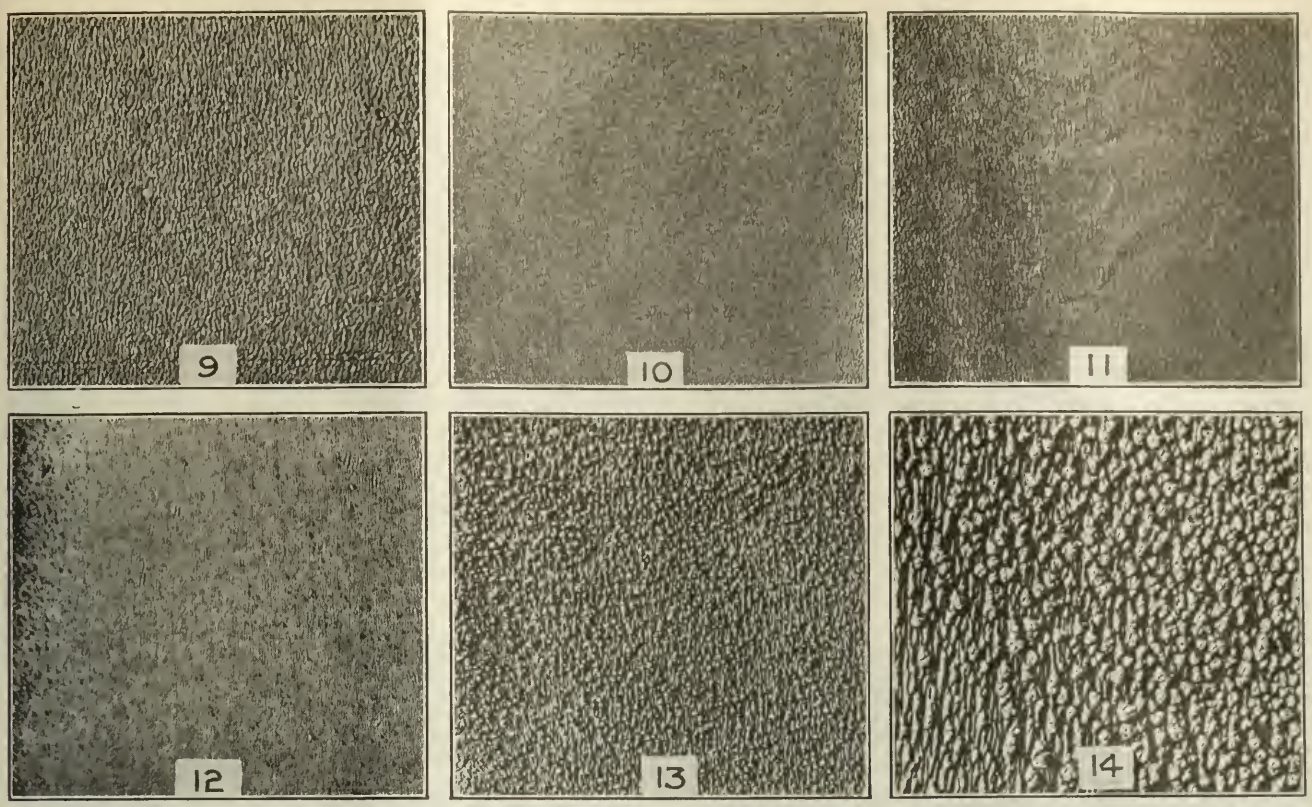
Fig. 8 shows a full-sized sheet that was stripped from the test-cell. The evidence of corrosion is plainly to be seen in the characteristic antimony structure. The



FIGS. 2 TO 7—DEPOSIT FROM SOLUTION CONTAINING 2 PARTS ARSENIC PER MILLION

Fig. 2—20-hr. deposit, arsenic 1 part per million. Fig. 3—26-hr. deposit. Fig. 4—33-hr. deposit.

Fig. 5—37-hr. deposit. Fig. 6—38-hr. deposit. Fig. 7—43-hr. deposit.



FIGS. 9 TO 14—DEPOSIT FROM SOLUTION CONTAINING 2 PARTS ANTIMONY PER MILLION

Fig. 9—34¾-hr. deposit. Antimony 1 part per million.
Fig. 10—6¾-hr. deposit.
Fig. 11—11-hr. deposit.
Fig. 12—21-hr. deposit.
Fig. 13—26¼-hr. deposit.
Fig. 14—26½-hr. deposit.

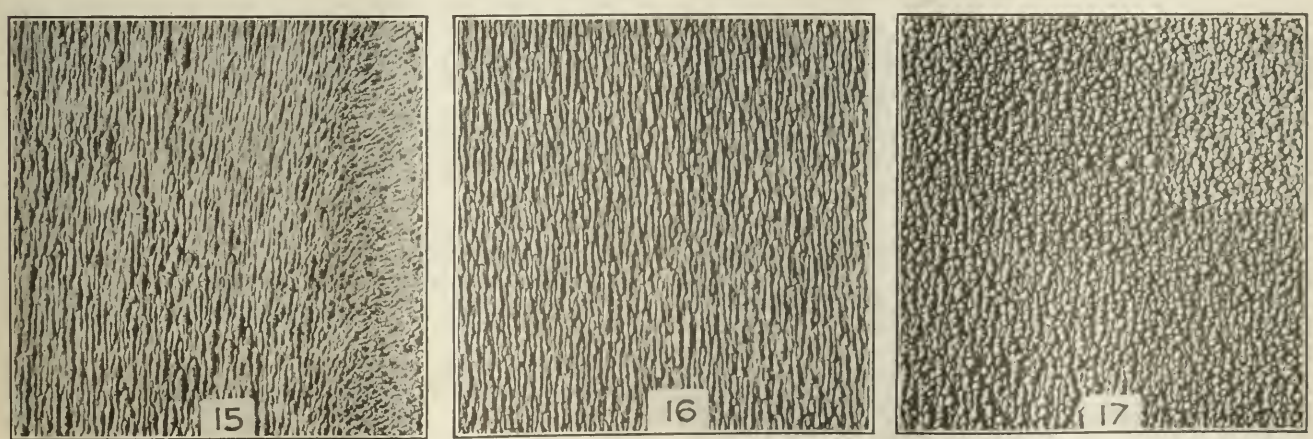
sheets were literally peppered with holes. In fact, there was very little weight left, the sheets being practically a lace-work of zinc.

After 30 hours deposition two sheets were stripped from the test-cell and the cathodes were replaced by new blanks. The zinc showed a distinct carrot-like bamboo structure on the surface and was beginning to redissolve very rapidly. At 34¾ hours the cell had to be stripped. Fig. 9 of the accompanying photographs shows this structure.

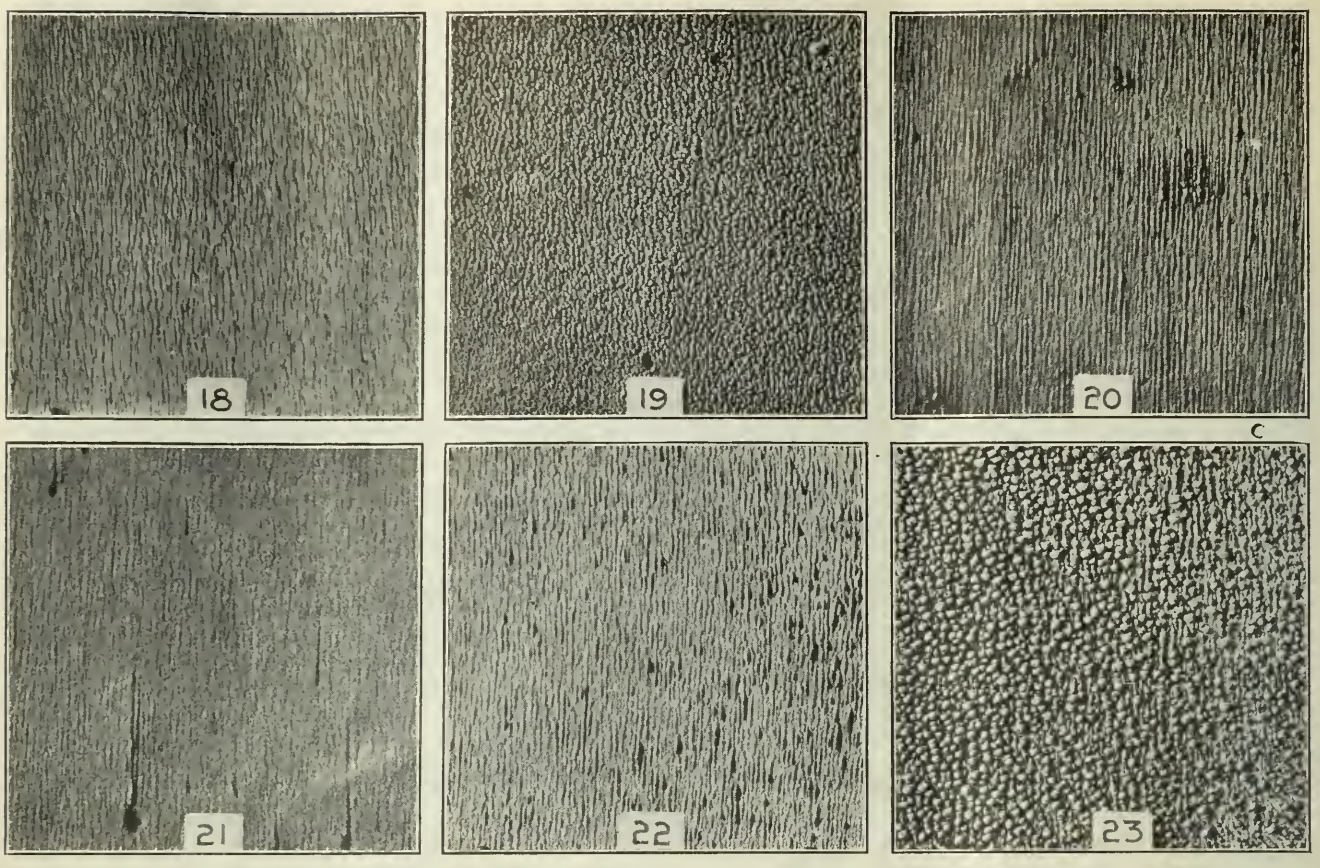
A test of the electrolyte of the cell after the zinc had been stripped revealed not the slightest indication of antimony. It would seem from this result that antimony is plated out. A test of the zinc from this cell did show antimony.

Another test was run in the top cell of a cascade in which two parts per million of antimony were added and successive hourly additions of the solution made for 48 hours to maintain this ratio. Fig. 10 shows a sheet 6¾ hours after the first addition of the "dope" solution, and Fig. 11 illustrates a sheet 11 hours old. Both reveal the action of antimony. A cathode put in the cell to replace that which yielded sheet shown in Fig. 10 was stripped 21 hours later and gave the plate represented by Fig. 12. Fig. 13 shows characteristic antimony effects. It is a sheet from the same cell, 26¼ hours old. The test run had to be discontinued before the sheets were 30 hours old, owing to the rapidity with which the sheets were dissolving. In these tests the zinc sheets were eaten away until there was only a thin backing or skeleton on the aluminum cathode, while the deposit was characterized by a growth such as is shown in Figs. 13 and 14.

A marked difference between the action of antimony



FIGS. 15 TO 17—COMMERCIAL CATHODES PRODUCED BY ELECTROLYTES CONTAMINATED BY ANTIMONY AND OTHER ELEMENTS



FIGS. 18 TO 23—DEPOSITS FROM SOLUTIONS CONTAINING COBALT

Fig. 18—22-hr. deposit. Cobalt 4 parts per million.
Fig. 19—34½-hr. deposit. Cobalt, 2 parts per million.
Fig. 20—48-hr. deposit. Cobalt, 2 parts per million.
Fig. 21—48-hr. deposit. Cobalt, 2 parts per million.
Fig. 22—Defective commercial cathode.
Fig. 23—48-hr. deposit. From cell below test cell.

and that of any other impurity is the total absence of black spots on the cathode, even though the deposit is literally peppered with holes.

Both Figs. 15 and 16 show evidence of the presence of too much antimony in the electrolyte. These sheets were taken from the cellroom nearly a month after the two special tests described above were run. It was evident from these sheets and others, like Fig. 17, that antimony was one of the elements that had been causing frequent trouble in the cellroom for the entire period of the operation of the plant. The degree of its effect, however, varied, depending of course upon the concentration of this element. There were periods when its effect was very slight.

It is quite possible that other plants have had similar or different results from the impurity antimony. I am of the opinion, and I think all will agree, that if one element alone is present in the electrolyte or present in a predominating amount, a distinctive effect is made upon the physical character of the zinc deposit, and in most cases is recognizable. On the other hand, when two or more impurities are present and in about equal proportions, it is almost if not entirely impossible to distinguish the effects as due to this or that element.

From the experience gained at Keokuk and under the conditions of the scheme of operations employed, it can safely be concluded that the presence of antimony in the electrolyte in excess of one part in five million is decidedly objectionable. Test-cells run by Dr. Mighill in the laboratory indicated a current efficiency of only 85 to 90 per cent even at this dilution.

FIG. 24—POROUS DEPOSIT FROM A PITTED CATHODE

Cobalt

In an effort to obtain some characteristic effects of cobalt upon the deposition of zinc, enough cobalt solution was added to the bottom cell of a cascade to bring the cobalt content in the electrolyte to four parts per million, the manganese content at the same time being 0.023 per cent. The addition of the cobalt solution was made after the deposit on the cathodes was 1½ hours old and enough solution was added hourly to maintain this ratio.

Instructions were left to report immediately any unusual occurrences. Twenty-two hours later the cell was "going bad." Within half an hour the sheets were inspected, having been withdrawn from the cell in the meantime. Fig. 18 is a photograph of a sample taken

from the sheets. The surface of the deposit was characterized by a blunt fibrous structure, showing excessive corrosion. The test had not proceeded far enough, however, as the weight of zinc indicated a current efficiency of over 80 per cent. A piece of zinc from this cell placed in the ordinary electrolyte dissolved just twice as fast as a piece from an adjoining cell. Under the microscope the former showed very smooth edges, while the zinc from the ordinary commercial cell which had not been "doped" was comparatively sharp. In the light of subsequent experience this test showed that the critical period between the deposition and the action of the cobalt had been reached.

Another test was run, using the top cell of a cascade, but with only two parts per million of cobalt in an electrolyte containing 0.021 per cent manganese. This content was maintained for 48 hours. As neutral solution alone was flowing into this cell, more striking results were expected. Fig. 19 shows a sheet 34½ hours old, very badly corroded but still having considerable weight. In this sheet the fibrous structure can be recognized, although disguised by its knotty character.

FIGS. 25 TO 27—48-HR. DEPOSITS FROM SOLUTIONS CONTAINING 2 AND 5 PARTS COPPER PER MILLION

A sheet from the same cell 15½ hours old but taken from the outgoing solution side of the cathode revealed nothing of value, it being only slightly roughened.

On the other hand, Figs. 20 and 21 illustrate the character of the deposit when the cell was stripped at the end of 48 hours. The similarity to Fig. 18 is apparent, although the fibrous structure shown in Fig. 20 is sharper and the sheet shown in Fig. 21 very porous, the latter being practically a skeleton.

These tests demonstrated the extremely dangerous action of cobalt when present in the electroylte in an amount from one part per million and upward.

While Fig. 22, which represents a typical sheet of zinc from the day's production, is similar in appearance to Fig. 20, yet the fibrous character is not as sharp nor the corrosion as deep, the deposit being considerably heavier.

Another striking effect of cobalt is shown in Fig. 23, which represents a 48-hour sheet taken from the cell next below the test-cell. The corrosion here is very marked and appears to be an advanced stage of Fig. 19. However, such contrasts are not unusual and often are explained by the position of the sheet in the cell. The side of a cathode facing the inflowing solution will almost invariably show the more marked and characteristic effects of an impurity. Then, too, cobalt appears to have a more virulent effect upon the deposit in the cells next below that which has been "doped" with the impurity.

Fig. 23 tends to support the supposition that some impurities do not reach their maximum effect upon the zinc deposit until they have been in the cells for some time. It is reasonable to believe that they enter into other forms or compounds under the action of the electric current or in association with other impurities in the cell or both.

Effect of Condition of Cathode

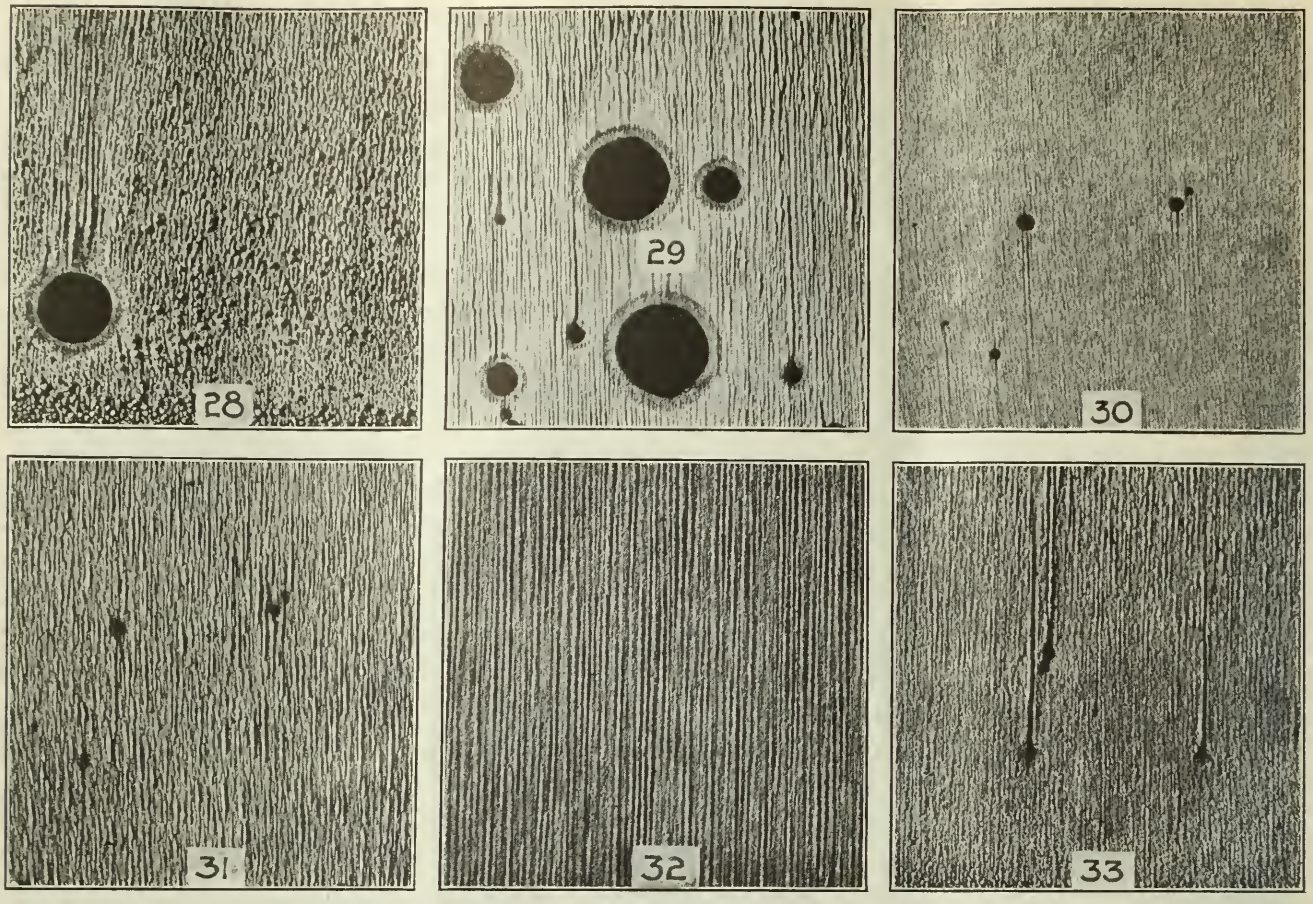
Fig. 24 shows the back of a fragment of a zinc sheet which was deposited upon a badly pitted cathode. This test was run to demonstrate that a badly corroded and pitted aluminum cathode will invariably yield a porous zinc plate, the holes in the deposit corresponding to the pits in the cathode. The test also gave supporting evidence to the idea that impurities in an electrolyte are much less active when the cathodes are clean and smooth than when they are rough and pitted. To confirm this view, 300 g. of the fragment (which, by the way, was not taken from the cobalt test cells) and 300 g. from a first-class zinc deposit of the same day were run for cobalt. The fragment showed a trace of cobalt, about one in five million, while the sample from the first-class deposit revealed no cobalt whatever.

Copper

It was known that copper was an undesirable element in the electrolyte, for whenever it rained any leaks through the cellroom roof dripping down upon the electrodes invariably streaked the deposits by washing copper sulphate from the copper conductor bars to the zinc deposit. The zinc would dissolve away wherever the copper solution came into contact with the plates, leaving the aluminum bare, but these plates would "heal" again after the dripping stopped.

To find the permissible limit of copper in the solution, cells were run using two and five parts of copper per million respectively. Apparently, however, these amounts had little effect upon the zinc deposit; the samples Figs. 25, 26 and 27 taken from the cells after 48 hours show nothing distinctive. Small test-cells gave a current efficiency as high as 92 per cent with one part per hundred thousand of copper.

The tests indicated that copper to a concentration of even five parts per hundred thousand might not be dangerous. Sufficient time was not left before the close of operations to go any further with the copper tests.



FIGS. 28 TO 33—DEPOSITS FROM SOLUTIONS CONTAINING NICKEL WITH PERHAPS COBALT AND ARSENIC

Fig. 28—Characteristic nickel rings.

Fig. 29—Characteristic nickel rings.

Fig. 30—17½-hr. deposit. Nickel 2 parts per million.

Fig. 31—32½-hr. deposit. Nickel 2 parts per million.

Fig. 32—48-hr. deposit. Nickel 2 parts per million.

Fig. 33—48-hr. deposit. Nickel 2 parts per million.

It can readily be appreciated that when the accumulation of copper sulphate which gathered on the conductor bars between stripping operations or through a period of 48 hours was washed down over the zinc deposit the strength of this solution in copper was considerably more than the limits used in the tests. Its action, therefore, while striking, was not an indication of what was to be expected from the ordinary electrolyte whose content in copper was comparatively very low.

It is consequently reasonable to conclude that the amount of copper ordinarily occurring in zinc sulphate electrolyte is not a factor of any moment in the corrosion of the zinc deposit, or, in other words, has not a serious influence upon the current efficiency.

Nickel

Effects that were later distinguished as characteristic of nickel had been noted in the cellroom deposits upon several occasions during the period of operations. In Figs. 28 and 29 the distinctive effect of nickel is shown in the "nickel ring," which is a concentric banded border surrounding a corroded area. A delicate pink color fringes the area and shades off to a dusty brown or black in the outer bands.

A special test-cell was run, adding sufficient nickel solution to make its content two parts per million of nickel. Fig. 30 shows a deposit 17½ hours old, Fig. 31 a sheet 32½ hours old and Figs. 32 and 33 sheets 48 hours old. An attempt was made to reproduce in this cell the characteristic nickel effects illustrated in Figs. 28 and 29, but without marked success. It was concluded that the concentration in nickel had not been sufficient, as tests made by Dr. Mighill in small laboratory cells showed an efficiency of 85 per cent with electrolyte "doped" with one part nickel in a hundred thousand.

It also appeared that nickel was more influenced in its action than any of the other elements by the presence of additional impurities in the electrolyte. Cobalt and arsenic effects can be detected in Figs. 30 to 33, their presence evidently retarded the usual effects of nickel.

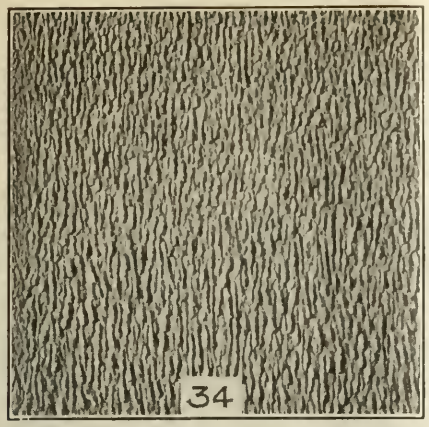
Outside of the "nickel ring" marking, electrolytes having too much nickel will produce zinc sheets that are porous and consequently light in weight.

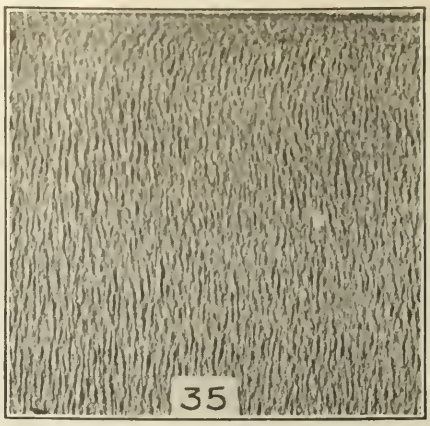
There is a similarity between the effects of cobalt and nickel in the fibrous structure, although the nickel sheets appear lighter in color and more regular in their physical characteristics.

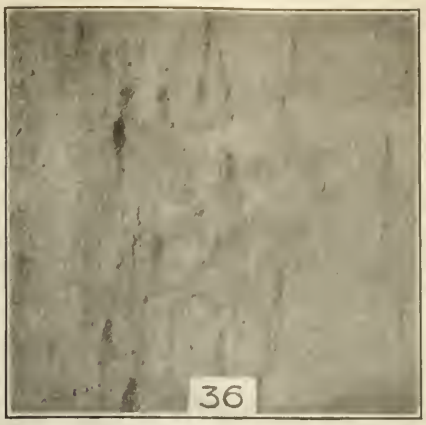
Miscellaneous Impurities

On a number of occasions the zinc deposit stuck so tenaciously to the cathodes that it was very difficult to strip the sheets. Figs. 34 and 35 illustrate sheets of zinc that were typical of deposits persisting for several days while the sheets stuck badly to the cathodes. Although Fig. 34 shows the effects of antimony, yet Fig. 35 is not distinctive but resembles more nearly a cobalt effect in its early stages. A great deal of speculation was indulged by various members of the staff upon the cause of "sticking" sheets, but no explanation actually fitted the phenomenon.

Tests conducted during the latter part of 1917 and







FIGS. 34 TO 36—MISCELLANEOUS TROUBLESOME SHEETS

Fig. 34—"Sticker"; probably affected by antimony.

Fig. 35—"Sticker"; cause unknown, possibly cobalt.

Fig. 36—Ferric hydrate working out through pores.

early in 1918 proved in a convincing manner that rough and pitted cathodes caused "sticking" of the deposit and furthermore, as noted above, that a badly pitted cathode invariably produced a porous deposit (Fig. 24). The sticking of the zinc, however, during the winter and spring of 1919 was on a more extensive and persistent scale than any previously experienced. It is quite likely that the accumulation of impurities or the presence of new impurities in the electrolyte had a contributing influence.

In this connection it should also be noted that a cathode that is too smooth will not retain a zinc deposit; it will break away as its age increases, and in some cases it actually falls into the cell or strips itself.

Colloidal Ferric Hydrate

Fig. 36 illustrates the action of re-solution, the brown streaks having been caused by gaseous action at the base of the deposit, working the "muck" out through the tiny holes in the zinc plating. In this case the "muck" was a ferric hydrate mud which had collected in the solution lines between the cellroom and the Dorr thickeners used for iron purification. It is a colloidal substance, almost non-filterable.

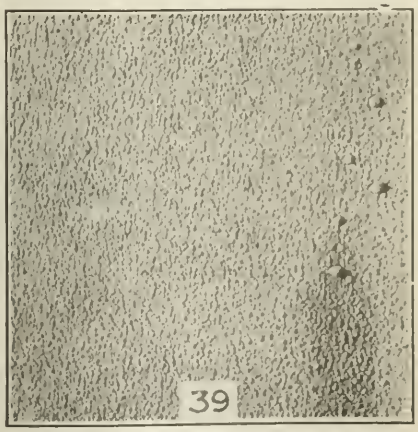
A number of test-cells were run to see what effect quantities of this "muck" would have upon the deposit. It was thought that it might carry the arsenic, antimony, cobalt, etc., and thus be the source of the many bad times the cellroom had experienced. However, the large cells that were doped with this muck did not reveal anything of interest. The zinc deposit was good and the current efficiency as high as in clean cells.

Glue

Whenever glue was omitted from the cells for a time, the deposit would become full of holes. This is undoubtedly due to the action of impurities which are rendered either inert or retarded in action by the glue. Fig. 37 shows a sheet that has healed after glue had been added to a cell previously free of glue. Fully half of the sheet had been dissolved away and then plated over, as evidenced by the raised patches.

The addition of glue after its total absence for some time causes a marked and almost instant change in the deposition of zinc. In one case the entire cellroom was in trouble, the sheets were peppered with holes and in some cases were actually on the verge of breaking away from the cathodes. The situation was acute, many remedies were suggested and many ideas were advanced to account for the condition, cobalt and nickel being the popular culprits. Glue was added and within 20 minutes a change had come over the entire cellroom. Re-solution had been arrested and in the great majority of cases the sheets had actually "healed" and plating had been resumed. From this and several no less striking experiments one cannot but conclude that glue has a deterrent effect upon the action of impurities.

A first-class, dense, hard crystalline deposit of zinc is shown in Fig. 38. A sheet of this character is very smooth; it is of good weight and will represent a cur-



FIGS. 37 TO 39—COMMERCIAL CATHODES

Fig. 37—Defective sheet healed with glue additions.

Fig. 38—First-class cathode.

Fig. 39—Satisfactory "pebbly" deposit.

rent efficiency in the 90's. In Fig. 39 is shown the characteristic "pebbly" deposit. It is an indication of good plating and high efficiency.

Conclusion

The tests brought out the fact that impurities, as a general rule, when within reasonable limits do not attack the zinc deposit very vigorously during the first 15 or 20 hours of deposition. While it has been shown by Tarbell, for example, that the action of cobalt is catalytic, yet it appears that there is likewise either a preliminary concentration before the catalytic action starts, or the impurity is changed into another state before the corrosion begins. It is also quite possible that the effects of the impurities thrown out of solution or formed under the electrolytic action in the cell under test, or in the preceeding cells when the former is not a top cell, might easily retard or disguise the true effects of the particular impurity under investigation. The time was too limited to extend the experiments to determine these points.

It is of course evident that the phenomena noted in these tests can be variously interpreted by different investigators. In several instances, however, the evidence appeared so convincing that the conclusions drawn should be of value as a basis for further investigation.

Keokuk, Iowa.

Fullers Earth Deposit Opened in Pennsylvania

THE Furness Corporation, with main office in Chicago, has opened up a deposit of high-grade fullers earth on a 270-acre tract located at Clarksville, Mercer County, Pa. The mill, located on the Pennsylvania Railroad, is about ready to operate. Power for the mill is supplied from a plant consisting of two 150-hp. Phœnix boilers, Reed feed-water heaters and one 350-hp. Hamilton Corliss engine. Water and fire pumps operate in conjunction.

The mill plant is equipped with a Marine Iron Works disintegrating mill. Material, after passing this unit, is run through two Cummer's rotary driers. From the driers it feeds into a No. 12 Brainard hammer mill, where the first stage of pulverizing takes place.

This unit has a feed opening of 5 x 12 in. and will pulverize 5 to 8 tons per hour, of which 90 per cent will pass through a ¼-in. mesh. The hammers weigh 100 lb. each and come in contact with the earth on the upstroke. The hammer shaft has a speed of 400 to 600 r.p.m.

FULLERS EARTH MILL AT CLARKSVILLE, PA.

The material next passes into the Kneutzberg pulverizers, which operate to distribute all the coarse material in such a way as permits all the applied power to be used for actual grinding. The result is a maximum of fines with a minimum of power consumption.

Tyler whip-tap screens follow the pulverizer, and from these the finished product finally lands in the storage bins. Material is handled between units of the plant by screw conveyor equipment, all furnished by the Weller Manufacturing Co. The plant has a capacity of 60 tons per 8 hours. Installation of a dragline excavator with steam shovels at the pits is contemplated.

Some Uses of Fullers Earth

Fullers earth obtains its name from its original use in fulling cloth, extracting the greases from the wool. Its principal use now is bleaching and clarifying or filtering oils, fats and greases and is alike applied to animal, vegetable, seed and mineral oils.

It is used in the manufacture of coconut butter, oleomargarine, cold-water paint and wall paper and in detecting certain coloring matter in food products. Its use is gradually extending, it being employed as a substitute for talcum powder, as a poultice and as an antidote for alkaloid poisons.

A common practice in filtering mineral oils is to dry the earth carefully and then grind it to a suitable mesh and run it into long cylinders through which the crude, dark mineral oils percolate slowly. The result of this practice is that the oil coming out first is perfectly white and much thinner than that which follows. The oil is permitted to percolate through the earth until its color reaches a certain maximum shade.

A radically different process is followed in filtering vegetable, seed and animal oils. In this case the oil is heated in large tanks beyond the boiling point of water, from 5 to 10 per cent of its weight of fullers earth is added and the mixture is vigorously stirred and then filtered off through bag filters, or filter presses. The coloring matter remains with the earth, likewise any foreign matter which the oil may contain, the filtered oil being a pale straw color, providing, of course, the operation has been performed with sufficient care.

New uses, such as deliming hides in the manufacture of leather, may be developed and in time create a good market for the absorbing fullers earth.

Fullers earth cake from oil mills can be used in the manufacture of hand soaps, concrete waterproofing and asphalt preparations.

Fluorspar Production in 1921

The fluorspar shipped from mines in the United States in 1921, according to H. W. Davis, of the U. S. Geological Survey, amounted to approximately 35,600 short tons, valued at $708,000, a decrease of 81 per cent in quantity and of 85 per cent in value as compared with 1920. The general average selling price per ton f.o.b. cars at shipping points for all grades of fluorspar in 1921 is estimated at $19.89, which is $5.37 less than the average price in 1920. The total shipments in 1921 were the lowest recorded for any year since 1908.

The imports of fluorspar into the United States in 1921 totaled 6,229 short tons, as against 24,612 tons in 1920, a decrease of 75 per cent in quantity and of 74 per cent in total value.

Non-Flammable Mixtures of Organic Solvents for Vegetable-Oil Extraction

Experiments With Gasoline, Benzene, Carbon Tetrachloride and Trichlorethylene Indicate That Fire Hazard Can Be Eliminated More Economically by the Use of Certain Mixtures of Flammable and Non-Flammable Solvents Than by Extraction With Pure Non-Flammable Solvents

By A. F. SIEVERS and J. D. McINTYRE

IN THE commercial extraction of vegetable oils by means of organic solvents one of the chief technical considerations is the selection of a suitable solvent. Three important factors enter into such a consideration: (1) Initial cost of the solvent and the thoroughness with which it can be recovered, (2) safety from fire hazard and the relation of such hazard to the cost of plant insurance, and (3) the quality of oil obtainable by the use of the solvent. The relative importance of these three factors depends to some extent on the character of the material to be extracted and the purpose to which the extracted oil is to be put. Economy of operation is at all times of paramount importance, hence the first two factors are closely interrelated. The third factor is probably of less importance, especially when the solvent used is sufficiently pure to admit of its complete removal from the extracted oil.

It is well known that the several solvents commercially practicable for extraction purposes have a selective action on substances other than the fat in the oleaginous material, notably the pigments. In a previous paper,[1] however, the writers have shown that in the case of the solvents gasoline (high- and low-boiling fractions), benzene, carbon tetrachloride and trichlorethylene when used in connection with such materials as cotton seed, soya beans, corn germs and peanuts, there is no relation among the color of the crude extracted oil, the color of the finished oil and the refining loss. It would seem, therefore, that so far as regards the four principal solvents—gasoline or naphtha, benzene, carbon tetrachloride and trichlorethylene—the question of the selective action is of secondary importance, the main considerations being economy and safety.

Purpose of the Experiments

Of the four solvents mentioned the two chlorinated hydrocarbons are non-flammable and the other two are flammable. Three are chemical entities with definite boiling points when pure, while gasoline is a mixture of hydrocarbons with a boiling range depending on its grade and quality. It was the purpose of the experiments recorded in this paper to determine the ratio in which the non-flammable and the flammable solvents must be mixed to make the mixture safe and to what extent such mixtures will fractionate into unsafe fractions when recovery is effected by direct heat or with a current of steam.

The chlorinated hydrocarbons are much more expensive than gasoline or benzene. While the latter solvents cost about 30c. a gallon, carbon tetrachloride and trichlorethylene cost about $1.35 a gallon (1922 quotations). It is evident, therefore, that if a considerable proportion of a cheap, flammable solvent can be mixed with the more expensive but non-flammable one, and if the resulting mixture will not fractionate into unsafe fractions upon recovery, the fire hazard can be eliminated with an appreciably lower cost than if pure non-flammable solvents were used.

Preparation of Solvents

The benzene and trichlorethylene for the following experiments were used without further treatment, but the trichlorethylene was somewhat yellow and was consequently distilled over a direct flame to obtain a colorless product. The gasoline was obtained from ordinary motor fuel by means of distillation under reduced pressure. The portion boiling below 85 deg. C. under a 25-in. vacuum was retained for use in these experiments.

TABLE I—BOILING RANGE OF THE SOLVENTS—GASOLINE, BENZENE, CARBON TETRACHLORIDE, AND TRICHLORETHYLENE

Fraction c.c.	Temperature (Degrees C.) Gasoline	Benzene	Carbon Tetrachloride	Trichlorethylene
Start*	65	73	58	60
5	90	81	75	87
10	96	81.3	76	87
15	104	81.5	76.7	87.5
20	110	81.6	77	87.5
25	116	82	77	87.7
30	122	83	77.5	87.9
35	130	84	79	88
40	141	85.5	81	88.8
45	162	87	85	90
50†	...	89	90	90.5

* Reading when the vapors began to pass into the condenser.
† In the case of gasoline only a portion of the last 5 c.c. actually passed over into the condenser; the remainder condensed on the sides of the flask.

In order to determine the boiling range of the several solvents, 50 c.c. was distilled over a direct flame and the temperatures noted after the collection of every 5-c.c. fraction. The results are shown in Table I.

Method of Testing

In testing the flammability of the several mixtures it was sought to copy as nearly as possible the conditions under which explosions or fires would most likely occur in an extraction plant—namely, the discharge of a spark in an atmosphere of the vapors of the mixture. The most likely source of ignition of such vapors in a plant is probably an electric spark such as might come from a motor. For testing purposes an automobile spark plug was suspended in a 300-c.c. beaker. By means of a hot plate the beaker was kept sufficiently hot to vaporize immediately the 2 c.c. of solvent introduced. In the midst of these vapors the spark was discharged at frequent intervals. Those mixtures which did not burst into flame from the spark were considered suffi-

[1] Sievers, A. F., and McIntyre, J. D., "The Relative Effectiveness of Several Organic Solvents for the Extraction of Vegetable Oils," *Cotton Oil Press*, vol. 4, February, 1921, p. 44.

TABLE II—SPECIFIC GRAVITIES OF THE MIXTURES IN SERIES *A*, *B* AND *C*

Mixture	Proportion (by Volume) Non-flammable (*a*) Per Cent	Proportion (by Volume) Flammable (*b*) Per Cent	Specific Gravities at 25 Deg. C. Series *A* (*a*) Carbon Tetrachloride (*b*) Benzene	Series *B* (*a*) Trichlorethylene (*b*) Benzene	Series *C* (*a*) Carbon Tetrachloride (*b*) Gasoline
	100	0	1.586	1.458	1.586
2	95	5	1.547	1.429	1.542
3	90	10	1.514	1.400	1.499
4	85	15	1.480	1.369	1.456
5	80	20	1.444	1.342	1.412
6	75	25	1.405	1.310	1.368
7	70	30	1.372	1.281	1.327
8	65	35	1.333	1.250	1.283
9	60	40	1.301	1.221	1.240
10	55	45	1.265	1.190	1.195
11	50	50	1.228	1.162	1.153
12	45	55	1.193	1.133	1.110
13	40	60	1.156	1.104	1.068
14	35	65	1.120	1.075	1.025
15	30	70	1.084	1.044	0.980
16	25	75	1.052	1.015	0.940
17	20	80	1.017	0.986	0.898
18	15	85	0.978	0.958	0.859
19	10	90	0.941	0.928	0.811
20	5	95	0.908	0.898	0.770
21	0	100	0.871	0.871	0.728
Difference in specific gravity between 1 and 21			0.715	0.587	0.758
Difference in specific gravity for every 1 per cent change in proportion			0.0072	0.0059	0.0076

ciently non-flammable to make their use in an extraction plant reasonably safe.

Preparation of Solvent Mixtures

Three series of mixtures were prepared: (*A*) Carbon tetrachloride and benzene, (*B*) trichlorethylene and benzene and (*C*) carbon tetrachloride and gasoline. In each case mixtures were prepared ranging from 95 per cent of the non-flammable and 5 per cent of the flammable to 5 per cent of the non-flammable and 95 per cent of the flammable. The specific gravities of all these mixtures are tabulated in Table II.

By the method previously described these various mixtures were tested for flammability. In series *A* it was found that 30 per cent by volume is the maximum safe proportion of benzene which can be used. In series *B* only 20 per cent by volume of benzene can be used. This shows the relative extinguishing power of the trichlorethylene and carbon tetrachloride. The gasoline as used in these experiments is evidently less flammable than benzene, since 35 per cent by volume can be used with carbon tetrachloride in series *C*. The foregoing proportions are, of course, not absolute, because with the method of testing used a difference of 1 or 2 per cent in the percentage cannot readily be detected. The proportions decided upon in the three series as being safe mixtures are all well within the safety margin. It must be understood, however, that the above mixtures are considered safe when used as such, without reference to what degree of fractionation may take place when such solvent mixtures are being recovered in an extraction plant. This phase of the matter will be taken up in the subsequent paragraphs.

Direct Distillation of Solvent Mixtures

In a solvent-extraction plant the operation most likely to lead to a leakage of solvent vapors is probably that of the recovery of the solvent either from the oil or from the residue. It is of utmost importance, therefore, that such mixtures of solvents as have been described must not only be non-flammable as such but must not fractionate upon recovery to such an extent that flammable vapors will be produced at any stage of the recovery operation. The three series of mixtures selected, which will be designated as I, II and III, were submitted to distillation under various conditions to determine the extent to which such fractionation takes place. The mixtures were first distilled directly on a steam bath, 500 c.c. being used and 50 c.c. fractions collected. The temperature at the start of each fraction was noted and the specific gravity of each fraction taken to determine the proportion of the two solvents present in the mixture. The results of these distillations are given in Tables III, IV and V.

TABLE III—RESULTS OF DIRECT DISTILLATION OF 500 C.C. OF A MIXTURE OF 30 PER CENT, BY VOLUME OF BENZENE AND 70 PER CENT OF CARBON TETRACHLORIDE. (MIXTURE I.)

Fraction	Temperature (Deg. C)	Specific Gravity at 25 Deg. C.	Proportion of Components (by Volume) Benzene	Carbon Tetrachloride
1	70	1.381	28.7	71.3
2	77.5	1.379	29.0	71.0
3	78	1.379	29.0	71.0
4	79	1.377	29.3	70.7
5	81	1.376	29.4	70.6
6	81	1.374	29.7	70.3
7	81	1.372	30.0	70.0
8	81	1.368	30.6	69.4
9	80.5	1.364	31.7	68.3
10	83–84	1.345	34.0	66.0

Specific gravity of mixture before distilling, 1.372
Specific gravity of all fractions mixed, 1.373.
Time of distillation, 1 hour, 5 minutes.

The extent of the fractionation in the case of the mixture in Table III was relatively small. The final fraction, which contained the largest proportion of benzene, was carefully tested for flammability and found to be safe. It is evident, therefore, that mixture I can be safely distilled by direct heat, because at no stage of the operation are the vapors flammable.

TABLE IV—RESULTS OF DIRECT DISTILLATION OF 500 C.C. OF A MIXTURE OF 20 PER CENT, BY VOLUME, OF BENZENE AND 80 PER CENT OF TRICHLORETHYLENE. (MIXTURE II.)

Fraction	Temperature (Deg. C.)	Specific Gravity at 25 Deg. C.	Proportion of Components (by Volume) Benzene	Trichlorethylene
1	76	1.320	24	76
2	85.5	1.324	23.1	76.9
3	86	1.328	22.4	77.6
4	86.3	1.330	22.1	77.9
5	86.3	1.333	21.6	78.4
6	86.5	1.335	21.2	78.8
7	89.5	1.340	20.3	79.7
8	90	1.347	19.2	80.8
9	92.5	1.355	17.8	82.2
10*	88	1.367	15.7	84.3

Specific gravity of mixture before distilling, 1.342.
Specific gravity of all fractions mixed, 1.341.
Time of distillation, 1 hour, 12 minutes.
* About 6 c.c. remained in the flask (consisting of 93 3 per cent of trichlorethylene).

In the case of the mixture in Table IV the maximum percentage of benzene is in the first fraction, which was found on testing, however, to be non-flammable. Mixture II can therefore be distilled by direct heat with safety.

TABLE V—RESULTS OF DIRECT DISTILLATION OF 500 C.C. OF A MIXTURE OF 35 PER CENT, BY VOLUME, OF GASOLINE AND 65 PER CENT OF CARBON TETRACHLORIDE. (MIXTURE III.)

Fraction	Temperature (Deg. C.)	Specific Gravity at 25 Deg. C.	Proportion of Components (by Volume) Gasoline	Carbon Tectrachloride
1	40	1.353	26	74
2	78	1.379	23.9	76.1
3	79	1.390	22.6	77.4
4	80	1.391	22.5	77.5
5	81	1.395	22	78
6	82	1.393	22.3	77.7
7	82	1.341	28.3	71.7
8	89	1.285	34.8	65.2
9	98	.938	75.1	24.9
10*	....	.....	....	....

Specific gravity of mixture before distilling, 1.283.
* Last fraction, apparently all gasoline, remained in flask.

It is evident at once from the data of Table V that gasoline cannot be used with carbon tetrachloride without fractionating toward the end of the distillation into practically pure gasoline, which would introduce an element of danger. This is, of course, to be expected from the wide range of temperature at which the gasoline boils. A similar mixture was distilled under reduced pressure, but in this case also the last two fractions were flammable. It follows for the same reason that gasoline could not be used with trichlorethylene.

Steam Distillation of the Solvent Mixtures

Since solvent recovery in a commercial extraction plant is accomplished to a great extent by means of steam distillation, mixtures I and II were subjected to such a distillation, with the results tabulated in Table VI.

A comparison of the results in Table VI with those obtained with direct distillation reveals the fact that a slightly greater fractionation takes place in both mixtures with steam distillation. This slight difference, however, is sufficient to make mixture II unsafe when the solvent mixture is recovered with a current of steam, since the first fraction thus obtained is flammable. The final fraction in mixture I is of doubtful safety according to the test, its proportion of benzene being a trifle too high to make such a mixture entirely safe when steam is used for its recovery. For commercial operation it would be advisable to choose a mixture with a slightly lower percentage of benzene. For instance, 28 per cent by volume of benzene and 72 per cent of carbon tetrachloride would be within the limit of safety. For mixture II a proportion of 17 per cent by volume of benzene and 83 per cent of trichlorethylene should be feasible.

TABLE VI—RESULTS OF STEAM DISTILLATION OF 500 C.C. EACH OF MIXTURES I AND II

	Mixture I — 30 Per Cent Benzene and 70 Per Cent Carbon Tetrachloride, by Volume				Mixture II — 20 Per Cent Benzene and 80 Per Cent Trichlorethylene, by Volume			
Fraction	Temp., Deg. C.	Sp. gr. at 25 Deg. C.	Benzene	Carbon Tetrachloride	Temp., Deg. C.	Sp. gr. at 25 Deg. C.	Benzene	Trichlorethylene
1*	40	1.387	28	72	45	1.308	25.6	74.4
2	68.5	1.384	28.3	71.7	72	1.315	24.5	75.5
3	68.5	1.382	28.6	71.4	72	1.323	23.2	76.8
4	68.5	1.380	28.9	71.1	74	1.326	23	77
5	68.5	1.377	29.3	70.7	75.5	1.331	22	78
6	69	1.375	29.6	70.4	77	1.335	21	79
7	70	1.371	30.1	69.9	79	1.344	19.7	80.7
8	71	1.365	31	69	79	1.349	19	81
9	73	1.356	32.3	67.7	79	1.359	18	82
10†	74–105	1.318	38	62	80–105	1.367	16	84

* Fraction 1 in mixture II is flammable.
† Fraction 10 in mixture I is of doubtful safety.

Distillation of Cottonseed Extract

In commercial operations the solvents must be recovered from the extracted oil and from the residues. Since the presence of nitrogenous and albuminous materials in the solvent extract frequently causes foaming, conditions are naturally somewhat different from those obtaining when the solvents alone are being recovered, as in the foregoing experiments. Consequently, in order to simulate plant conditions cottonseed extracts were made with a mixture of benzene and carbon tetrachloride in the ratio of 30 to 70 and with a mixture of benzene and trichlorethylene in the ratio of 17 to 83, and the solvent mixtures recovered. These extracts contained approximately 20 per cent of oil besides the usual impurities extracted by organic solvents from such seed. The distillations were started by direct heat from a steam bath and when the concentration of the extract became such as to slow up the process a current of steam was admitted and the recovery of the solvent completed. The results of this experiment are recorded in Table VII.

From these results it may be concluded that the presence of extraneous matter extracted with the oil from cotton seed does not noticeably affect the extent of the fractionation and will not result in the production of flammable solvent vapors if the proper mixture is used. It is further evident, as concluded from Table VI, that in order to provide a somewhat greater margin of safety the proportion of benzene in mixture I must be reduced from 30 to 28 per cent by volume.

In connection with the use of such mixtures as have been discussed consideration must be given to the possibility of mixtures of vapors separating according to their density. If in the course of recovery or storing such mixtures quantities of vapors should escape and remain for some time in a closed room, there is a possibility that the carbon tetrachloride vapors would settle toward the floor, thus leaving an upper stratum of flammable benzene vapors. In a mixture of vapors, however, the force of diffusion and the force of gravity are operating against each other. An attempt was made to obtain some data on this point by volatilizing several hundred cubic centimeters of mixture I in a large ash can about 3 ft. high and 14 in. in diameter and carefully sealed. After 12 hours, samples of the vapors remaining uncondensed were drawn from the top and from the bottom of the can and tested. No great difference could be discovered. Three wide-mouthed liter bottles were filled with vapors from the top of the can, pure benzene vapors and ordinary air respectively. Lighted tapers were then inserted into each bottle. The bottle containing benzene was immediately filled with flame, while the two other tapers acted very much alike except that the one in the bottle containing only air burned somewhat longer. If these results are at all indicative of what would take place on a large scale it would not seem likely that a condition such as described would result in a serious fire risk.

TABLE VII—RESULTS OF DISTILLING 500 C.C. OF COTTONSEED EXTRACTS MADE WITH MIXTURES OF BENZENE AND CARBON TETRACHLORIDE AND BENZENE AND TRICHLORETHYLENE

	Proportion of Components (by Volume)			
	Mixture I — 30 Per Cent Benzene, 70 Per Cent Carbon Tetrachloride		Mixture II — 17 Per Cent Benzene, 83 Per Cent Trichlorethylene	
Fraction	Benzene	Carbon Tetrachloride	Benzene	Trichlorethylene
1	29	71	19.7	80.3
2	29	71	18.7	81.3
3*	30	70	18	82
4	30	70	17.3	82.7
5	30.1	69.9	17	83
6	30.3	69.7	16.5	83.5
7	30.7	69.3	16	84
8	31.3	68.7	15	85
9	32.6	67.4	13.7	86.3
10†	36	64	13.5	86.5

Fraction 1 of mixture II was non-flammable.
Fraction 10 of mixture I was of doubtful safety.
Fraction 10 of both mixtures was not full 50 c.c. in volume.
* Beginning with this fraction steam was admitted in distilling mixture II.
† Beginning with this fraction steam was admitted in distilling mixture I.

Economic Considerations

In estimating the approximate economy that may be effected by the use of such mixtures of solvents as have been described consideration will be limited to the two factors, fire risk and cost of solvent.

The technical objection to the chlorinated hydrocarbons—namely, that they have a tendency to

decompose slightly in the presence of steam with the formation of hydrochloric acid, which injures the equipment, will not be discussed here. As to the quality of the oils produced by the use of the several solvents under discussion, it is not believed that there is sufficient difference in their action to be a controlling factor. The cost of carbon tetrachloride and trichlorethylene fluctuates considerably, but their cost as a rule is at least four and one-half times that of benzene. Assuming that benzene costs 30c. a gallon and the carbon tetrachloride and trichlorethylene $1.35 a gallon, the comparative costs of 1,000 gal. of the several solvents and mixtures I and II would be as indicated in Table VIII.

TABLE VIII—COMPARATIVE COST OF 1,000 GAL. OF BENZENE, CARBON TETRACHLORIDE (OR TRICHLORETHYLENE), AND MIXTURES I AND II

Solvent	Cost Per Gal.	Cost Per 1,000 Gal.	Amount Saved on 1,000 Gal. as Compared With Pure Carbon Tetrachloride or Trichlorethylene
Benzene	$0.30	$300	.....
Carbon tetrachloride or trichlorethylene	1.35	1,350	.....
Mixture I: Benzene 28 per cent Carbon tetrachloride 72 per cent	1.06	1,056	$294
Mixture II: Benzene 17 per cent Trichlorethylene 83 per cent	1.16	1,161.50	$188.50

As indicated in the table, the saving on 1,000 gal. of mixture I over a similar quantity of pure carbon tetrachloride is $294, and that on 1,000 gal. of mixture II over pure trichlorethylene is $188.50. From another viewpoint it may be said that it costs the difference between $1,056 and $300, or $756 per 1,000 gal., to eliminate the fire risk by using mixture I, while by the substitution of pure carbon tetrachloride for benzene it will cost the difference between $1,350 and $300, or $1,050, to attain this end. In the same way the cost of eliminating the fire risk with mixture II amounts to $1,161.50 less $300, or $861.50. The cost of the fire hazard as reflected in insurance rates is difficult to estimate, but it should be easy to determine for each extraction plant whether such mixtures could be economically used provided there are no other objections to the employment of carbon tetrachloride or trichlorethylene as solvents.

Conclusions

The use of such flammable solvents as benzene and gasoline in the extraction of vegetable oils has the great advantage of low cost per gallon over the non-flammable solvents carbon tetrachloride, trichlorethylene and other members of the chlorinated hydrocarbons. However, even with carefully constructed equipment and all possible safeguards the fire risk is naturally considered by insurance underwriters to warrant a much higher rate of insurance on such a plant if flammable solvents are used than is otherwise the case. A mixture of the two types of solvents in such proportion that the mixture or its vapors are at all times non-flammable would reduce the original cost below that of the high-priced non-flammable solvent and at the same time eliminate the high insurance rates.

It was found by experiment that a mixture of benzene and carbon tetrachloride in the ratio of 30 to 70 per cent by volume, a mixture of benzene and trichlorethylene in the ratio of 20 to 80 per cent by volume and a mixture of gasoline and carbon tetrachloride in the ratio of 35 to 65 per cent by volume are non-flammable to the extent that their vapors cannot be exploded or set afire by an electric spark.

These mixtures when distilled by direct heat or by a current of steam fractionate to a certain extent. The mixture containing gasoline becomes entirely unsafe. The benzene mixtures fractionate much less, that containing trichlorethylene producing a flammable fraction at the start of the distillation and that containing carbon tetrachloride producing at the end a fraction which is so nearly flammable that its use would be risky.

Mixtures entirely safe when recovered by means of either steam or direct distillation from extracted oil and at the same time containing the maximum amount of the cheaper component benzene would consist of (1) benzene 28 per cent and carbon tetrachloride 72 per cent by volume, (2) benzene 17 per cent and trichlorethylene 83 per cent by volume.

The comparative cost per gallon of the three pure solvents and of mixtures I and II indicates that the use of the latter as a means of eliminating fire risk can be effected much more economically than by the use of either of the pure non-flammable solvents.

Bureau of Plant Industry,
U. S. Department of Agriculture,
Washington, D. C.

Air Lift Supplies Cold Water for Tire Manufacture

By Ralph T. Stone

THE Denman-Myers Cord Tire Co. recently constructed a plant near Warren, Ohio, for the exclusive manufacture of cord tires. The Osborn Engineering Co. of Cleveland, Ohio, was the engineer and contractor and the equipment for producing 1,000 tires per day was installed in record time. The layout involves several distinctive features, chief of which is the use of Sullivan air lifts for delivering water from the artesian wells on the property. Large quantities of water of even temperature are required. Water from these deep wells is of constant temperature, 55 deg. F., the year around. It was realized that if the well water were pumped to a storage reservoir or tank, it would become warm in summer and the greater part of the advantage of cold water would be lost. An ingenious arrangement was devised to distribute the cold water from one of the wells direct to the plant and maintain constant pressure on the mains without the use of a storage tank. Two wells about 160 ft.

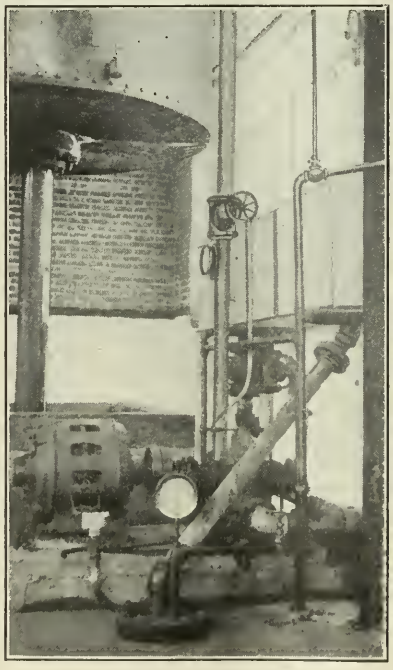


FIG. 1—VIEW IN ENGINE ROOM, SHOWING WELL NO. 1 WITH CENTRIFUGAL PUMP, COLLECTING TANK AND FLOAT-OPERATED AIR VALVE

deep and 8 in. in diameter were found to supply ample water. Well No. 1, Fig. 1, is located below the power house and Well No. 2 about 250 ft. north of the power house. Well No. 2 is equipped with a 3-in. Sullivan standard air life pump and a 24 x 24-in. booster-separator. The discharge from this well is delivered through a horizontal pipe 182 ft. long into the storage reservoir at 6 ft. elevation above the well head, as shown in Fig. 2. The booster, which is placed in the small house at the head of the well, separates the air from the water and discharges the water in a steady stream as shown.

The water from Well No. 1 is not discharged into the reservoir, but is distributed direct through the plant and furnishes a splendid supply of cold water for drinking fountains, lavatories and the mills and calenders. The low temperature of the water used in the mills and calenders greatly increases their capacity and improves the quality of the product.

Well No. 1 comes up through the floor in the engine room as shown in Fig. 1. It is equipped with a 3-in. Sullivan standard air lift pump and the water is discharged through the inclined pipe into the collector tank attached to the wall. The eduction pipe from the

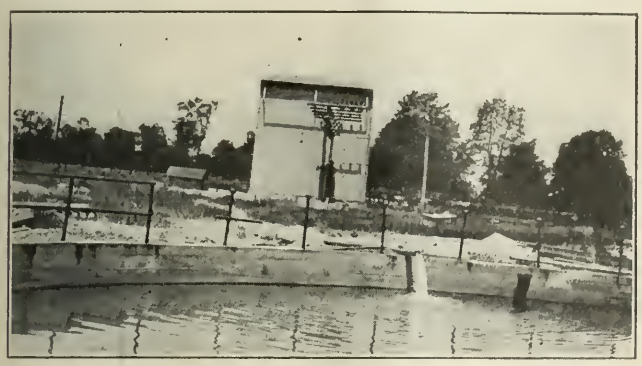


FIG. 2—DISCHARGE FROM WELL NO. 2, SHOWING RESERVOIR AND SMALL HOUSE CONTAINING BOOSTER IN THE BACKGROUND

well comes up through the bottom of the tank above the water level and is fitted with an umbrella separator to control the discharge and prevent splashing. The air line to the well passes over a corner of the collector tank and is equipped with a float-operated valve which is very sensitive in operation. This valve keeps the water at constant level in the collector tank and prevents overflowing.

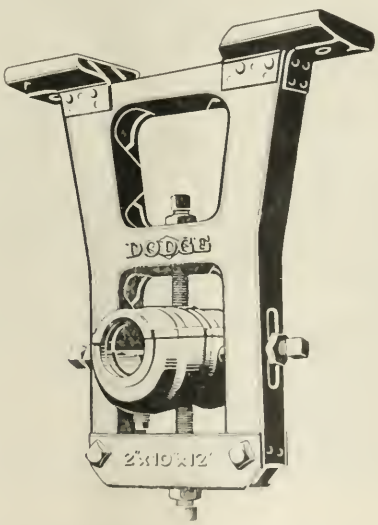
The suction of the centrifugal pump is connected to the bottom of the collector tank as shown in Fig. 1, and since it is below the water level in the tank, the pump is always primed. This pump runs continuously and maintains a constant discharge head of 90 lb. Advantage is taken of the well-known fact that a centrifugal pump maintains fairly constant pressure, independent of the quantity of water handled. The water is used all over the plant and the quantity drawn varies considerably, depending upon the number of spigots and valves which may be opened at any one time. Every valve in the distributing system may be closed at the same time without affecting conditions at the pump. In order to prevent heating of the pump when no water is being used, a ¾-in. pipe is tapped into the discharge line close to the pump and led back to the top of the collector tank as shown in the illustration. This pipe is provided with an ordinary globe valve which is kept slightly open, permitting a small stream of water to flow back into the collector tank. The apparatus has been in continuous operation since Oct. 1, 1920, and has required little attention. The plant has enjoyed an ample supply of water at all times and has been entirely free from shutdowns due to shortage of water.

Air System

Compressed air for the wells and for several manufacturing purposes is supplied by a Sullivan Class "WA-6" center crank, straight line steam-driven air compressor. This machine has a 9 x 10-in. single steam cylinder, and an 11 x 10-in. single stage air cylinder.
a capacity of 258 cu.ft. of free air per minute. The air compressor is provided with a governor which automatically slows down the machine to deliver the exact quantity of air needed. The air requirements vary and most of the time the machine is run at moderate speed.
An unloader is provided on the air cylinder which
pletely unloads the compressor when no air is being used and permits the machine to run idle with the consumption of very little steam. Adjustment is provided on the governor which makes it impossible for the compressor to stall when running at minimum speed.
The amount of air required to pump the wells, for the water supply thus far needed, is so small as to be scarcely noticeable in the load carried by the air compressor. Some of the other purposes for which the compressed air supplied by the compressor decribed above is employed include removing inner tubes from the mandrel on which they are made; holding the tires in the metal molds by means of a "bag" filled with compressed air; cleaning the molds by means of sand blasts and a gas flame under air pressure.

A New Pressed Steel Lineshaft Hanger

The accompanying illustration shows a pressed steel hanger for general purpose use, developed by the Dodge Sales & Engineering Co. of Mishawaka, Ind. This hanger is designed to meet the need for a lineshaft



hanger of lightness and strength to serve under conditions not severe or unusual and where first cost is of guiding importance. It is not believed that steel hangers are suitable for every purpose regardless of their construction, but this type seems to be quite practical under conditions which permit its use and where extreme vibration is not a factor.

Recent Chemical & Metallurgical Patents

American Patents

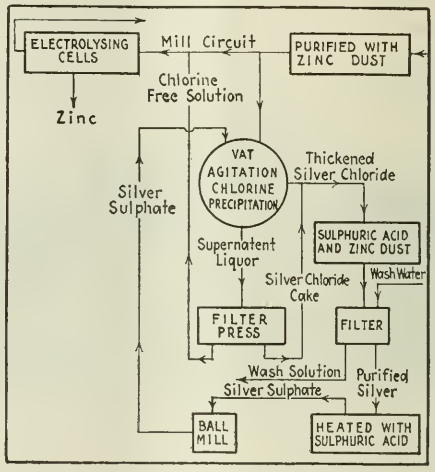
Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Anhydrous Aluminum Chloride.—The specification covers the production of aluminum chloride by suspending aluminum carbide, ground to 200 mesh, in hydrochloric acid gas and passing the mixture into a brick-lined reaction chamber wherein the application of heat brings about the reaction resulting in the formation of aluminum chloride. The reaction chamber is provided with a pair of arc electrodes which supply the heat necessary to start the reaction. The volatile anhydrous aluminum chloride passes into a series of condensers fitted with baffle plates, wherein it is deposited in powdered form. Once the operation is established, the arc is discontinued, the reaction proceeding exothermically. (1,405,183. Louis Burgess, New York, assignor to Standard Oil Co. of New Jersey. Jan. 31, 1922.)

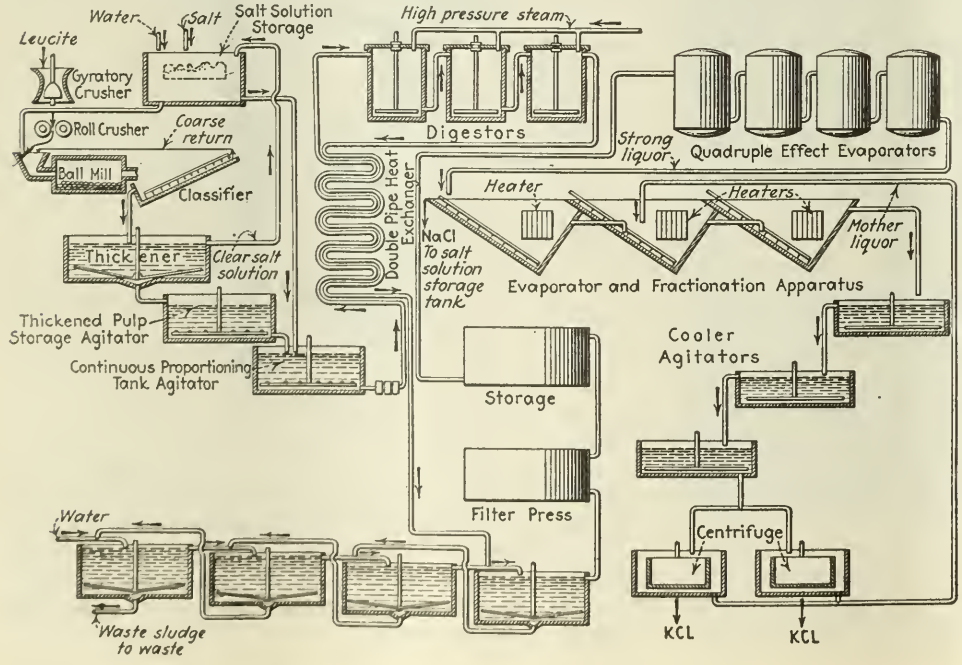
Recovery of Zinc and Copper From Brass Scrap.—Oliver C. Ralston, of Niagara Falls, N. Y., dissolves brass in chlorine water, $CuCl_2$ solution, or HCl and oxygen. If this is properly done, the zinc and copper both enter solution as chlorides. The solution, heated to 100 deg. C. is passed through a ball mill charged with a further amount of brass scrap, whereupon preferential solution occurs, the zinc passing into solution, leaving behind or reprecipitating metallic copper, and reducing soluble cupric chloride to insoluble cuprous chloride. Zinc chloride solutions resulting from this operation may be filtered, purified and electrolyzed for zinc, the chlorine also being recovered for re-use as a solvent. Cuprous chloride may also be converted into various useful salts or metallic copper. (1,402,015; assigned to Hooker Electrochemical Co. Jan. 3, 1922.)

Production of Potassium Chloride.—A continuous wet process for the recovery of potash from leucite (or a similar mineral containing a double silicate of aluminum and potassium) is based on the wet grinding of the mineral in a solution of common salt. After crushing the mineral to a suitable size and grinding it with the salt solution, the sludge is thickened and passed to a storage tank, where it is continually agitated to prevent settling. It is then passed to the proportioning tank, where salt solution is added in excess of that required to substitute the sodium for the potassium in the mineral. Thence the mixture is fed to a group of digestors subjected to high steam pressure and is raised to the temperature and pressure required for completing the chemical reaction. By fractional evaporation or otherwise the solid sodium chloride and solid potassium chloride are removed from the strong liquor, the former being returned for further use in the process, and the latter passed to a series of agitators which it traverses in series. From these coolers the crystallized KCl and mother liquor is run to a centrifuge from which the dried product is ready for shipment. The mother liquor in whole or in part is returned to the evaporating apparatus. The details of the procedure can be more easily understood if reference is made to the accompanying drawing. In this diagram no attempt is made to show the pumps which must be employed at different places in the system.

The inventor claims that 80 to 90 per cent of the potash in the mineral is replaced by the sodium providing proper conditions of concentration, temperature and pressure are maintained. (1,402,973; Mark Shoeld of Chicago, Ill, assignor to Armour Fertilizer Works. Jan. 10, 1922.)



Electrolytic Zinc.—David Avery and R. H. Stevens, of Australia, have patented a method of eliminating chlorine from zinc sulphate electrolytes, believing it the principal cause of disintegration of the lead anodes and aluminum cathodes ordinarily used in the process. (If glue is used in the process, as much as 50 mg. Cl per liter may be tolerated.) Chlorine is kept below the danger point by bleeding a certain quantity of the circulating mill solutions, after they have been purified with zinc dust. It is then made slightly acid with H_2SO_4, and finely powdered Ag_2SO_4 added to reduce (by precipitation of AgCl) the soluble chlorine to 2 or 3 mg. Cl per liter. Agitation for 1 hour is required to complete the reaction, the solution then neutralized and the precipitate coagulated by adding electrolyte. After settling, the clear solution is filtered, treated with a small amount of zinc dust, refiltered, and returned to the circuit. Methods are also outlined for the complete recovery of the silver reagent, as summarized in the diagram printed above, and consisting essentially of reduction by zinc. (1,403,065; assigned to Electrolytic Zinc Co. of Australasia Proprietary, Ltd., Jan. 10, 1922.)



Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Program of American Chemical Society Meeting Announced—Muscle Shoals Trip Canceled

With the appearance of the complete program for the spring meeting of the American Chemical Society at Birmingham, Ala., April 3 to 7 inclusive, preliminary preparations are brought to a point where an interesting session is assured. Monday, the first day of the meeting, will be devoted to a Council meeting and the Councilors' dinner at the Southern Club. Tuesday will be occupied by two general meetings and a smoker in the evening. Wednesday and Thursday will be given over to the meetings of the various divisions, all of which have arranged programs of papers except the Leather and Fertilizer Divisions. Excursions to the steel, acid, cement and other industries in the Birmingham district are planned for Friday.

The proposed side trip to Kingsport, Chattanooga and Muscle Shoals has been abandoned. The running of the special train was contingent upon 125 guaranteed fares, and since the total number of applications received up to March 20 fell short of that number, the project was dropped. As a result there will be no provision made for those attending the meeting to visit Muscle Shoals in a body.

A rate of one and one-half fare for the round trip has been granted, good from all parts of the United States except west of Utah. This reduction is contingent upon the attendance of not less than 350 members. In order to take advantage of this reduced rate, members must obtain certificates at the ticket office where the one-way ticket to Birmingham is purchased.

The general meetings will be held in the Auditorium of the Hotel Tutwiler. The divisional meetings will be held at the Hotel Tutwiler or the Southern Club unless otherwise announced. The final program is as follows:

Monday, April 3

4 p.m.—Council meeting. Southern Club.

6:30 p.m.—Dinner to the Council at the Southern Club.

Tuesday, April 4

10 a.m.—General meeting, Auditorium, Hotel Tutwiler.

Address of welcome, Nathan L. Miller, Lieutenant-Governor of Alabama.

Response, Edgar F. Smith, president, American Chemical Society.

Carlile P. Winslow, director, U. S. Forest Products Laboratory, "The Development of the Forest Products Industry in the South."

William H. Stone, associate editor, *Manufacturers Record*, "The Remarkable Development of the South and Its Relations to the American Chemical Industry."

2 p.m.—General meeting, Auditorium, Hotel Tutwiler.

Theodore Swann, "The Manufacture of Phosphoric Acid in the Electric Furnace by the Condensation and Electrical Precipitation Method."

Van H. Manning, "The Pioneer's Field in Petroleum Research."

Charles L. Reese, "Information Needs in Science and Technology."

W. C. Geer, "Recent Developments of the Chemistry of Rubber."

W. D. Bigelow, "Some Research Problems in the Canning Industry."

Francis P. Venable, "Chemistry in the Old South and the New."

8 p.m.—Smoker as guests of the Alabama Technical Association at the Southern Club.

Wednesday, April 5

9:30 a.m.—Divisional meetings, Tutwiler Hotel and Southern Club (see divisional programs).

2 p.m.—Divisional meetings continued.

8 p.m.—Public meeting, Southern Club ball room. Public address. People of Birmingham, especially ladies, invited. Marston Taylor Bogert, past president, American Chemical Society, "The Flower Fields and the Organic Chemist: Perfumes—Natural and Synthetic."

Thursday, April 6

9:30 a.m.—Divisional meetings, Tutwiler Hotel and Southern Club (see divisional programs).

2 p.m.—Divisional meetings continued.

4 p.m.—Meeting of chairmen and secretaries of local sections, Tutwiler Hotel.

7 p.m.—Banquet, Tutwiler Hotel.

Friday, April 7, and Saturday, April 8

Excursions.—There will be an excursion by special train, on Friday, to the blast furnaces, steel plants, coke ovens, mines, etc., of the Tennessee Coal & Iron Co. A barbecue dinner will be served in Southern style at 1 p.m., at Bayview Mines. The train will traverse the famous Red Mountain, which will afford an inspiring view of the industrial district.

Arrangements have also been made for individual or small party trips on Saturday to the various industrial plants in the city, such as sulphuric acid, fertilizer, slag and portland cement, cottonseed oil and filtration plants, where members may desire to go. Detailed information of this will be supplied at the registration desk. Automobiles will be furnished for this trip.

Divisional Meetings

The following divisions and sections will meet on the days noted:

Division of Agricultural and Food Chemistry, Thursday: 21 papers to be presented.

Division of Physical and Inorganic Chemistry, Wednesday and Thursday: 26 papers to be presented.

Section of Chemical Education, Wednesday and Thursday: 19 papers to be presented and a round table discussion on chemical engineering education.

Section of History of Chemistry, Thursday: 11 papers are to be presented, several of which will be supplemented by exhibits of rare books, autograph letters, documents and apparatus.

Division of Organic Chemistry, Wednesday and Thursday: 34 papers.

Division of Rubber Chemistry, Wednesday: 7 papers.

Division of Industrial and Engineering Chemistry, Wednesday and Thursday: 23 papers. This list includes 8 papers constituting a symposium on distillation.

Section of Cellulose Chemistry, Wednesday and Thursday: 18 papers.

Section of Sugar Chemistry, Wednesday and Thursday: 18 papers.

Division of Dye Chemistry, Thursday: 12 papers.

Division of Biological Chemistry, Thursday: 14 papers.

Section of Petroleum Chemistry, Wednesday: 11 papers.

Division of Water, Sewage and Sanitation, Thursday: 8 papers.

Would Shorten Term of Patent Protection

Under a bill introduced by Senator Ladd, of North Dakota, a patent would expire within 5 years after its issuance unless the patentee exercised the right to make or use the invention or discovery. In event of the assignment of the patent, the patent rights would extend only for 2 years if not worked.

Dye Monopoly Charges Begin to Look Ridiculous as Additional Testimony Refutes King Charges

Senator King of Utah, chief accuser of domestic chemical enterprises before the Senate investigating committee, very evidently is beginning to think better of the industry. That he has been embarrassed in no slight degree by the failure of his informants to justify the charges which he has voiced is very apparent. No one questions that Senator King was thoroughly convinced that all of his charges could be proved. On these fundamentals he built great superstructures, which now appear to be edifices of cards. The Utah Senator cannot hide his chagrin as one by one his charges are controverted to the seeming satisfaction of the investigating committee. Senator King's part was well done, but his mysterious informants—who were so ready to make charges—appear to be unable to substantiate any one of them. This does not mean that Senator King is convinced that the chemical industry has been conducted in an entirely flawless manner, but it is the very general impression that he has revised his opinion of the industry.

One of the outstanding developments of the week was the very convincing showing made before the committee by the Chemical Warfare Service. General Fries was not only able to refute entirely the charges which have been made against his organization, but was able to say some things about the organic chemical industry which carried more weight than if they had come from representatives of the industry.

Not the least interesting high light in the week's hearings was the testimony of H. A. Metz, who attacked the embargo from the standpoint of the importer. Mr. Metz was caustic in his comments as to the criticisms passed upon his actions by Francis P. Garvan and others, accusing him of being a German agent and insinuating that he was party to German propaganda. When Mr. Garvan interjected a remark during his account of his tariff activities, Mr. Metz flashed back, "Don't try and tell me anything about the dye business, Mr. Garvan. I've been in it 40 years and you've been in it 15 minutes."

The testimony of representatives of the manufacturers was concluded on Saturday, March 18. Joseph H. Choate, Jr., counsel for the American Dyes Institute, informed Senator Shortridge at that time that the manufacturers felt they has made their position clear and would rest their case unless it developed that the testimony of Mr. Metz made necessary the recall of some of the witnesses.

Metz Defends His Record

An extended statement in defense of his views in opposition to the embargo on dyestuffs and in reply to charges alleging a persistent effort in the interest of the German dye monopoly on his part was read into the record by Herman A. Metz of New York, importer and manufacturer of dyes and pharmaceutical products. He stated that there was no doubt that Germany had a monopoly on the organic chemical industry before the war, not because she had a monopoly on the raw materials but because of the excellence of the products. When the war broke out in 1914, Mr. Metz said, he realized the serious effect that the German embargo would have on consumers in the United States and he immediately took steps to have the embargo lifted as far as America was concerned, in order that this country might continue to receive the drugs and dyestuffs that it needed. He pointed out that he had used his best efforts to establish the manufacture of salvarsan and novocain in this country and had succeeded in producing products equal in quality to the German. "What possible basis can there be for charging me with having subserved the purposes of Germany when after 1914 I did what I always have done—assisted in the import of dyes and pharmaceuticals from the only country from which they could be obtained?" he asked.

Mr. Metz sketched the history of the importers of dyes in this country from the time when he entered the employ of an importer as office boy, 40 years ago. He touched upon his own political career and his activities as an importer and a manufacturer during the war and his litigation with the Alien Property Custodian.

The witness said that much "pure bunk" had been distributed from the Department of Commerce and other sources concerning the ability of American manufacturers to make dyes and the quality of the dyes. The trouble with the American manufacturers is that the Americans "don't know what their colors will do and the mills don't know what they want."

In reply to questions from Senator Sterling, the witness stated that he did not believe American manufacturers would ever make the high-grade dyes not made here today, because the cost would be out of proportion to the demand for them. The Germans could, he continued, because they once had the world market, but the American market is only 10 per cent of the world market.

Going into the question of salvarsan, Mr. Metz stated that the American-made product was superior to the German, but that some physicians and patients demanded the latter. Much of the German product is now being smuggled in, he told the committee. "That's the basis of my objection to the licensing system," he went on. "A man should be allowed to get what he wants if he is willing to pay for it."

Mr. Metz then went into the story of his troubles with the Alien Property Custodian. He related that Joseph H. Choate, Jr., then connected with the Alien Property Custodian, suggested that he consent to an examination of his property, the expense, to be reasonable, to be paid for by him. The Alien Property Custodian was then seeking to trace German-owned property. He agreed, but the investigation continued 5 months and the cost was $30,000. He felt that this occurrence made "highway robbery an amateur sport by comparison."

Grasselli Company Claims to Be Losing on $4,500,000 Dye Investment

The Grasselli Co. will discontinue the manufacture of dyes unless proper protection is given against foreign competition, according to statements in the testimony of William T. Cashman, vice-president of the company. The Grasselli Co. went into the dye business with much hesitation, Mr. Cashman said, knowing the difficulties ahead of it. The total invested capital of the company is $50,000,000, of which $4,500,000 is invested in the dye business. It has not put any additional capital into the business for the past year or two because of the uncertainty as to whether Congress will support the industry with protective legislation. The witness declared that keen competition exists among American dye producers, citing as examples his company's experience with Wool Green S and nigrosene.

Tariff Not Sufficient Protection

No tariff could be written to cover the American dye and organic chemical industry, testified George H. Whaley, principal owner of John Campbell & Co., New York City; the Amalgamated Dyestuffs & Chemical Works, Newark, N. J., and the Republic Color & Chemical Works, Reading, Pa. Time for research is the chief essential for development of the industry, he continued. "That time we cannot gain unless the Germans are prohibited from shipping into this country dyestuffs made here."

Emphasizes Relation of Industry to Education

Harrison E. Howe, formerly of the National Research Council, stated his belief that all chemical education and research work in the future in American universities, colleges and schools must depend upon the existence and development of a domestic dye and organic chemical industry.

"It would be futile to endow chemical education without the industry," he declared, "for the industry supports education. The industry provides opportunity for necessary research work and also provides careers for the graduate chemists of our institutions."

Dr. Howe told of the purposes of the National Research Council, which dates from the Civil War, explaining that its overhead expenses are paid from the income of a $5,000,000 endowment from the Carnegie Foundation. He said that the first suggestion of an exhibit concerning the dye and organic chemical industry came from Dr. Julius Stieglitz,

a University of Chicago professor without commercial connections with the industry. The Chemical Warfare Service obtained permission to co-operate in the exhibit as a commendable educational step. After some difficulty, he continued, the American Dyes Institute and the Chemical Foundation were persuaded to bear part of the cost. In addition, some contributions were received from individuals in the dye industry.

Value of Industry in Case of War Emergency

The testimony of Dr. Howe in regard to the exhibit was corroborated by Brigadier-General Amos A. Fries, chief of the Chemical Warfare Service, who testified that the exhibits were prepared without having in mind any special group of interests or legislation. At the beginning of the war, he said, America was without an organic chemical industry and consequently without chemical weapons. It was 11 months after the Germans began the use of poison gas before the Allies were able to retaliate but in the mean time there had been 350,000 Allied casualties from poison gas.

In answer to questions from the chairman, General Fries said that neither Francis P. Garvan, president of the Chemical Foundation, or any of its representatives ever sought to influence him to support any particular legislation, but he saw from his own experience in France the need of an organic chemical industry in this country and the need for its protection during development.

Small Manufacturers Add Voice to Denial of Monopoly Charges

Samuel Isermann, president of the Chemical Company of America and secretary-treasurer of Van Dyck & Co., of New York and New Jersey, appeared before the committee as the representative of more than forty small chemical manufacturers throughout the country. Dr. Isermann declared that the charges that had been made against the American industry were made with the idea of discrediting the entire organic chemical industry in the United States.

"We invite cross-examination by Senator King and Senator Moses," he added. "I challenge either of the Senators or anyone else to prove a monopoly exists. It simply cannot be done, and they know it. That is why they are not here. They know they cannot prove their loosely made charges by which they sought to damn this vitally important industry."

Dr. Isermann sketched briefly his own experiences as a manufacturer and his efforts on behalf of the small manufacturer to obtain legislative protection. He also read into the record extracts from a speech made on the floor of the house on July 9, 1921, by Representative Layton of Delaware, a practicing physician. Mr. Layton spoke in advocacy of the chemical schedule, pointing out the importance of the organic chemical industry in the prevention and curing of disease and for purposes of defence in time of war. Dr. Isermann also quoted from a speech made by Herman A. Metz in 1910, in which he showed very clearly that there was no organic chemical industry in the United States at that time. Practically all of the fine chemicals that were produced in this country were made by simple combination of highly refined foreign intermediates or by the purification of imported crude material.

Not the least interesting part of Dr. Isermann's testimony was his specific references to a number of cases where the German producers of fine chemicals and pharmaceuticals were able to charge outrageously high prices for their products until their patents expired or until forced down by boycotts. Ionone, for example, sold as high as $1,100 a pound in 1904, when the witness stated that he undertook the manufacture of the substance on a small scale. He was able to sell it with a profit at $75 a pound. Synthetic musk, which was introduced into the United States in 1899, sold at $1,600 per pound. As the time of expiration of the patent drew near, the price was reduced until it sold at about $20 a pound. Just before the war the price was down to $2. Numerous other specific synthetic preparations were mentioned by the witness in support of his contention that reasonable treatment could not be expected in the future at the hands of the German Cartel.

Industrial Developments of the Week

Glass. — The Wilcox-Durand Co., Newfield, N. J., has resumed operations at its local glass-manufacturing plant, following a period of curtailment. Orders on hand insure production for some time to come.

The Cape May Glass Co., Cape May, N. J., manufacturer of bottles, etc., has resumed production at its plant, following a number of weeks' shut-down. A large force of glass blowers is being employed, and certain departments are on a double shift basis.

Rubber.—The Lee Tire & Rubber Co., Conshohocken, Pa., is operating on a capacity schedule at its local plant, manufacturing about 2,000 tires a day. The new plant addition is also running on the same basis. This is the first time that maximum output at both plants has prevailed.

Oil.—The Producers' Oil & Refining Co. has resumed operations at its refinery at Gainesville, Tex., following a shut-down for about a year. The plant gives employment to about 100 men and has a capacity of 15,000 bbl. daily.

The Corona Petroleum Co. has placed its refinery at Chijol, Vera Cruz, Mexico, in commission. The plant has a daily capacity of 37,000 bbl., and is the largest in the Tampico field.

Iron and Steel.—The Carnegie Steel Co. is arranging for the blowing in of the No. 3 blast furnace at its Isabella Works, Pittsburgh district, Pa. The unit has been down since last May. The company is operating at fourteen of its fifteen furnaces in the Youngstown district, Ohio.

The Bethlehem Steel Co., Bethlehem, Pa., has resumed operations at its Saucon, Pa., plant, after an idleness of a number of weeks.

During the first week in March about 300 men were added to the working forces of the Gary, Ind., steel plants, bringing the quota to about 15,000 men in the different departments, as compared with approximately 12,000 last December. Additions will continue, it is stated, on a basis of from 200 to 300 men weekly.

The Gulf States Steel Co., Birmingham, Ala., is now operating at 100 per cent in the blast-furnace department for the first time in a number of months. The finishing mill at the plant is running on a basis of about 300 carloads during March.

The Woodward Iron Co., Birmingham, Ala., has two blast furnaces in operation at its plant, and is considering the blowing in of a third stack at an early date.

Tin Plate.—The N. & G. Taylor Co., Cumberland, Md., is arranging for the immediate resumption of operations at the bar mill and open-hearth furnaces at its local tin plant. These departments have been closed down for about a year. The mills are now giving employment to about 400 men, and this number will be increased considerably with the resumption.

Coke.—The H. C. Frick Co., Uniontown, Pa., is firing additional ovens at its local plant.

During the week ended March 9 an addition of 640 ovens was added to the active producing list at the coke plants in the Connellsville, Pa., district. Since the first of the year over 2,000 additional ovens have been placed in service.

Miscellaneous.—The Glidden Co., Cleveland, Ohio, manufacturer of paints, varnishes, etc., has adopted an overtime schedule in certain departments at the plant, about two-thirds of the working force operating until 8 o'clock each night. A full working quota is being employed at the plant. The company is operating its lithopone plant at Baltimore, Md., at full capacity, and is said to have sufficient orders on hand to insure this basis for 12 months to come.

The Solvay Co. is operating its chemical plant at Detroit, Mich., at full capacity.

The Tennessee Copper Co., Chattanooga, Tenn., will increase production in its byproduct department, primarily for a greater output of sulphuric acid for a large order received from the Standard Oil Co., to be used in connection with petroleum refining.

The Bethlehem Spark Plug Co., Bethlehem, Pa., will increase production at its plant. The company has taken an order for spark plugs for the Packard Motor Car Co., Detroit, Mich., requiring an output of about 250,000 plugs a year.

Potash Producers Ask Tariff Protection to Give American Industry a Fighting Chance

A number of points of interest in connection with the efforts of chemical industries established in America during the war to obtain adequate protection in the pending tariff legislation are brought out in the petition of forty-five American potash producers recently presented to Congress. The petition is drawn up in the form of a 43-page booklet, profusely illustrated, and presents, in popular style, a review of the development of the local potash industry under the stress of war-time needs. It also calls attention to the large amount of private capital which is tied up in potash enterprises throughout the country and which is yielding no return because the surplus of foreign potash that has been dumped on the market makes operation unprofitable.

The brief opens with a statement of the grievances of the American producers. It is pointed out that the German Government, through the Kali Syndikat, has to all intents and purposes destroyed property owned by American citizens to the extent of about $30,000,000. This attempt on the part of the German monopoly to regain its world-wide control of the potash market was predicted by German agents in 1917 when the basis of an American potash industry was being laid. It is also affirmed that German agents are now conducting an extensive propaganda in this country to mislead Congress and the public about the needs of the American potash industry to the end that it may be denied the protection it seeks from foreign aggression.

The development of local sources of potash on a commercial scale when the annual 200,000 tons which had been imported from Germany was cut off is described in the brief. The increase in production in America from 1,000 tons in 1915 to 54,000 tons in 1918 is traced, and then the decline until 1921 when the American plants were forced to shut down because of the selling at "cut rates" of enormous quantities of potash below the American cost of production. All of them are now shut down, and the carrying charges and the loss of interest are very heavy. The

POTASH WORKS OF TRONA CORPORATION AT SEARLES LAKE, CALIFORNIA

producers find now that they cannot sell a pound of potash on the American market at any price, owing to the terms of the German contracts with the fertilizer manufacturers.

The sources of supply which have been worked commercially are very widespread. Among the more promising may be mentioned the natural brines of the Nebraska lakes, Searles Lake, alunite, silicates and kelp, blast-furnace dust, molasses-distilling waste, cement-mill dust, waste from beet-sugar mills and wood ashes. Of these sources, the first are probably the most promising and represent a capital investment of over $20,000,000. At the end of 1920, the sum of $28,696,143 had been invested in the numerous plants within the United States. Some of these plants represent a cost of from $5,000,000 to $6,000,000, others a few thousands.

The American Trona Corporation, with two large plants at Searles Lake, California, is one of the principal producers of American potash. The Searles Lake deposit has been officially estimated by the U. S. Geological Survey as being sufficient to supply the potash requirements of the United States for at least 100 years to come.

Kali Syndikat Gave Warning

The brief emphasizes the deliberate and confident efforts of the Kali Syndikat to prevent the development of an American industry as follows:

"Paul Freudrichsen, whose official title is propaganda manager for the German Kali Syndikat for the Western

ANOTHER PLANT AT SEARLES LAKE

States and Hawaii, came into the offices of the Trona Corporation at different times during the 3 or 4 months immediately preceding the United States entering the World War, and stated . . . that the stockholders of the American Trona Corporation were foolish and unwise to invest their money in a potash reduction enterprise in the United States, for the reason that the German Kali Syndikat and the Imperial German Government would, after the conclusion of the war, absolutely destroy the American potash industry by marketing the German potash in the United States at such low figures as absolutely to preclude and bar any and all competition; that the German Kali Syndikat and the Imperial German Government absolutely controlled the potash production and market of the world, and pictured in great detail the immensity and strength of the German Kali Syndikat, governmentally controlled, and stated that it was useless and futile for any potash reduction enterprise in the United States to undertake to compete with the German potash, for said syndicate and the Imperial German Government intended to destroy all competition."

Threat Carried Out

"The American middlemen and fertilizer manufacturers who purchase the greater part of the potash used in this country found themselves in 1921 in an intolerable situation. The Germans manipulated the market from day to day and week to week, so that there was no stability in the business, and only one thing was certain—the German potash monopoly was underselling the American producers no matter what price was offered.

"In that situation, with some companies facing failure, owing to heavy inventories, and others fearful of making substantial purchases lest they become overstocked, the German agents approached the middlemen and fertilizer mixers with a proposition that seemed to afford some relief. In brief, they offered to sell the harassed middlemen and fertilizer companies any amount of potash at a fixed price which was very low. Then they went further, and stated they would be prepared to undersell any American producer who attempted to meet this already low figure, provided the Americans would agree to purchase all of their requirements from the Kali Syndikat during the term of the contract.

The contract was closed on Sept. 28, 1921, on the basis of the remainder of the season's supply of potash, with thirty-four American concerns dealing in potash as middlemen and fertilizer manufacturers. It provided that these concerns should purchase at the minimum 75 per cent of their requirements. It was held that it did not give the German syndicate a monopoly, since it allowed 25 per cent of the potash requirements of the trade to be supplied from other sources.

"Soon after the signing of the contract with the German Kali Syndikat, a contract similar in terms in almost every word was executed between the Société Commerciale des Potasses d'Alsace, the French potash syndicate, and the same thirty-four American potash middlemen and fertilizer companies, for 25 per cent of their seasonal requirements.

"Under these contracts, the American potash producers now find themselves completely cut off from their market, because 75 per cent of the potash used in the United States is dumped from Germany and the remaining 25 per cent is dumped from Alsace."

Pending Tariff Schedule

The American potash producers believe that the adoption of the compromise schedule which is now before the Senate will adequately protect the industry. The bill provides for a sliding scale duty on potash imports for 5 years, fixed at 50 cents per unit for 2 years, 40 cents the third year, 30 cents the fourth and 20 cents the fifth year, after which time potash will go on the free list. Domestic producers believe that this protection would assure them a reasonable price for their product and thus enable them to plan and build up quantity production. This not only would enable them to cut production costs by the development of efficient processes, but would also permit of more advantageous shipping arrangements.

The Senate Finance Committee promises to report the tariff bill by April 1. The committee has had the bill since July 21, when it was passed by the House. The unprecedented delay in handling the bill has been occasioned by an avalanche of protests against many of the rates provided in the House bill. The rates themselves would not have called out such a volume of objections, had it not been that they were coupled with American valuation, which would have the effect, many think, of increasing these rates materially. The Senate committee is keeping its own counsel. It does not confirm or deny the many rumors that are afloat as to the action it is said to have taken. It is the policy of the committee not to pass with absolute finality on any provision of the bill until it is placed on the Senate calendar.

Production Costs

The freight rate on potash from the Searles Lake region to the Atlantic seaboard is in the neighborhood of 30 cents per unit. The producers of that district believe, however, that quantity production will enable them to establish a water route through the Canal by which they will be able to lay down potash on the Atlantic seaboard at prices which can meet foreign competition.

It is also put forth that a further development of solar evaporation at the lake deposits will further reduce the cost of potash to the consumer. The present production cost has been estimated at $1.10 per unit. The German price, under the recent contract, is 64 cents. Given the protection afforded by the proposed sliding scale of duty, American producers believe that this price difference can be overcome in the 5-year period so that potash will then be put on the free list without fear of foreign competition.

Norwegian Government Considering Establishment of State-Owned Arc Process Nitrate Plants

M. Hagenmann, formerly engineer at the Norwegian Hydro-Electrical Nitrogen Co.'s works, has placed before the Ministry of Agriculture a proposal for the construction and operation of arc process nitrate plants by the government. It is calculated that niter can be sold for between 23 and 24 kroner per 100 kilos—that is, at about two-thirds of the price of Norwegian niter in December.

Claims That Tariff on Cyanide Would Menace Permanence of Gold Standard

A special plea for duty-free cyanide has been made before the Republican members of the Senate Finance Committee by Senator Oddie of Nevada. He told the committee that it is the duty of Congress to insure free cyanide to the gold producers of this country because of the bearing which the production of new gold has on the whole financial structure. He told the committee that a duty would be in the interests of a German trust and that it would discriminate in favor of German manufacturers as against American manufacturers who had located their plants just across the Canadian frontier, so as to obtain the advantages of waterpower. He also told the committee that a duty on cyanide would preclude absolutely the treatment of millions of tons of tailings. He cited the case of the Goldfield Consolidated Co. as a typical one. If cyanide is on the free list, that company will undertake the recovery of the gold content in 1,500,000 tons of tailings. The margin of profit is so narrow, however, that a duty on cyanide would put a stop to the undertaking and prevent the accretion of this new wealth.

Senator Oddie does not hesitate to criticise the attitude of the Secretary of the Treasury, which, in the opinion of the Senator, he has unconsciously taken against the gold industry. In Senator Oddie's opinion, there is only one way to insure the permanency of the gold standard, and that is to speed up the production of gold decidedly. There is a great shortage of gold in all parts of the world except the United States. Unless we turn loose our gold to meet this shortage, he says, some other standard is going to be set up. Secretary Mellon, Senator Oddie believes, is unconsciously playing into the hands of those who oppose the gold standard. His theory of no encouragement for the gold mining industry, says Senator Oddie, is as dangerous to the financial fabric of the world as are the theories of Lenine and Trotsky to its political structure. The proposal to reduce by one-half the amount of gold in gold coin is a part of this same opposition, Senator Oddie believes.

Prohibition of Oil Discharge Into Streams Issue of Moderated Pollution Bills

A new bill designed to protect shore property, fisheries and bathing from oil and acid pollution has been introduced in Congress by Representative Appleby of New Jersey. It confines the prohibition to the discharge of oil and authorizes the Secretary of Commerce to make investigation as to the effect of pollution of other discharges upon fish, reporting in 2 years with remedial legislation. Previous bills on the subject would have affected mining, coal and chemical industries by the inhibition of pollution of navigable waters.

The new bill prevents oil pollution only, including, however, oil of any kind or in any form, such as fuel oil, oil sludge or oil refuse. Except for smoothing the sea or quelling the force of waves in case of emergency and except as otherwise permitted by regulations of the Secretary of War no person or vessel would be allowed to discharge oil or permit it to run or flow into navigable waters of the United States. The Secretary of War would prescribe regulations for the use, handling and disposition of oil and for equipment of structures and vessels as will prevent oil from being discharged into such navigable waters. As punishment for violation, the offender would be subject to a fine of $2,500 or to 30 days imprisonment, or both, and denial of clearance of vessels from United States ports until the penalty was paid, and in addition revocation or suspension of license of the masters of the vessels. The penalties would not begin until 3 months after the law became effective.

The bill authorizes the Secretary of Commerce to determine what substances if any other than oils are emptied into navigable waters in such manner as to endanger or interfere with navigation, commerce or fisheries, reporting in 2 years with legislative recommendations.

Senator Frelinghuysen of New Jersey has introduced a bill identical with that introduced in the House by Representative Appleby.

Brigadier-General Fries Emphasizes Value of Chemical Warfare Service

The drastic reduction in the appropriation for the Chemical Warfare Service recently prescribed by the House Appropriations Committee has aroused a storm of protest from those who feel that necessary defensive research will be crippled by lack of funds. Although it is generally felt that the agreement of the Arms Conference definitely outlawed the production of poison gases, there is considerable doubt as to what extent a national defense program demands research in order to be on guard against the use of gas by unscrupulous enemies.

Brigadier-General Amos A. Fries, chief of the Chemical Warfare Service, has issued a statement, dated March 21, in which he points out the place filled by the Chemical Warfare Service during the war and outlines the value of such service for the future. Extracts from the statement follow:

Whether or not a service shall be separate under the General Staff depends on whether that service is fundamentally different from all other services. We have a Chemical Warfare Service to handle all general chemical problems just as every great organization today has a chemical, research, development and proving organization distinct from its engineering organizations.

The present work of the Chemical Warfare Service can be largely extended to the benefit of the army and navy. Wherever general chemical investigation or development is needed, whether research, small-scale manufacture or the proving out and testing of chemicals, the Chemical Warfare Service, with its highly trained personnel, its close contact with chemical societies, the chemical business industries and chemical research institutions, can do the work quicker and cheaper than any other agency available to the army or navy. Likewise, whenever information on any chemical subject is needed, the Chemical Warfare Service, through its contact with the above-named agencies and all governmental departments interested in chemistry, can collect the information in the form desired quicker and cheaper than any other agency.

Interpretation of Gas Treaty

The treaty concerning submarines and gases does not pretend in any way whatsoever to abolish the Chemical Warfare Service. It is simply an agreement not to use gas against each other in war. Our allies in the World War—England and France—through their representatives, particularly emphasized this point, thereby making it clear that they expected to go right ahead with full preparations in chemical warfare even to the extent, if necessary, of accumulating supplies of war gases and the shells and other containers in which to use them to meet a possible violation of the treaty by a signatory power or the refusal of some power not to sign the treaty.

Protection against gases in war can be achieved only by the mask and protective clothing. We must have these in perfect shape and ample quantities, based on chemical knowledge that is kept up to the minute. Without them a gas attack means annihilation to an army.

Question of Economy

No economy can be achieved by its combination with any other service. As before stated, chemistry is such a fundamental and far-reaching science that men must give their entire time to it if they are to achieve efficiency. That being true, there could be no efficiency in putting it under another service, because it would not decrease personnel. Indeed, under another service its cost would be greatly increased through loss of the esprit de corps of the workers and the loss of the support of the profession and industries represented in civil life by chemistry.

Functions Other Than Poison Gas Research

The Chemical Warfare Service has from the beginning handled not only research, proving, development and manufacture and supply of war gases, but the research, development, proving, manufacture, filling into containers and supply of all smoke and incendiary materials. Incendiary materials, except as incidental to smoke, are of comparatively little importance. Smoke, however, on account of its extraordinary screening properties, is of vital importance to the army and the navy.

There is one phase of the work of the Chemical Warfare Service not yet touched upon. It is, however, of vital importance. It lies in the twilight zone between the work of the medical department and pure chemistry. It is pathology, or the study of the effects of gases and other chemicals on flesh, whether fowl, beast or man. It is absolutely essential in determining whether a gas is powerful enough for use in war. This study is just as necessary for defense as it is for offense. It is a guide to what the enemy may use. It is used first to determine the toxicity of various chemical compounds, of which there are several hundred known. It becomes the final test in the field as to whether the result achieved in the laboratory can be reproduced practically in war.

Chicago Engineers Told of Research Work on Insulating Materials

Speaking before a joint meeting of the Chicago Section of the American Society of Mechanical Engineers and the Western Society of Engineers March 20, Dr. Edward R. Weidlein outlined the development of the Mellon Institute of Industrial Research. It had been expected that Dr. Weidlein might give some results of the high-temperature insulation work which the Institute is now conducting, but as this subject is to be reserved for the spring meeting of the Mechanical Engineers, consideration of this phase was limited to the general characteristics of 85 per cent magnesia insulation. The accepted figure of loss from bare pipe of 3 B.t.u. per hr. per sq.ft. per degree difference in temperature has been found to be higher as the temperature of the steam is increased and to vary with the diameter of the pipe. With insulated pipe the loss increases slightly with the temperature, but in no such ratio as for bare pipe. Enthusiastic discussion followed on insulation for underground piping, the effect of air velocity over the piping and a variety of subjects.

Memorial Fund to Stimulate Study of Chemistry Planned in Honor of Charles Baskerville

The faculty and students of the College of the City of New York have launched a drive for the collection of funds for a memorial to the late Charles Baskerville. According to present plans the memorial will take one, two or all three of the following forms:

1. The placing of a bronze tablet on the Chemistry Building, which is to be renamed Baskerville Hall.
2. The founding of a fund to provide for a medal to be called the "Charles Baskerville Prize" and to be awarded each year to the student doing the best work in chemistry.
3. The establishment of a scholarship to permit students who qualify to pursue advanced chemistry courses in other technical schools either here or abroad.

Friends of Dr. Baskerville who wish to contribute to this fund should send contributions to Prof. W. L. Prager, Department of Chemistry, College of the City of New York.

Prepares National Pure Paint Bill

Ingredients of all paints and varnishes handled in interstate commerce must be listed on the container, if legislation being drafted by Senator Ladd of North Dakota is written on the statute books. Senator Ladd was influential in obtaining the pure paint law in North Dakota. That law has been in effect for 12 years and according to Senator Ladd has proved to be a boon to the public and to paint manufacturers. He will make national legislation to the same effect one of his principal objectives. He expects to obtain the co-operation of a number of manufacturers of paints and varnishes.

Expect Tariff Bill to Be Reported This Week

While the dye schedule of the tariff bill is still subject to change, the Finance Committee of the Senate is understood to be in practical agreement on a duty of 7 cents a pound and 50 per cent ad valorem on intermediates and 7 cents a pound and 60 per cent ad valorem on finished coal-tar products. It is expected that the tariff bill will be reported to the Senate March 31.

Congressional Committees Considering Muscle Shoals Offers Visit Plants

Three days in actual inspection of the Muscle Shoals, Ala., nitrate plants will be spent by members of the Senate Committee on Agriculture and the House Committee on Military Affairs in their consideration of the various proposals to lease the property. The inspection by the legislators will be divided into a 1-day visit to the Gorgas steam plant on the Warrior River and 2 days at Nitrate Plants No. 1 and No. 2.

The official party left Washington at 10 p.m. March 25 and was scheduled to arrive at Parrish, Ala., in the morning of March 27. Members of the Senate committee who are making the trip are Senators Norris of Nebraska, Heflin of Alabama, Harrison of Mississippi, Kendrick of Wyoming, Ransdell of Louisiana, Smith of South Carolina, Caraway of Arkansas, Ladd of North Dakota and Norbeck of South Dakota. Other Senators accompanying the committee were McKellar of Tennessee, Harreld of Oklahoma, McKinley of Illinois, Stanfield of Oregon and Nicholson of Colorado. Ten members of the House Committee on Military Affairs made the trip. A number of the members of the committee were unable to go on account of other activities and the size of the delegation also was limited by the $2,000 appropriation made to cover its expenses. The House members who made the trip are Hull of Iowa, James of Michigan, Kearns of Ohio, Miller of Washington, Hill of Maryland, Wurzbach of Texas, Quin of Mississippi, Fisher of Tennessee, Wright of Georgia and Stoll of South Carolina. The first day was to be spent in visiting the Gorgas plant. March 28 and 29 were scheduled for the inspection of the nitrate plants, the party returning to Washington March 31.

Senator Lodge of Massachusetts, Senate leader, expressed a desire that the committee defer its investigation of the plants until after the vote on the naval limitation treaty, but the Senate Agricultural Committee decided that as the trip would be short the business of the Senate would not be delayed unduly by the absence of the Senators.

Chemical Industries Protest Revival of Patent Convention of 1909 With Germany

Action by the Senate, authorizing the President to revive the patent convention entered into with Germany in 1909, has raised a storm of protest. As a result it seems probable that the President will withhold the notice reviving that treaty, pending an investigation.

The 1909 patent convention with Germany provides that, in case the United States should amend its patent laws by the insertion of a working clause, this legislation would not apply to patents of German origin. The agreement is reciprocal.

There are certain American industries which are anxious to have this reciprocal safeguard, but the arrangement is regarded as being a very detrimental one to the domestic chemical industry. The situation is made the more serious by the determination of Senator Ladd of North Dakota to push his bill requiring that patents be worked within certain periods or be forfeited. Senator Ladd is convinced that there is a growing sentiment in this country for the addition of a working clause to the patent code.

The Synthetic Organic Chemical Manufacturers' Association has voiced objection to the revival of the convention before adequate provision is made by enactment of legislation that will prevent the same situation developing in the future that faced American organic chemistry prior to the war. The attitude of this association was expressed in a letter written by Charles H. Herty, its president, to Under Secretary of State Fletcher.

The American Institute of Chemical Engineers has also set forth its objections in a memorandum forwarded to Mr. Fletcher by the president of that organization, Henry Howard, of Cleveland, Ohio. In his letter of transmittal Mr. Howard declares that it would be "nothing short of a calamity if the President should cause the patent convention treaty with Germany to be reinstated." Extracts from the memorandum follow:

"It is a known fact that this treaty was conceived and engineered by certain chemical interests of Germany and these same interests in the United States because of their fear that the United States would pass a law providing for some kind of a 'working clause' in its patent system.

"The German chemical interests realized that if they were obliged to work their patents in the United States it would be the beginning of the end of their absolute monopoly in the United States of the synthetic organic chemical industry.

"The willingness of the German Government to enter into such a treaty was from Germany's point of view almost solely to prevent a possible injury to its monopoly in the United States above referred to, and clearly shows the enormous value that those in control of the German Government placed on this monopoly and the sacrifices they were prepared to make to maintain it.

"We maintain that it is improper to allow the monopoly granted by our own patent law to be used either by an American or by an alien to foster the development of a new industry in a foreign country and at the same time to make use of this patent monopoly to prevent such new industry from being developed in the United States."

Technical Societies Interested in Philadelphia Sesquicentennial

A very pronounced feeling exists in engineering circles in Washington that the proposed Engineering Congress to be held in connection with the Philadelphia Sesquicentennial should be promoted in a national and international way, and that this can be done best by the Federated American Engineering Societies. Local promotion of the Congress would be handicapped, it is believed, by the assumption that Philadelphia engineers naturally would be inclined by the incidental benefits to their city to represent such a gathering as certain to be a momentous occasion. If the arrangements were handled by the national machinery which the organizations in many branches of engineering have set up, it is believed a different impression will be created.

At a recent meeting of the Philadelphia Section of the American Chemical Society, a national meeting of the society in Philadelphia during the Sesquicentennial Exposition in 1926 was urged.

Mexican Chamber of Commerce of U. S. Formed

Announcement is made of the organization and incorporation of the Mexican Chamber of Commerce of the United States. The object of the organization is the promotion of business and economic relations between Mexico and the United States and the dissemination of general information of reciprocal interest. The directorate is composed of an equal number of citizens of the two countries. It is said that considerable preparatory work done prior to its organization enables the Chamber to offer immediate service. Offices are established in the Woolworth Building, New York City, and at 45 Bolivar St., Mexico City.

To Explore New Territory for Oil

Arrangements have been made between the Canadian Government and Chester P. Thompson, managing director for the Thompson Oil Syndicate and for the Sanctuary Oil Co., whereby these companies will explore and in the event of discovery develop the Pakow-Ski Bird Reserve for oil and natural gas. The reserve consists of 1,920 acres and is situated in southern Alberta, just north of the international boundary.

Examination Announced for Computer Cyrogenic Lab

The United States Civil Service Commission announces an open competitive examination for computer, cyrogenic laboratory, on April 26, 1922. A vacancy in the Bureau of Mines and positions requiring similar qualifications, at $1,800 to $2,500 a year, will be filled from this examination. Applicants should apply at once for Form 1312 to the Civil Service Commission, Washington, D. C.

Enlarged German Chemical Exposition Scheduled for Hamburg in June

In connection with the general meeting of the Verein Deutscher Chemiker at Hamburg, June 7 to 11, the Fachgruppe für chemischer Apparatewesen of this society will hold its third annual exhibition of chemical apparatus, products and processes. The full title "Ausstellung der Fachgruppe für chemisches Apparatewesen" is shortened to "Achema." At Achema I in Hannover, 1920, 4,000 visited the 75 exhibits, which occupied 3,770 sq.ft. of floor space. In Stuttgart, in 1921, 120 exhibitions used 10,750 sq.ft. and there were 8,100 visitors. The space available for Achema III will be approximately 25,000 sq.ft. It is planned to continue the exhibition for a week after the close of the general meeting of the Verein Deutscher Chemiker. This society is composed largely of industrial chemists, the present membership being over 6,500.

Paper Week in New York

The week of April 10 is designated as paper week in New York, meetings of all the important associations of pulp and paper manufacturers being scheduled for that week. The annual meetings of the American Pulp and Paper Association and the Technical Association of the Pulp and Paper Industries will be held at this time, headquarters to be established in the Hotel Waldorf-Astoria. Monday will be devoted to committee meetings, Tuesday and Wednesday to general meetings and sectional meetings. The majority of the sectional meetings will deal with the technical problems of the industry. The annual banquet will be held Tuesday and the election of officers on Wednesday.

Industrial Films to Be Censored by Experts

A board of censorship for technical and industrial moving pictures has been set up by the Bureau of Mines, in conjunction with the Department of Commerce. T. T. Read is the representative of the Bureau of Mines on the board and Oliver P. Hopkins represents the Department of Commerce. These two members are to select a third member, who is to be a specialist in the activity with which the picture deals. In each instance, at least two additional persons familiar with the subject of the picture are to sit with the committee in an advisory capacity. While only the pictures prepared in the Interior and Commerce Departments will be subject to the board's jurisdiction, it is believed that other departments and outside agencies preparing industrial moving pictures will seek to have films reviewed.

Personal

Edward L. Doheny, president of the Mexican Petroleum Company, New York, has started on an inspection trip of the company's properties in Mexico, accompanied by Edward L. Doheny, Jr., and a number of other officials of the company.

Charles B. Durgin has been granted a 6 months' leave of absence from the U. S. Department of Agriculture and is now doing research work for the Federal Phosphorus Co. of Anniston, Ala.

Dr. Arthur D. Hirschfelder, professor of pharmacology of the University of Minnesota, addressed a recent meeting of the Rochester Section of the American Chemical Society, on "The Chemistry of Drugs."

S. M. Kinter has been appointed manager of the research department of the Westinghouse Electric & Manufacturing Co., succeeding C. E. Skinner. He will be located in the research laboratory building near East Pittsburgh, Pa.

M. M. Marcus, general superintendent of the Rhode Island Malleable Iron Works, Hillsgrove, R. I., spoke before the Providence Engineering Society, March 14, on certified malleable iron castings, describing the modern scientific practice in their manufacture.

George A. Miller, Jr., resigned as chief metallurgist of the Frankford Arsenal, Philadelphia, March 8, after 5 years in charge of the research metallurgical laboratories, to accept a position with the Lakecrest Citrus Products Co., South Lake Weir, Marion County, Fla., as chief chemist and general manager in the manufacture of citrus byproducts, etc.

Dr. R. B. Moore, of the Bureau of Mines, delivered an address entitled "The Rare Gases: Their History, Properties and Uses," before the Chemical Society of Washington, on March 16. The address was illustrated with lantern slides.

G. M. Norman, chemical director of the Hercules Powder Co., Wilmington, Del., becomes technical director, April 1, in charge of both the chemical and engineering departments. W. C. Hunt will become assistant technical director.

L. C. Sadd, of Pittsburgh, Pa., has been elected president of the Pittsburgh Paint, Oil and Varnish Club for the ensuing year. L. C. Stuckrath has been elected vice-president and J. D. Watson treasurer. George F. Smith has been re-elected secretary for the twenty-eighth term.

C. E. Skinner, manager of the research department of the Westinghouse Electric & Manufacturing Co., has been appointed assistant director of engineering in that company. His new duties will cover research, standards and other work along these lines. He will be located in the main engineering offices at East Pittsburgh, Pa.

J. B. Wiesel, formerly in the nitro cotton division of the Wilmington, Del., office of the Hercules Powder Co., has been transferred to the Union Plant at South River, N. J., as superintendent.

Obituary

Philip Argall, mining and metallurgical engineer, of Denver, Col., died in that city on March 19, at the age of 68, after a short illness. Mr. Argall gained prominence in his profession due to his successful treatment of low-grade Cripple Creek gold ores by the process of cyanidation. He had been identified with the mining industry of the Rocky Mountains for many years, having come to the United States from Ireland in 1887. In the course of his professional life Mr. Argall proved himself a worthy pioneer in engineering and technology and a vigorous writer in defense of his ideas. He was a member of the Mining and Metallurgical Society of America, the Colorado Scientific Society, the Institute of Mining and Metallurgy (London) and the Royal Irish Academy.

Henry A. Laughlin, one of the pioneers of the iron and steel industries in the United States, died on March 11 at his home in Chestnut Hill, a suburb of Philadelphia. He was 84 years old, and retired from active business 22 years ago. Mr. Laughlin was chairman of Laughlin & Co., Ltd., until that concern was absorbed by the Jones & Laughlin Steel Co. He was a director in the last named company when he retired in 1900.

Benjamin Magnus, consulting engineer and specialist in electrolytic refining, died at Poughkeepsie, N. Y., on March 12, 1922. Mr. Magnus was born in New York on June 23, 1878, and was educated at Columbia University, where he received the degree of electrical engineer in 1900. He was superintendent for the Anaconda refineries 1900-1903, after which he was for several years in the employ of the Calumet & Hecla Co. of Michigan and the Mountain Copper Co. of California. In 1907 he went to Australia, where he remained until 1916, being successively general manager for the Electrolytic Refining & Smelting Co. and the Mt. Morgan Gold Mines. Returning to New York he engaged in consulting practice until his death. During the war he served as a Captain in the 140th Engineers. He was a member of the American Institute of Mining and Metallurgical Engineers, Mining and Metallurgical Society and the American Electrochemical Society.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Signs of Progress

At least two of the favorable factors commented on in our recent review of February's contribution to fundamental business progress have now been confirmed by the official figures of the United States Bureau of Labor Statistics. We refer to the noticeable increase in the volume of employment that occurred during February and to the distinctly upward trend in wholesale prices. In the case of the latter the pronounced rise in the value of farm products and foodstuffs has done much to correct the maladjustment in the price levels of the principal groups of commodities. The spread between manufactured products and those of agriculture has been a serious deterrent to progress. Now the gap between the products the farmer wishes to sell, such as grains and live stock, and those he wishes to buy, such as farm implements and other manufactures, is apparently being closed in from both directions.

The rapid advances in cotton, wheat, corn, oats, rye, flaxseed, cattle, hogs and sheep caused the bureau's weighted average of 116 in January to rise to 126 in February, an increase of over 8½ per cent. Metal and metal products, on the other hand, decreased approximately 1¾ per cent in February and housefurnishings one-half of 1 per cent. Furthermore, clothing, fuel and lighting, building materials, and chemicals and drugs show no change in price levels.

The general index for all commodities, which is based on a series of 327 articles, increased from 148 to 151. The index numbers for the individual groups are as follows:

INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES (1913 = 100)

	1921, February	1922, January	1922, February
Farm products	129	116	126
Food, etc.	150	134	138
Cloths and clothing	198	183	183
Fuel and lighting	218	183	183
Metals and metal products	146	117	115
Building materials	221	202	202
Chemicals and drugs	178	159	159
Housefurnishing goods	277	214	213
Miscellaneous	180	146	150
All commodities	167	148	150

Comparing February's prices with those of a year ago, it will be seen that the general level has declined approximately 9½ per cent during this period. Metals have shown a decrease in average price, as measured by these index numbers, of 21 per cent, chemicals and drugs 10½ per cent and building materials 8½ per cent.

Changes in Employment and Wage Rates

Tabulations from representative establishments in thirteen manufacturing industries and in the bituminous coal mining show that there was a striking increase in the volume of employment during February. The figures show that in ten of these industries there were increases in the number of persons on the payroll in February as compared with January and in only four were there decreases. The largest increase, 9.3 per cent, was in the iron and steel industry, where the survey included 108 establishments. Fifty-seven paper mills reported an increase of 1.4 per cent in the number on their payrolls in February as compared with January. In thirty-seven leather plants the increase in employment was 1.8 per cent.

Wage changes in some of the chemically controlled industries are reported in the following paragraphs.

Leather.—A decrease of 12 per cent, affecting 87 per cent of the force, was reported by one tannery. About 35 per cent of the men in one establishment were reduced 10 per cent in wages, while 75 per cent of the men in another establishment had a wage rate decrease of approximately 8 per cent. An increase of 2.7 per cent in per capita earnings appeared when January and February figures were compared.

Iron and Steel.—All employees in one mill were reduced 25 per cent in wages, while in two other mills the reduction to all employees amounted to 15 per cent. A decrease in wage rates of 13 per cent was made to 65 per cent of the men in one establishment. Four establishments reported a wage reduction of 10 per cent, affecting approximately 50 per cent of the force; while in four other establishments one-half of the employees were reduced 4½ per cent in wages. A wage cut of 8 per cent, affecting 50 per cent of the force, was reported by one concern. Another concern reduced the wages of 18 per cent of the employees about 3 per cent. Increased force and amount of time worked were reported for this industry. An increase of 5.9 per cent in per capita earnings was shown when January and February payrolls were compared.

Paper Making.—In three mills a decrease of 10 per cent in wages was made, affecting the entire force in one mill, 95 per cent of the force in the second and 36 per cent of the force in the third. One-tenth of the men in one establishment were cut 6¼ per cent in wages. Business conditions remained much the same for this month and the per capita earnings show no change when compared with the past month.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.65
Last week	157.49
March, 1921	157
March, 1920	252
April, 1918 (high)	286
April, 1921 (low)	140

The index number again remains practically unchanged and continues at the higher level reached early in the current month. During the past week eight of twenty-five commodities included in this compilation changed in price. Prices for five of them—citric acid, ammonium sulphate, barium chloride, caustic potash and potassium carbonate—increased and three—formaldehyde, bleaching powder and linseed oil—were selling at lower prices.

Raising Output and Reducing Costs

A number of manufacturers in their efforts to reduce production costs have turned their attention to their personnel departments, where by improving industrial relations they hope to eliminate lost motion and to obtain greater efficiency from the individual workers. The policies pursued by the American Smelting and Refining Co. are illustrative of this principle. According to a recent report, a "job analysis" covering every operation was made in one of the company's larger plants so that each employee could fully understand his function in the operation, his efficiency, the purpose, limitations and the possibilities of his position, as well as the character and necessity of the work leading up to his activity. In other words, he was acquainted with the scope and meaning of every step in the production of the company's product.

Classes were formed in executive and administrative work, in foremen's general training, and in vocational instruction. The company reports that "out of this industrial training has grown a better and closer supervision by plant executives, so that the working force on each operation has been reduced to a minimum never before

reached and a much greater production per man has been obtained."

A few figures taken from operating records at some of the company's plants during 1921 will illustrate this increase in efficiency:

Plants	Operation	Tons Per Man—Per 8-Hour Day Average 1914	Tons Per Man—Per 8-Hour Day Average Oct., 1921
Durango	Crushing	31.8	52.2
Murray	Unloading	9.2	25.3
Arkansas Valley	Roasting	6.4	13.6
El Paso	Bricking	2.0	4.4

The effect of these managerial policies on labor costs is summarized in the statement:

"In 1914, repair, supply and construction labor was paid an average of $2.42 for an 8-hour day, while in November, 1920, the rate was $5.39, an increase of 123 per cent. In December, 1921, through various readjustments, the rates for repair, supply and construction labor had been reduced to $4 for an 8-hour day. This was a decrease of 25.9 per cent below the highest rate, $5.39, paid in November, 1920."

Another saving has resulted from the installation of efficient mechanical equipment in all places where it was certain that it would reduce labor-hours per ton. This has been an important factor in lowering costs due to savings both in time and material.

Twenty-Two New Chemical Companies Organized in February

According to the compilations of the *Journal of Commerce*, twenty-two companies were organized in February for the manufacture and distribution of chemicals, drugs and dyes. The indicated investments totaled $5,200,000. In January, 1922, there were thirty-two new companies, with an aggregate investment of $37,650,000.

In the month of February a year ago the total capitalization of new organizations in the drug and chemical fields reached $12,585,000. Sixty-five new companies, each with a capitalization of $50,000 or more, were also organized in February, 1922, to engage in the petroleum industry. This compares with ninety-two such companies in January. The gross capitalization of the first noted reached $100,173,000, as against $100,250,000 in the preceding month.

The following table shows the new capital in drug and chemical concerns since August, 1914:

Five months of 1914	$16,838,000	1918	$73,403,000
1915	65,565,000	1919	112,173,000
1916	99,244,000	1920	487,148,000
1917	146,160,000	1921	108,410,900

Market and Financial Notes

German Potash Prices Are Advanced.—A dispatch from Berlin on March 21 states that an increase of 21 per cent in the market prices of potash salts had been granted the Kali Syndikat by the Imperial Potash Council. The producers, who submitted their petition to the government on March 15, declared that the higher prices were necessary because of further increases in the wages paid in the mines and to a recent advance in the freight rates on potash salts.

American Linseed Co.—The 1921 report of this company showed an operating loss of $1,043,132, as compared with a profit of $6,238,597 for the 15 months ended Dec. 31, 1920.

U. S. Cast Iron Pipe & Foundry Co.—This company had a net profit of $100,841 for the year ended Dec. 31, 1921, according to its recent report. Approximately $432,000 was charged off for depreciation.

Mathieson Alkali Shows Deficit.—The Mathieson Alkali Works, Inc., reported a net loss of $149,635 in 1921, as compared with a net profit of $524,874 in 1920. The profit and loss surplus on Dec. 31, 1921, was $1,479,932 and on the corresponding date in 1920, $1,684,347.

Freeport Sulphur Co. and the Texas Co. Agreement.—In the annual report of the Freeport Texas Co. for the year 1921, President E. P. Swenson states that the subsidiary, the Freeport Sulphur Co., has entered into a contract with the Texas Co. for taking over the latter's sulphur deposits in Hoskins Mound, Brazoria County, Texas. It is understood that the arrangement is on a contingent royalty basis.

The New York Market

NEW YORK, March 27, 1922.

The chemical market during the past week showed pronounced signs of expansion and business in the aggregate was much better, although there still remain some traces of small-scale operations. There have been instances of both shading and advancing prices on various commodities according to the demand. In the first-hand market March sales have probably not been quite up to the standard established during February. This condition is accounted for by the fact that for a number of reasons the large consumers greatly increased their February allotments. The resale market, however, has not had any setback so far this month and in many cases jobbers have completely withdrawn from trading circles in order to await higher prices.

General Chemicals

Caustic Potash.—Supplies of spot material have noticeably diminished on the 88-92 per cent imported grade, with buyers showing a little more interest in covering requirements. Small sales were reported at 6c. per pound early in the week, but later quotations were around 6¼c. Stronger conditions in this commodity abroad have also had a better influence on spot values.

Carbonate of Potash.—A reduction in offerings and an improved demand are directly responsible for the sharp advance in this commodity. The 80-85 per cent calcined was advanced to 4½c. per pound.

Bleaching Powder. — Prices on domestic material are a trifle lower. Leading sellers offer large drums at $1.70 per 100 lb., f.o.b. works, and report sales at this figure. The range is up to 2c. per pound. Imported goods are quoted at $1.85 per 100 lb. The demand has slackened off considerably.

Barium Chloride.—Prices have advanced sharply and the market is in a very firm condition. Goods afloat sold at $75 per ton. Spot material was held at $80@$85 per ton according to seller and quality. The demand was very brisk.

Caustic Soda.—Dealers report March material exceedingly firm for export and quote prices around $3.70 per 100 lb. Some sellers have booked goods far into June and state that their output for earlier months is entirely sold. Producers have not altered quotations and ask 2½c. per pound, basis 60 per cent, f.o.b. works, in carload lots.

Citric Acid.—The market showed a much firmer tendency and while the demand as yet is not especially active, spot prices have been pushed ahead by prominent sellers of imported goods. The closing price on spot was 46c. per pound. Shipments were quoted at 45c., c.i.f.

Formaldehyde.—Some manufacturers have reduced prices to 8½c. per pound, f.o.b. works, with the general quotation at 8½@9½c. per pound, depending on quantity. Competition is responsible for the present low price, which is recorded as the lowest since July, 1915.

Prussiate of Soda.—The consuming demand has fallen off considerably and the change in the market has resulted in a decided reduction in quotations. Prices as low as 17¼c. per pound were heard with the range from 17¼@17½c.

Oxalic Acid.—Continuous competition among first hands has resulted in lower prices on spot and at the works. The best price heard was 11½c. per pound. The general quotation was from 11½@12½c. per pound, depending on quantity and brand.

Sal Ammoniac.—Shipments of this material from abroad are much firmer and the market is quoted at 6¾c. per pound, c.i.f. New York. Spot prices are higher with sellers asking 7¼c. per pound for the white and gray goods.

Sulphate of Ammonia.—This material continues to be in extremely limited supply and the few who can offer goods for immediate shipment are asking 3½c. per pound.

Sulphide of Soda.—There has been a decided improvement in this material, with several sellers refusing to shade 4½c. per pound, for the fused 60-62 per cent on spot. Goods afloat were quoted at 4¼@4¼c. per pound. Domestic material was held firm at 5¼c. per pound.

Coal-Tar Products

Benzene.—Producers of this material have found a ready market since the beginning of the year and prices have been

firmly maintained on both grades. Spot goods are exceedingly scarce and regular contract shipments are still uncertain for any definite deliveries. The 90 per cent is quoted at 27@32c. per gallon and the pure water white is being held at 29@35c. per gallon. Resale material on spot is nominal at 40c. per gallon for the 90 per cent.

Solvent Naphtha.—Sales of crude are reported by producers on the basis of 22c. per gallon, while small lots have brought as high as 27c. Pure water white is moving on contract at 25@28c. per gallon. Crude heavy is held at 10@14c. per gallon.

Anthracene.—Producers report a fair inquiry for the different grades and are booking shipments at 75c. per pound for the 80-85 per cent test and at 15c. per pound for the 40-45 per cent. The low-grade 20-25 per cent material is moving on the basis of 11c. per pound.

The Chicago Market

CHICAGO, ILL., March 23, 1922.

Better conditions were to be noted in the industrial chemical market during the past week. Buyers, while still inclined to shop around considerably before placing an order, are taking on supplies in a somewhat larger volume. Prices with a few exceptions are very firm and spot stocks are only moderate. It is evident that the tendency of the market is toward higher prices, but no radical revision upward is expected in any quarter.

General Chemicals

Caustic soda, while firm, lacks quotable change, and supplies are reported to be only moderate. Solid 76 per cent is priced at $3.75 per 100 lb. and the ground at $4.50. *Caustic potash* continues in a very firm position, with small supplies offered at 6½c. per lb. delivered. *Soda ash* is moving in a routine way at $2.30 per 100 lb. for 58 per cent material in cooperage.

Alum is showing a slightly firmer tendency and is quoted at 5@6c. per lb. for lumps and 6@6½c. for powdered. *Bleach* is in fair demand and can be had in single drum lots at 3c. per lb. *White arsenic* continues firm, with small parcels quoted at 8½@9c. per lb. *Copper sulphate* is said to be moving fairly well, with $5.90 per 100 lb. the best figure noted for small lots. *Copperas* is in some demand and is available in single-barrel lots at $1.75 per 100 lb. *Carbon bisulphide* is unchanged at 6¾@7c. per lb. in single-drum lots. *Carbon tetrachloride* is in somewhat better demand at 10½@11c. per lb. *Formaldehyde* is said to be moving well, but due to the unstable condition of the methanol market the price is easy at 9½@10c. per lb. *Glycerine* is showing no improvement and c.p. material in drums is quoted by refiners at 16c. per lb.

The *bichromates* are in routine demand and lack quotable change at 11¾c. per lb. for the potash and 9@9½c. for the sodium. *Potassium permanganate* is steady at 17c. per lb. for the U.S.P. crystals and is reported to be moving fairly well in small parcels. There are as yet no supplies of *red prussiate of potash* on the market and as far as could be determined nothing for near future delivery. *Yellow prussiate of potash* is very firm, with only moderate supplies available at 28@30c. per lb. *Sodium bicarbonate* continues to move in the regular consuming channels at $2.30@$2.40 per 100 lb. *Sodium fluoride* has shown a better demand of late and is moving fairly well at 10½@11c. per lb. *Hyposulphite of soda* is being bought by the photographic trade in a better volume and pea crystals are quoted by manufacturers at $3.25 per 100 lb. for barrels.

Linseed Oil

Linseed oil was reported by a prominent factor to be moving in a very satisfactory volume. For the past week the tendency on this material has been down, but this has had little effect on the movement. Boiled oil was quoted today at 84c. per gal. in 5-drum lots and the raw oil in similar quantities at 82c.

Naval Stores

Turpentine is enjoying a very good demand and the market is firm. Today's price for 5-drum lots was 87c. per gal. *Rosin* is moving freely and with supplies heavy the competition is very keen. The WG grade was quoted today in carlots at $6.85 per 280 lb.

The Iron and Steel Market

PITTSBURGH, March 24, 1922.

The disparity in views in different quarters as to the nearby future of the steel market is much more pronounced. The divergence of opinion is so wide that a clarification within a few weeks is practically certain. In some quarters it is predicted positively that demand for steel will continue to increase in marked fashion, say to the extent that by June 1 production will be at 25 per cent greater rate than at present. In other quarters it is asserted that the call upon the mills for steel lately has been greatly in excess of the consumption, it being insisted that if the country were consuming steel at the producing rate the general appearance of industry would be quite different from that actually presented.

Those who maintain that demand will continue to increase argue that the material recently bought has been urgently needed or the buyers would not have insisted upon quick shipment as they did, that the season of the year promises an increase in consumption and that the railroads are buying more and more freely.

Those who maintain that the demand is already above a natural relation with the state of business generally suggest that buyers have simply been partly restoring their extremely depleted stocks, and probably have anticipated some of their requirements, in fear that the coal strike April 1 would interfere with production and shipments of steel.

A few weeks will stop this debate, for one party or the other will be forced to see its error. The respective sets of premises on which they argue cannot stand side by side for any length of time.

Production of steel ingots is running along at between 29,000,000 and 30,000,000 tons a year, showing but a slight increase in the past 3 or 4 weeks. Some companies are preparing to increase operations, however.

Prices

Whatever may be theory, as to commodities being marked for intermittent price declines for several years, or as to steel prices being below cost of production, the plain market fact is that in no branch of the finished steel market has there been any decline for 2 or 3 weeks past, while in some respects there has been a stiffening. The price decline may be resumed any number of times in the future, but the present fact is that the long decline, which really dates back to the latter part of 1920, stopped a fortnight or more ago. Bars, shapes and plates are firm at a minimum of 1.40c., and some business has been booked in the past few days at 1.45c. and 1.50c. while recently there was not a little business done at well under 1.40c. Several mills have formally announced that a 1.50c. minimum is their objective. Nails have been quite steady at $2.40 in recent weeks, while formerly this price was shaded somewhat. In sheets it looks as if there might be an advance from the prices ruling for over 3 months, but only after customers were given an opportunity to place orders at current prices. One independent mill has announced an advance of $3 a ton, from 3c. for black, 4c. for galvanized and 4.35c. for automobile sheets, to become effective April 1. In pipe the shading does not seem to be any greater than in the past.

By fairly heavy absorption of spot and prompt furnace coke last week the price of $3.25 has disappeared in the Connellsville trade, leaving $3.50 as the market, but demand has been light this week and additional ovens are going in. Foundry coke remains at $4.25@$4.75. Demand for Connellsville coal has become light and prices are lower. A decline in the market for Pittsburgh (union-mined) coal is also seen. There is no diminution in the prospect as to the suspension at the union mines April 1, and the market development therefore indicates that consumers generally were forehanded in laying in stocks, so as to avoid a possible rush in the last 2 or 3 weeks of March. Accordingly there is the reverse of a rush.

Pig iron remains quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, f.o.b. valley furnaces, with $1.96 freight to Pittsburgh. Demand is very light, although perhaps improving a trifle, and prices seem to be quite firmly held.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.40 – $0.42
Acetone	lb.	$0 11½ – $0 12	.12¼ – .12½
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2.65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5.30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9 00 – 9.50	9 75 – 10 00
Boric, crystals	lb.	.11 – .11¼	.11½ – .12
Boric, powder	lb.	.11¼ – .11⅓	.11¾ – 12½
Citric	lb.	—	.46 – .46½
Hydrochloric	100 lb.	1 15 – 1.25	1 30 – 1 75
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11 – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10¼ – .12
Lactic, 22 per cent tech	lb.	.04 – .04¼	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg.	lb.	.06¼ – .06½	.06¾ – .07
Nitric, 42 deg.	lb.	.06¾ – .07	.07¼ – .07½
Oxalic, crystals	lb.	.11⅓ – 12	.12½ – .13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08¾ – .09½
Picric	lb.	.20 – 25	.27 – .35
Pyrogallic, resublimed	lb.	—	1.65 – 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	—
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	—
Sulphuric, 66 deg., tank cars	ton	16 00 – 16 50	—
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32 00	33.00 – 34 00
Tannic, U. S. P.	lb.	—	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	—	.26½ – .28
Tartaric acid, imported, powdered	lb.	—	.27½ – .30
Tartaric acid, domestic	lb.	—	— .30
Tungstic, per lb. of WO	lb.	—	1.00 – 1.10
Alcohol, ethyl	gal.	—	4 75 – 5 50
Alcohol, methyl (see methanol)		—	—
Alcohol, denatured, 188 proof No. 1	gal.	—	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	—	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½ – .04	.04¾ – .05
Alum, chrome lump	lb.	.07½ – 08	.08¼ – .08½
Aluminum sulphate, commercial	100 lb.	1 65 – 1.85	1 90 – 2 40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07¼ – .07¾
Amylacetate tech	gal.	—	2 00 – 2 40
Arsenic, white, powdered	lb.	.07½ – .07½	.07¾ – 08
Arsenic, red, powdered	lb.	12 – 12½	12½ – 13
Barium chloride	ton	80 00 – 85 00	86 00 – 90 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21¼ – .22
Barium nitrate	lb.	.06½ – 07	.07¼ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03½ – 04	.04¼ – 04½
Blanc fixe, dry	lb.	.04 – .04½	—
Blanc fixe, pulp	ton	45 00 – 55.00	—
Bleaching powder	100 lb.	1 70 – 1.95	2 00 – 3 00
Blue vitriol (see copper sulphate)		—	—
Borax	lb.	.05¼ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1 75 – 2 00	—
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01⅔ – .02	.02¼ – .02½
Calcium peroxide	lb.	—	1.40 – 1.50
Calcium phosphate, tribasic	lb.	—	.15 – .16
Camphor	lb.	—	.89 – .91
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07¼
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	—	.60 – .75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chalk, precip.—domestic, light	lb.	.04¼ – .04½	—
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	—
Chalk, precip.—imported, light	lb.	.04½ – .05	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	—	.37 – 40
Cobalt oxide	lb.	—	2 00 – 2 10
Copperas	ton	15.00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	.19 – 20	.20¼ – 21
Copper cyanide	lb.	—	.58 – 60
Copper sulphate, crystals	100 lb.	5.55 – 5 65	5 70 – 6 25
Cream of tartar	lb.	—	.23½ – 25
Epsom salt (see magnesium sulphate)		—	—
Ethyl acetate com. 85%	gal.	—	.60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	—	.93 – 1 00
Formaldehyde, 40 per cent	lb.	.08½ – .09	.09¼ – 10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	—
Fullers earth—imported powdered—net	ton	30 00 – 32 00	—
Fusel oil, ref.	gal.	—	2 50 – 3 00
Fusel oil, crude	gal.	—	1 40 – 1 75
Glauber's salt (see sodium sulphate)		—	—
Glycerine, c. p. drums extra	lb.	—	.16 – .17
Iodine, resublimed	lb.	—	4 05 – 4 15
Iron oxide, red	lb.	—	.12 – 18
Lead acetate	lb.	—	.09 – 11½
Lead arsenate, powd.	lb.	.15 – 15½	15½ – 16½
Lead nitrate	lb.	—	.15 – 20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – 08
Magnesium sulphate, U. S. P.	100 lb.	2 60 – 2 65	2 70 – 3 00
Magnesium sulphate, technical	100 lb.	—	1.00 – 1 80
Methanol, 95%	gal.	—	.57 – 58
Methanol, 97%	gal.	—	.59 – 60
Nickel salt, double	lb.	—	.11 – 11½
Nickel salt, single	lb.	—	.11 – 11½
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	—	.30 – .35
Potassium bichromate	lb.	.10½ – .10¼	.10½ – 10¾
Potassium bromide, granular	lb.	—	.20 – .25
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.05¾ – .06	.06½ – .08
Potassium cyanide	lb.	—	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6.25 – 6.40	6.45 – 7.00
Potassium iodide	lb.	—	3.10 – 3.15
Potassium nitrate	lb.	.07⅞ – .07½	.08 – .09
Potassium permanganate	lb.	.16 – .17	.17½ – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	26 – .26½	.26¾ – .27
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac, white, granular	lb.	.07¼ – .07½	.07¾ – .08
Salammoniac, gray, granular	lb.	.07¼ – .07½	.07¾ – .08
Salsoda	100 lb.	1.60 – 1.70	1.75 – 2.00
Salt cake (bulk)	ton	17.00 –20.00	—
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04¼ – .04½	.04¾ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .08	.08¼ – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5 50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12 00 –13 00	—
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.75	3.80 – 4.30
Sodium hyposulphite	lb.	.03½ – .03½	.03¾ – .04
Sodium nitrite	lb.	.08½ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	—	.18 – .21
Sodium prussiate, yellow	lb.	.17½ – .17½	.17¾ – .18
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.50 – 2.60	2.65 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.10	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04⅜ – .04½	.04¾ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 –20.00	—
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	—	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	—	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	—
Talc—domestic powdered	ton	18 00 –25 00	—
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	—	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14⅔ – .15½
Zinc chloride, gran.	lb.	.05¼ – .06	.06¼ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97 %, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.27 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.15 — 1.20
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	.11½ —	15
Pyridine	gal.	1.75 —	2 75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1 80
Salicylic acid, tech., in bbls.	lb.	.20 —	21
Salicylic acid, U. S. P.	lb.	.22 —	23
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 —	12
Sulphanilic acid, crude	lb.	.25 —	27
Toluidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.32 —	.38
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.25 —	.28
Beeswax, refined, light	lb.	.30 —	.32
Beeswax, white pure	lb.	.35 —	.40
Candellila, wax	lb.	.25 —	.26
Carnauba, No. 1	lb.	.45 —	.46
Carnauba No. 2, North Country	lb.	.24½ —	.25
Carnauba, No. 3, North Country	lb.	.15½ —	.16
Japan	lb.	.17½ —	.18
Montan, crude	lb.	.04½ —	.04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04⅜ —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02⅞ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03⅛
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04⅛
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.04⅝
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05¼
Stearic acid, single pressed	lb.	.08¾ —	.09
Stearic acid, double pressed	lb.	.09¼ —	.09½
Stearic acid, triple pressed	lb.	.10¼ —	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.15 —	5 20
Rosin E-I	280 lb.	5.25 —	5.30
Rosin K-N	280 lb.	5.90 —	6.65
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.87 —	....
Wood turpentine, steam dist.	gal.	.84 —	....
Wood turpentine, dest. dist.	gal.	.68 —	.70
Pine tar pitch, bbl.	200 lb.	.... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	9.50
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Sulphate of Ammonia—f.a.s. N. Y.,—100 lb.—$3.50
All other prices remain quotably unchanged

Crude Rubber

Prices remain same as previous report.

Oils

VEGETABLE

The following prices are f.o.b. New York tor carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10 —	$0.10¼
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls	lb.	.14½ —	.14¾
Coconut oil, Ceylon grade, in bbls	lb.	.09 —	.09¼
Coconut oil, Cochin grade, in bbls.	lb.	.09½ —	.10
Corn oil, crude, in bbls	lb.	.11½ —	.11⅝
Cottonseed oil, crude (f. o. b. mill)	lb.	.10 —	10⅛
Cottonseed oil, summer yellow	lb.	.11¾ —	.12
Cottonseed oil, winter yellow	lb.	.13¼ —	.13½
Linseed oil, raw, car lots (domestic)	gal.	.79 —	.80
Linseed oil, raw, tank cars (domestic)	gal.	.75 —	.76
Linseed oil, in 5-bbl lots (domestic)	gal.	.82 —	.83
Olive oil, denatured	gal.	1.12 —	1.15
Palm, Lagos	lb.	.08 —	.08¼
Palm, Niger	lb.	.06¾ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.85 —	.86
Rapeseed oil, blown, in bbls	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11 —	..
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¼ —	..

FISH

Light pressed menhaden	gal.	$0.54 —	..
Yellow bleached menhaden	gal.	.57 —	..
White bleached menhaden	gal.	.56 —	..
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Shellac, orange fine	lb.	.87 —	.88
Shellac, orange superfine	lb.	.90 —	.91
Shellac, A. C. garnet	lb.	.72 —	.73
Shellac, T. N.	lb.	.85 —	.86

All other prices remain unchanged.

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130 00
Carborundum refractory brick, 9-in.	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b., Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	53–55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30

Ferro-Alloys

Quotations remain same as previous report

Ores and Semi-finished Products

Prices same as March 22nd report

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent.	19.00
Antimony, wholesale lots, Chinese and Japanese	4 25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35 00
Monel metal, ingots	38.00
Monel metal, sheet bars	40 00
Tin, 5-ton lots, Straits	29.25
Lead, New York, spot	4.70–4 75
Lead, E. St. Louis, spot	4.40–4.45
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.675–4.70

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90 00
Iridium	oz.	170.00@190.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19 25
Copper bottoms	27 75
Copper rods	19.25
High brass wire	16 75
High brass rods	14 25
Low brass wire	18 25
Low brass rods	18 75
Brazed brass tubing	23 00
Brazed bronze tubing	28 00
Seamless copper tubing	20 75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10 50
Copper, heavy and wire	10 00@10.25
Copper, light and bottoms	7 75@8.25
Lead, heavy	3 60@3 85
Lead, tea	3 00@3 25
Brass, heavy	4 50@4 75
Brass, light	4 00@4 25
No. 1 yellow brass turnings	4.00@4 25
Zinc	2.25@2 50

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The E. J. Owen Co., 6th St., has preliminary plans under way for the erection of a new foundry for the manufacture of iron and other metal castings.

Arkansas

FORT SMITH—The Fort Smith Glass Products Co., recently organized, is arranging for the establishment of a local plant for the manufacture of bottles and other glass products, with initial output of about 40,000 bottles per day. C. M. Penn is president, and L. E. Duckworth, secretary and treasurer.

California

NATIONAL CITY—The Jet Oil Co., has acquired a local site for the erection of a new plant for the production of lubricating oils. The first unit is estimated to cost about $55,000. Plans will be prepared at an early date.

TEHACHAPI—The Henry Cowell Lime & Cement Co., 2 Market St., San Francisco, has acquired a tract of property in the vicinity of Tehachapi, and plans for the erection of a new cement-manufacturing plant and lime works. The plant will consist of a number of buildings, and is estimated to cost in excess of $750,000.

Connecticut

STAMFORD—The Stamford Foundry Co., Canal St., has had plans prepared for the construction of an addition to its plant, with improvements in the present foundry. Emmens & Abbott, Stamford, are architects.

TORRINGTON—The Anaconda Copper Co., 25 Broadway, New York, N. Y., has tentative plans under consideration for the erection of an addition to the plant of the American Brass Co., a subsidiary, at Torrington, to be equipped as a rolling mill.

Georgia

LUDOWICI—The McDonald Brick Co., operated by C. J. McDonald & Sons, is planning for enlargements in the local plant of the Ludowici Brick & Tile Co., recently acquired. The capacity will be increased to about 60,000 bricks daily. A number of improvements will be made also in the existing works.

Illinois

MATTESON — The new chemical plant to be erected here will be owned and operated by the K. I. Herman Chemical Corp., 332 South Michigan Ave., Chicago, and not by the Mid-West Box Co., Chicago, as recently noted in these columns. K. I. Herman, president of the chemical company, has been secretary and general manager of the Mid-West company, recently organizing the company bearing his name with a capital of $300,000, under Illinois laws. The plant will be 3-story, 60 x 140 ft. Harvey C. Miller, 112 West Adams St., Chicago, is architect.

CHICAGO—Fire, March 9, destroyed the north section of the plant of the Elaborated Ready Roofing Co., 44th and La Salle Sts., manufacturer of asphalt roofing products, comprising a 2-story factory with machinery. The loss is estimated at about $42,000.

Kansas

WICHITA—The Golden Rule Refining Co. is planning for the rebuilding of the section of its local oil refinery, destroyed by fire, March 6, at 29th St. and Topeka Ave.

CRESTLINE—The Kanok Metal Co. is considering tentative plans for the rebuilding of its concentrating plant, recently destroyed by fire with loss estimated at $45,000, including equipment.

Kentucky

NEWPORT—Officials of the Kentucky Rolling Mills Co. have organized the Andrews Steel Co., under Delaware laws, with capital of $750,000, and are reported to be planning for the erection of a new blast furnace and steel plant in the vicinity of Bay City, Mich., where options on property have been secured. The company is headed by Joseph B. and W. N. Andrews, Newport.

LOUISVILLE.—Ayer & Lord Tie Co., 80 East Jackson Blvd., Chicago, will build a 2-cylinder creosote plant here. The Leonard Construction Co. of Chicago will be in charge of material buying, which will consist mainly of steel tanks, creosote cylinders 130 ft. long by 7 ft. 6 in. diameter fabricated for 250-lb. pressure, tram cars, boilers, hydraulic pumps, air compressors.

Maryland

BALTIMORE—The American Sugar Refining Co. has filed plans for the erection of another building at its new sugar mill at Clement and Woodall Sts., to be 1-story, 62 x 73 ft.

BALTIMORE—The Colloidal Process Paint Co., Lexington Bldg., will expend about $30,000 for the erection of its new local plant, and will install equipment for a daily output of about 250 tons of bitumens. H. A. Hughes is secretary and treasurer.

BALTIMORE—The Mexican Petroleum Corp., 120 Broadway, New York, N. Y., will construct a new tankage and distributing plant on 1st St., to cost about $40,000. Work will be placed under way at once.

Missouri

CARUTHERSVILLE—The City Council will install a new water-purification plant in connection with extensions and improvements in the municipal waterworks. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., are engineers.

WEBB CITY—Fire, March 13, destroyed a portion of the refinery of the Wilhoit Oil Co. The estimated loss has not been announced; the loss in the tankage department approximated $30,000.

North Carolina

WILLETS — The Natural Abrasive Mining Co., Waynesville, N. C., is planning for the construction of a new grinding plant at its properties at Willets, with initial capacity of about 150 tons daily, estimated to cost about $100,000. An additional sum of approximately $200,000 will be used for development and general operatings, including new equipment. Frank R. Hewitt is treasurer.

New Jersey

TRENTON—The Semple Rubber Co. has acquired its leased plant on Murray St. for a consideration of about $40,000, consisting of a number of buildings, with adjoining site for expansion. The company manufactures inner tubes for automobile tires and other rubber products.

TRENTON—The Trent Brick Co., Princeton Ave., is considering plans for the rebuilding of the portion of its plant, recently destroyed by fire. A. W. Goulding is treasurer.

HOBOKEN—The Fisher-Sweeny Bronze Co., 1301 Grand St., is planning for the rebuilding of the portion of its plant, destroyed by fire, March 15, with loss estimated at close to $150,000, including equipment. The company specializes in the manufacture of bronze, brass and other metal castings.

EAST ORANGE—Plans have been prepared for the immediate installation of an automatic gas producer plant at the factory of the Ward Baking Co., Ampere section, 35 x 57 ft.

New York

GLENDALE, L. I.—The Conley Tin Foil Co., 521 West 25th St., New York, will soon break ground for the erection of a 1-story plant on Woodhaven Ave., Glendale, to cost about $175,000, including equipment. The general building contract has been let to the Foundation Co., 120 Liberty St., New York.

LOCKPORT—The A. W. Jack Corp., Mill St. and North Transit Road, manufacturer of asbestos millboard products, etc., is planning for the rebuilding of the portion of its plant, destroyed by fire, March 7.

Oklahoma

OKLAHOMA CITY— George Sohlberg and A. E. Kull, Oklahoma City, are organizing a new company, capitalized at $200,000, to establish a local plant for the manufacture of special metal castings.

MUSKOGEE—The Muskogee Vitrified Brick Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire. F. C. Nicholson is president.

Pennsylvania

LANCASTER—The Armstrong Cork Co., Liberty and Mary Sts., will soon break ground for the erection of a 4- and 6-story addition to its plant, 50 x 215 ft. The general building contract has been let to Herman Wohlsen, Woolworth Bldg., Lancaster.

CHESTER—The Scott Paper Co., foot of Market St., has enlargements under way at its plant to increase the capacity about one-third. A number of improvements will be made in the present factory, including the installation of considerable new machinery. The work is estimated to cost about $450,000.

PHILADELPHIA—The Gulf Refining Co., Widener Bldg., has acquired property aggregating about 70 acres of land in the Girard Point district, as a site for the erection of a large distributing plant. Actual operations will be deferred until a later date. Wesley A. Looney is general manager.

Tennessee

NASHVILLE—In connection with its new plant at Old Hickory, the Nashville Pulp & Paper Corp. plans for the erection of a finished paper mill at a later date, with installation to comprise two 30-ton machines and auxiliary equipment. Three buildings are now in course of erection, with remodeling of a number of structures formerly used by the government. Equipment is being installed in the different plant departments and it is expected to commence production in a portion of the plant in May. R. J. Cullen is president and general manager.

Texas

DALLAS—The Davis Mfg. Co., Knoxville, Tenn., has construction under way on its new local plant for the manufacture of chemicals and chemical byproducts. It will be 3-story, totaling about 15,000 sq.ft. of space. The building will be owned by Dallas interests, and occupied under a long lease. It is planned to commence the installation of machinery at an early date. Grover C. Davis is president and general manager.

MARSHALL—The Darco Corp., Wilmington, Del., a subsidiary of the Atlas Powder Co., will proceed with the erection of three units of its new local plant, instead of limiting the work to a single unit, as originally planned. The construction is expected to require about 12 months. The plant will produce refined carbon for sugar, chemicals and other service, and when in full operation will give employment to about 1,000 operatives.

Virginia

RICHMOND—The Cauthorne Paper Co., Cary and Tenth Sts., has plans nearing completion for the erection of a new 4-story plant, and will commence erection at an early date. It will cost about $75,000. Carneal & Johnson, Richmond, are architects. R. A. Cauthorne is president.

West Virginia

ATHENS—The Town Council, in cooperation with the state, is arranging for the installation of a filtration plant in connection with the waterworks system, to be used, also, by the State Normal School. C. E. Collins, Drexel Bldg., Philadelphia, Pa., is engineer.

CHARLESTON—The Young Bros. Foundry Co., recently organized, is planning for the erection of a new 1-story plant for the manufacture of steel and other metal castings. R. M. and Walter Young head the company.

Washington

SPOKANE—The Bentley Paste Co., Minneapolis, Minn., is planning for the erection of a new branch plant at Spokane, for the manufacture of pastes and kindred products. V. E. Benley is vice-president.

New Companies

THE SPRINGFIELD MICA PRODUCTS CO., Boston, Mass., has been incorporated with a capital of $200,000, to manufacture mica products and affiliated specialties. William P. Heck is president; and F. L. Glover, 104 Coolidge Hill Road, Watertown, Mass., treasurer.

THE FEDERAL FIBRE CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture fiber products. The incorporators are R. C. Richter and E. T. Walton. The company is represented by J. G. Pekberton, 130 West 42d St., New York.

THE STANDARD BRICK CO., Macon, Ga., has been organized to manufacture brick and other burned clay products. The company will take over and consolidate the Bibb Brick Co., A. T. Small Brick Co. and the Cherokee Brick Co., all operating in this district. W. E. Dunwody is president.

THE DYSCO CHEMICAL CO., West Hoboken, N. J., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Charles Rose and Carnig Ajamian. The company is represented by Charles Ajamian, 515 Bergenline Ave., West Hoboken.

THE HIGBIE SALT CO., 111 West Washington St., Chicago, Ill., has been incorporated with a capital of $50,000 to operate salt properties and manufacture salt byproducts. The incorporators are Fred K. Higbie, M. J. Haggerty and W. B. Nay.

THE PITT PAINT CO., Beaver, Pa., has been incorporated with a capital of $5,000, to manufacture paints, varnishes, etc. C. D. Miller, Wilkinsburg, Pa., is treasurer.

THE FRENCH-AMERICAN ENAMEL MFG. CO., Wilmington, Del., has been incorporated under state laws with capital of $100,000, to manufacture paints, enamels and kindred products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE MODEL BRICK CO., Houston, Tex., has been incorporated with a capital of $10,000, to manufacture brick and other burned clay products. The incorporators are W. J. Carter and J. F. Meyer, both of Houston.

THE INTERNATIONAL RUBBER CO. OF AMERICA, Wilmington, Del., has been incorporated under state laws with a capital of $20,000,000, to manufacture tires and other rubber products. The company is represented by the Corporation Service Co., Wilmington.

THE PLATINUM METALS RESEARCH SYNDICATE, Grants Pass, Ore., has been incorporated with a capital of $50,000, to manufacture refined metals and engage in metallurgical experiments. The incorporators are Morton Webster and Henry M. Lancaster, both of Grants Pass.

THE NON-CORROSIVE PAINT CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture metallic and other paints. The incorporators are A. Berman, J. P. Segal and R. Arenwald. The company is represented by I. Gainsburg, 258 Broadway, New York.

THE NORMA LABORATORIES, INC., Albany, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals and affiliated products. The incorporators are L., C and R. P. Branche. The company is represented by C. R. Watson, Albany.

THE CRESCENT RUBBER CO., Trenton, N. J., has been incorporated with a capital of $25,000, to manufacture rubber products. The incorporators are Martin M. Glassman, A. Abrahams and John L. Heher, 150 East State Street, Trenton.

THE CARBO BRICK CO., Berlin, Conn., has been incorporated with a capital of $100,000, to manufacture vitrified brick, terra cotta tile, etc. The incorporators are John Carbo, Edward J. Lardner and M. M. Lardner, all of Kensington, Conn.

THE BUTLER SILICA CO., Butler, Pa., has been incorporated with a capital of $15,000, to manufacture silica products. George B. Lambert, Butler, is treasurer.

THE SNEEZO CO., INC., 40 North Dearborn St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are J. Lewis, J. C. Turner and M. C. Suhr.

THE APOLLO FOUNDRY, INC., Brooklyn, N. Y., has been incorporated with a capital of $25,000, to manufacture iron, steel and other metal castings. The incorporators are represented by I. W. Eckstein, 61 Park Row, New York.

THE REX CHEMICAL CO., Washington, D. C., has been incorporated under Delaware laws with capital of $1,000,000, to manufacture chemicals and chemical byproducts. The incorporators are G. Victor Yonce and R. B. Sheldon, Salem, Va.; and Eugene A. Chanaberry, Washington. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE NACCO CHEMICAL CO., 191 Market St., Newark, N. J., has filed notice of organization to manufacture chemical products. James A. Dennis, 34 South Tenth St., heads the company.

THE ROME FIREPROOFING CO., Rome, Ga., has been incorporated with a capital of $100,000, to manufacture brick and other burned clay products. The company will succeed to the plant and business of the Rome Brick & Tile Co. The incorporators are H. H. Woodruff, Rome; and B. Mifflin Hood, Atlanta, Ga. The last noted is head of the B. Mifflin Hood Brick Co.

E. E. ZIMMERMAN, INC., Pittsburgh, Pa., has been incorporated with a capital of $35,000, to manufacture paints, varnishes, etc. I. M. Anderson, 3874 Perrysville Ave., Pittsburgh, is treasurer.

THE NEW YORK LABORATORIES, INC., New York, N. Y., has been incorporated under Delaware laws, with capital of $250,000, to manufacture chemicals and affiliated products. The company is represented by the Delaware Registration Co., 900 Market St., Wilmington, Del.

THE IROQUOIS OIL CORP., 118 North La Salle St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture petroleum products. The incorporators are John H. and Robert C. Quirk, and O. S. Springer.

THE SUPREME LEATHER CO., 131 New Jersey Railroad Ave., Newark, N. J., has filed notice of organization to manufacture leather products. James A. Veneziano, 201 Parker St., heads the company.

THE MOHAWK BRICK CO., Mechanicville, N. Y., has been incorporated with a capital of $20,000, to manufacture brick and other burned clay products. The incorporators are J. Vett and C. D. Agonisto. The company is represented by F. A. Tate, Mechanicville.

THE PIONEERS CONSOLIDATED PETROLEUM CO., Wilmington, Del., has been incorporated with a capital of $250,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE FRENCH POLISH MFG. CO., 4716 Dorchester Ave., Chicago, Ill., has been organized to manufacture polishes and other chemical specialties. The company is headed by Fred W. Bentley and Jean B. Hassewar.

THE COLORLAKE CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture colors, chemicals, paint products, etc. The incorporators are R. E. Mertens, W. D. Goss, Jr., and H. G. Sidebotto. The company is represented by H. B. Corey, 290 Broadway, New York.

THE HUBBELL RUBBER CO., Wilmington, Del., has been incorporated under state laws with a capital of $600,000, to manufacture tires and other rubber products. The company is represented by the Corporation Registry Co., 900 Market St., Wilmington.

THE ZENITH PAINT & COLOR CORP., New York N. Y., has been incorporated with a capital of $125,000, to manufacture paints, varnishes, etc. The incorporators are G. and G. W. Miller, and S. Glasner. The company is represented by S. C. Sugarman, 1540 Broadway, New York.

THE ATLAS BULB CO., 289 Valley Road, West Orange, N. J., has filed notice of organization to manufacture glass bulbs and other glass products. The company is headed by M. D. Grove and Joseph A. Dorrity.

THE LOOP STEEL MFG. CO., Ponca City, Okla., has been incorporated with a capital of $500,000, to manufacture steel products. The incorporators are J. B. Hinkle, Ponca City; Swan C. Burnette, Pawhuska, Okla.; and C. H. Loop, Arkansas City, Kan.

THE BRITITE CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $6,000, to manufacture chemical products for rust prevention and other service. The incorporators are L. M. Flohr, A. Rich and S. Schoening. The company is represented by J. H. Marsh, 220 Broadway, New York.

THE WALLACE OIL & REFINING CO., Wilmington, Del., has been incorporated under state laws, with capital of $500,000, to manufacture refined oil products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE UTICA PAINT REMOVER CORP., Utica, N. Y., has been incorporated with a capital of $50,000, to manufacture chemical products. The incorporators are G. A. Armstrong and F. J. Matteson. The company is represented by W. S. Matteson, 400 Broadway, Utica.

THE NATIONAL LEAD-CONSTRUCTION CO., Jenkintown, Pa., has recently been formed. C. H. Kimberly is president. At present the company is interested in designing and installing all classes of lead work and will later enter the equipment field.

THE GREAT EASTERN GASOLINE REFINING CO., New York, N. Y., has been incorporated under Delaware laws, with capital of $500,000, to operate an oil and gasoline refining plant. The incorporators are Thomas P. Hall, Charles Sears and John G. Powers. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

Capital Increases, Etc.

THE CHICAGO HEIGHTS OIL MFG. CO., 140 West Van Buren St., Chicago, Ill., has filed notice of increase in capital from $45,000 to $100,000.

THE HUMPHREYS-MEXIA CO., Mexia, Tex., operating oil refineries, has filed notice of change of name to the Humphreys Oil Co., at the same time increasing its capital from $10,000,000 to $15,000,000.

THE NEW YORK COAL-TAR PRODUCTS & CHEMICAL CO., recently incorporated under Delaware laws with capital of $1,000,000, has filed notice of charter at Albany, N. Y., to operate in New York. The company is represented by I. D. Shneller, 25 West 43rd St., New York.

THE SINCLAIR CONSOLIDATED OIL CORP., 45 Nassau St., New York, N. Y., operating oil refineries, is disposing of a bond issue of $45,000,000, the proceeds to be used for general financing and operations.

THE DEFAY RUBBER WORKS, 45 North Third St., Easton, Pa., has filed a voluntary petition in bankruptcy.

THE STANDARD OIL CO. OF KENTUCKY, Louisville, is arranging for an increase in capital from $6,000,000 to $12,000,000.

Stockholders of the RYDON TIRE & RUBBER CO., 765 Broad St., Newark, N. J., are arranging for a dissolution of the corporation. Edgar J. Haaren is secretary.

THE CELLULOSE PRODUCTS, INC., 1459 Broadway, New York, N. Y., has arranged financing plans for increased operating capital, to be used for general expansion in production.

THE PHOENIX RUBBER MFG. CO., Boston, Mass., has filed an involuntary petition in bankruptcy.

THE AIR REDUCTION CO., 342 Madison Ave., New York, manufacturer of welding apparatus, has acquired the plant and business of the Davis-Bournonville Co., Van Wagnen Ave., Jersey City, N. J., manufacturer of oxy-acetylene equipment, and will operate the property as a subsidiary.

Industrial Notes

THE BONE CHAR PRODUCTS CO., LTD., of Allentown, Pa., recently sold its bone oil recovery plant to L. Martin Co. of New York, by the receiver, D. S. Chamberlin. The consideration was $20,000. A process for the recovery of bone oil by the use of a volatile solvent, chiefly benzene, was tried out at this plant, but was not commercially successful. It is understood that the New York company will use the plant as a storage warehouse.

HAROLD G. MANNING, chemical engineer and patent lawyer, who opened an office last April in Waterbury, Conn., has now changed his location to the new Waterbury National Bank Bldg., 193 Grand St., that city.

E. F. DREW & Co. has been incorporated at Albany, N. Y. The assets of E. F. Drew & Co., which have been in custody of the courts for the past few months, have been turned over to the new organization and the business of the company, its subsidiaries and its branches will be conducted as formerly.

THE SURFACE COMBUSTION CO., New York, has obtained the exclusive license for exploiting in this country and in foreign countries the Andrews rustproofing process which was used during the war by the British Government.

THE ALTAU CO., Balboa Bldg., San Francisco, Cal., is engaged in the development of deposits of fullers earth, diatomaceous earth and talc in California and Nevada.

W. S. ROCKWELL CO., New York, announces that Gibbons Bros., Ltd., Dudley, Worc., England, has been appointed its representative for the British Isles.

THE NATIONAL PACKAGING MACHINERY CO., Jamaica Plain, Mass., announces the appointment of John C. Kay as New York City representative, with offices at 90 West Broadway.

THE PETROLEUM IRON WORKS CO. announces the appointment of J. A. Connelly.

formerly manager of the Tampico, Mexico, office, as sales manager, with headquarters at Sharon, Pa.

HERVEY J. SKINNER of Skinner, Sherman & Esselen, Inc., chemist and engineer, of Boston, has been selected as technical adviser by the Associated Industries of Massachusetts. The executive committee of that organization recently decided to establish a technical information service similar to its legal, taxation, accounting, insurance and banking services. The new technical information service, to be conducted by Mr. Skinner, will answer inquiries on industrial processes used in manufacturing operations. It will be in a position to advise members on technical subjects and to give general information that will be of material assistance in solving industrial problems. Care will be exercised to discriminate between information which should be furnished free and that for which members of the Associated Industries of Massachusetts should retain a competent firm of engineers.

THE HARDER FURNACE & ENGINEERING CORP. announces the sale of its licenses to use the Harder patents and of the services of its engineering department of the Fuels Utilization Corp., Knickerbocker Bldg., 152 West 42nd St., New York City. The Harder Furnace & Engineering Corp. will move to that address and occupy adjacent offices.

THE ORTON & STEINBRENNER CO., Chicago, Ill., manufacturer of locomotive cranes, clam-shell and orange-peel buckets and coal crushers, has made arrangements with Walter Hasendahl, 1213 Fuller Ave., Los Angeles, Cal., to act as representative in southern California.

LLOYD A. HALL has severed his connection as manager of Vodin, Inc., to establish business on his own account under the name of the Chicago Chemical Products Co., 6148 Wentworth Ave., Chicago. This company is engaged in a general line of manufacture, including toilet specialties, insecticides and automobile polishes.

THE WILSON WELDER & METALS CO., New York, announces the appointment of R. L. White as district manager in charge of the Detroit office.

THE GEORGE J. HAGAN CO., Pittsburgh, Pa., has opened two new offices. One is at 20 East Jackson Boulevard, Chicago, in charge of V. A. Hain, and the other in the Murphy Bldg., Detroit, in charge of J. Sandberg.

J. T. DONALD & CO., LTD., chemical engineer and consulting chemist, of Montreal, announces its removal to new and larger premises at 40-42 Belmont St., which the company has purchased and specially equipped for its laboratory and consulting work.

THE PNEUMERCATOR CO., INC., manufacturer of pneumatic mercury gages for measuring liquid contents of tanks, has moved its factory from Philadelphia, Pa., to the Sperry Bldg., 40 Flatbush Ave. Extension, Brooklyn, N. Y. Its general offices will be transferred from 15 Park Row, New York City, to the new factory location.

THE ARMSTRONG CORK CO., Pittsburgh, Pa., has opened a new office in Milwaukee, Wis., at 1011 Majestic Bldg. Hugh Krampe is in charge. It is also announced that the Denver office has been reinstated and is in charge of Alexander Callow.

THE DAYTON-DOWD CO., Quincy, Ill., announces the opening of a district office in Pittsburgh at 809 Keenan Bldg., covering the sale of centrifugal pumps and Underwriters' fire pumps. The office will be in charge of T. J. Barry, who for the past several years has been connected with the home office on engineering and sales.

WALLACE & TIERNAN CO., INC., Newark, N. J., announces the opening of an office in the McKnight Bldg., Minneapolis, Minn., which is in charge of B. M. Conaty, formerly of its Chicago office. This new district will cover the states of Minnesota, North Dakota, South Dakota and Montana, and the Canadian provinces of Alberta, Saskatchewan and Manitoba. It is also announced that E. M. Lawson, formerly of its San Francisco office, has become its representative at Kansas City, located at 707 Commerce Bldg.; that R. B. Mowry has recently been appointed its representative for the New Jersey, Delaware and Maryland districts, and will be located at the Newark, N. J., office; that Wallace & Tiernan, Ltd., was recently organized with headquarters at 73 Adelaide St., East, Toronto, Ont., Canada, in charge of J. Van Benschoten; that several additions have been made to its technical force recently, including S. H. Gregg and G. I. Nelson, who will become attached to the personnel of its Chicago office; A. LoPrest, who will become attached to the San Francisco office; R. M. Finch, who will be attached to the main office at Newark, N. J., and also that in the main office sanitary and industrial sales will be handled separately—L. H. Goebel becoming manager of industrial sales and R. V. Donnelly becoming manager of sanitary sales.

THE MEDART PATENT PULLEY CO., St. Louis, Mo., announces the change of its corporate name to "The Medart Company."

THE READ MACHINERY CO., York, Pa., recently held its ninth annual convention of the executives and sales representatives. The keynote of the convention was the same as in former years, "Better Service to the Chemical Industries."

F. W. REISMAN and L. E. TURK, formerly traveling sales manager and treasurer, respectively, of the Quigley Furnace Specialties Co., New York, have organized and incorporated the Keystone Refractories Co. and will manufacture high-temperature cement and granular refractories. The office is located at 122 Liberty St., N. Y., and the factory is in Jersey City.

THE MCCLAVE-BROOKS CO., Scranton, Pa., has appointed A. R. St. John as manager of the New York office, succeeding S. G. Smith, whose resignation took effect last January. Mr. St. John was formerly in charge of the Boston office. It is also announced that K. S. Holmes, Jr., has been appointed a representative of this company in Cincinnati, with offices in the Gwynne Bldg., and that the office at Charlotte, N. C., has been moved to Greenville, S. C.

THE HAUCK MFG. CO., Brooklyn, N. Y., has removed its Philadelphia office to 1726 Sansom St. Herbert Vogelsang, who has been connected with the company for 6 years, will be in charge.

THE COLORADO SOCIETY OF ENGINEERS at its recent annual meeting and banquet elected the following officers: President, R. M. Hosea; vice-president, W. M. McMechen; secretary-treasurer, C. M. Lightburn; directors, F. C. Dreher, I. C. Crawford, J. S. DeRemer, R. G. Hosea, F. C. Steinhauer, R. J. Randall, V. A. Kauffman, C. B. Daniels.

THE PACIFIC CHEMICAL CO. is now located in its new quarters at 70 Cliff St., New York.

THE RATHBUN JONES ENGINEERING CO., Toledo, O., has appointed the Ingersoll-Rand Co., New York, general sales agent for Rathbun gas engines.

Dr. BAXERES DE ALZUGARAY, consulting chemist and metallurgist, announces the removal of his office and laboratory to 23 Washington St., New York.

THE PITTSBURGH TESTING LABORATORY, Pittsburgh, Pa., announced at its recent annual meeting the retirement of its president, George H. Clapp, his reappointment as a member of the board of directors of the company, and the election of Colonel James Milliken to the presidency of the company. Colonel Milliken's experience as a mechanical officer of the Pennsylvania Railroad Company, his experience in designing, constructing and in the shipment of all manner of the railroad equipment for the military railways shipped to France during the war and his subsequent experience fit him for the operation of this company.

THE SHALE OIL & REFINING CORP. has changed its name to "Industrial By-Products, Inc." but is still located at 25 Broadway, New York City.

THE SARGENT PAINT CO., of Indianapolis, Ind., has changed its firm name to "The Sargent-Gerke Co."

THE CHICAGO FLEXIBLE SHAFT Co. has resumed its St. Louis office, which is located in the Railway Exchange Bldg. It is in charge of J. J. Wittenburg, who has been with the Chicago office of the company for 3 years.

THE NORWALK IRON WORKS CO., South Norwalk, Conn., announces a number of changes in the executive personnel of the organization. The executive staff is now as follows: C. L. Thompson, president and general manager; Howard E. Adt, first vice-president; Harold B. Knowles, treasurer and assistant secretary; Thomas M. Steele, secretary; A. R. Betts, vice-president in charge of sales; W. E. Mathews, vice-president in charge of manufacturing and engineering; G. W. Wardwell, chief engineer; W. M. Greene, general superintendent.

The "Informashow" is the name of the exposition to be held at Exposition Park, Rochester, N. Y., May 15 to 20, under the direction of the Purchasing Agents Association of Rochester, N. Y., which is affiliated with the National Association of the Purchasing Agents.

THE C. W. HUNT CO., INC., of West New Brighton, Staten Island, N. Y., announces the reestablishment of its New York City office at 143 Liberty St. It has taken over all the sales and engineering work which has heretofore been carried on by its subsidiary company, the C. W. Hunt Engineering Corp., for the past 18 months, as the business of this latter corporation has now been consolidated with the C. W. Hunt Co., Inc.

THE BLAW-KNOX CO. has moved its New York office from the City Investing Bldg. to the Carbide & Carbon Bldg., 30 East 42nd St.

THE WORTHINGTON PUMP & MACHINERY CORP., New York, calls attention to Bulletin W-605, which is an instruction book for centrifugal pumps. There are informative data on the erection and installation of centrifugal pumps, a curve showing the maximum water temperature permissible for different suction lifts and curves showing the head capacity and efficiency capacity characteristics of the centrifugal pump. The bulletin is well illustrated. Copies will be sent upon request.

THE VULCAN SOOT CLEANER CO., DuBois, Pa., has recently issued Bulletin 548, on the use of Vulcan cleaners with Stirling boilers and Bull. 451, on B & W type boilers.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY and the AMERICAN PULP AND PAPER ASSOCIATION will hold annual meetings at the Waldorf-Astoria, New York, the week of April 10.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting: June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

R. S. McBRIDE
SIDNEY D. KIRKPATRICK
A. E. BUCHANAN, JR.
GRAHAM L. MONTGOMERY
CHARLES WADSWORTH, 3d
CHARLES N. HULBURT
Assistant Editors

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"Executives Are Urged to Co-operate"

PROMPT return of monthly oil refinery figures would materially improve the production reports issued by the Bureau of Mines. This fact is the occasion for the request made by that bureau recently from which the title of this editorial is quoted. The bureau well says that "there is need for prompt co-operation, in view of the great value of these data to the oil refiner," for it is the industry itself which profits or loses according as the results are complete and promptly available, or incomplete and late.

Moreover, this is not an isolated case in which co-operation of industry with government investigations is important. At the present time the Bureau of the Census is making its biennial survey of the manufacturing industries. The results of that survey will be of tremendous importance to business, particularly to each business from which statistics are gathered. Co-operation with the census is therefore very important to business itself.

Reliable statistics are tools of great importance in planning production, distribution or sales. A knowledge of recent and current market prices is of no greater value to an industry than similar current data of production, distribution or stocks on hand. Where such figures are not already being gathered industry should set about having them made accessible promptly. And in the meantime those who are getting more or less belated returns now should see to it that the laggards in their industry speed up in order to permit quick, complete reports within those fields already covered either by government or association work. The value of the statistics is greatly enhanced by promptness, and the co-operation or lack of co-operation by the industry itself will altogether determine this factor.

The Strain Of War

PHYSICAL tests of army officers which have lately been in progress show "the most clear-cut evidence of physical deterioration" due to the "strain incident to the prosecution of the world war." It is found that they suffer from "instability of the nervous system," "an unnatural tendency to worry, fatiguability, low blood pressures and a lowered resistance to infectious disease," and that they show a "tendency toward increased introspection and mental exaggeration" of all forms of worry and mild physical ills. Blood pressures are abnormally high in men over 45, and among younger officers of 25 to 30 it is abnormally low.

What else should we expect? War is and always has been a debauch of anger. Active war experience is replete with shocks due to insomnia, muscular exertion, emotional excitation and physical injury. According to Dr. GEORGE W. CRILE of Cleveland, these cause histological changes in the brain, the suprarenals and the liver, and while some of his conclusions as to the wounding of the brain by shock have been questioned by his colleagues, we know that, in the main, experiences of this sort do cause injury, and these medical examinations prove it.

There has been a terrible let-down in reasonableness all over the world. Such instability of the nervous system, unnatural tendency to worry, chronic introspection and exaggeration of all sorts of ills do not apply to army officers alone. It is far more general. We have, all of us, been under great strain, and many of us are not over it yet. Some of us are permanently injured.

War upsets the mental balance, injures the understanding and the effectiveness of both victor and vanquished. History offers a leading example to which we have paid too little attention, because it was our own European forbears who did the damage. The Arabs maintained a wonderful civilization in Spain and Portugal. Their gardens were gardens of delight, and the remnants of their architecture indicate a cultivation and development that was far beyond that of any part of Europe for many centuries. It is among them that we find the beginnings of science as distinguished from abstract philosophy. We know but little of GEBER —but in chemistry we begin with him. The Arabs were also physicians and astronomers, and they gave us our numbers.

Then we good Europeans took up the white man's burden, and we drove the Arabs out. We disagreed with them on certain points of what is sometimes called "revealed truth" and we routed them utterly. We got into the habit of fighting them and hating them. And we conquered their proud spirit. We killed all those wholesome doubts within them which are the very foundations of science and which lead to inquiry and thought. We drove them back to their own traditions —and they have been living on them ever since; intellectually living on nothing but traditions. We spoiled them for a thousand years.

How much of their chemistry did we take from them? Nothing but the cheapest, easiest necromancy; the get-rich-quick foible of turning baser metals into gold. Why hadn't we better taste or more discrimination in our stealing? Because the wars had injured us white folks very much as they had injured the Arabs. For over half a millennium we were a low-lived lot.

When ERASMUS, with his great vision, saw the possibilities of chemistry and induced PARACELSUS to study it, the stage was set for progress, but there was still so much war going on, with its pernicious sequelæ, that the result was far more quackery than honest research. Even old GLAUBER used to sell love-potions.

And it was not until the seventeenth century that ROBERT BOYLE made chemistry the profession of a gentleman.

The big war has hurt everybody, victors and vanquished. We've all gone off in our competence, our understanding, our level-headedness. We're excitable, nervous, hysterical. Look at the United States Senate, the House of Representatives, at every parliament in existence! The members behave like wayward children. Honest debate has become almost a lost art. It is time to steady ourselves and to think straight. We have big jobs ahead of us and we are not ready for them. One of these big jobs is for us white folks to get along together, to understand one another, to stop yelling and to be decent as well as sensible. Army tests during the draft indicate that 40 per cent or more of the people of the United States do not develop mentally above the age of 10 or 12 years. Some of these children occupy high offices and they prove the fact every day.

Be a Good Neighbor —It Pays

THE man who has a job in a factory or plant located in a suburban section usually considers himself fortunate, for the surroundings are pleasant and comfortable and working conditions in general much more agreeable than in congested locations in the heart of a city. The residents of such suburban districts, on the other hand, usually do not welcome factories for next door neighbors, and often with good reason. However, under modern conditions with up-to-date ideas of how to operate a plant, the objections to most types of factory are rapidly disappearing. One of the largest factors in this change is the approved method of boiler and power plant operation which is now possible.

No one likes to live next door to the proverbial boiler factory. The noise from such an establishment is, of course, quite objectionable. But it is no less objectionable to the housewife to live near a beautiful factory building artistically designed and surrounded by beautiful lawns if the power plant of the establishment belches forth black smoke and spots the clothes on Monday and soots up curtains and furnishings all the rest of the week. Proper boiler design and operation will eliminate this factor without difficulty.

There is no reason, with modern equipment and modern methods of firing, for making any objectionable quantities of smoke or dirt. Coal can be received and ashes removed without serious nuisance to surrounding buildings or residences. The smoke or gases from the stack can be made quite unobjectionable. In other words, there is no reason why the power plant of any commercial establishment should cause the institution as a whole to be an undesirable neighbor.

If those who are planning and those who are operating will bear these facts in mind they can contribute their part toward more satisfactory plant locations. And with more satisfactory plant location will come better satisfied operatives. Everyone from the president in his mahogany-furnished office to the stoker or ash handler will enjoy being in a neighborhood where a few lawns and a few trees are possible instead of only brick alleys and the congested backyards of the factory district. It will pay well for the power plant to make itself a good neighbor.

Are Technical Editors Timid?

THE other day a manufacturer friend of ours told us that he did not think the editors of technical papers were courageous. When we asked him to be specific, he stated that, as a class, we were afraid to publish the facts about a new development unless it had been thoroughly tried and proved successful. As an example, he told of a new application of his company's product, which has been made at the request of a customer. This has been carefully worked out from an engineering standpoint and has been tried experimentally, but as yet has not been put to practical use. Our friend thought that under the circumstances we would not be willing to give the matter any editorial attention.

This is indeed far from the facts. We wonder how such misconceptions arise and how far they spread. One of the prime functions of a technical paper is to present the news of its field. Naturally, nothing can be published without sufficient examination to convince us that the principle involved is sound and that the source of our information is reliable. But when we can obtain news of a worth-while attempt to advance engineering practice, our first duty, provided the originator is willing, is to pass the information on to our readers. Often we are enjoined to secrecy. When publicity is earnestly sought it is too often for its advertising value.

No, our friend is mistaken. When he is ready to give us permission to do so, if we find his new development of interest to our readers, we shall be willing and glad to bring it to their attention.

Railroad Earnings And Service

THE new practice of considering economic questions quantitatively may well be applied to the so-called railroad problem. It may be putting it rather strongly to say that the old-fashioned "political economy" represented theory, while quantitative economics represents facts, but the difference is of that character, at any rate.

A report is now available for the full calendar year 1921 as to the earnings of the railroads, the net railway operating income having been $614,810,531, while 6 per cent on the tentative valuation (a trifle under 19 billion dollars) would be $1,115,940,000, according to the computation of the Bureau of Railway Economics. Thus the rate actually earned was 3.31 per cent. In the first 2 months of the year there were deficits, earnings then increasing to a maximum of 5.01 per cent for August, and dwindling thereafter to a rate of 3.44 per cent for December.

In this question of where railroad rates should be fixed, therefore, there is an amount of money involved, to be paid by the public or to be saved by the public, of less than half a billion dollars a year. No one states any definite figure, hence it is necessary to guess the amount of money folks are talking about, using as a basis the figures cited above.

The National Bureau of Economic Research last year studied the income of the American people for the years 1909 to 1918 inclusive, and found the income in 1913, the last pre-war year, to have been about 35 billion dollars, while for 1918 it was 61 billion, the increase being due chiefly to the advance in prices, for

the bureau concluded that the 1918 income reduced to 1913 dollars would be about 39 billion.

Merely the roughest sort of guesses are sufficient to reduce the present question to a quantitative basis. As such guesses we may take 40 billion as the present income and 50 billion as the income if business were "good," as those who wish railroad rate reductions argue would be the case if the reductions were made. Taking the 50 billion, one finds that the outside amount at stake in the rate discussion is 1 per cent of the national income.

From the quantitative viewpoint, therefore, the question is whether an amount of money equal to 1 per cent of the national income can have much effect upon the conditions that produce the income. One is entitled to have doubts. It is argued, however, that high freight rates interfere with certain kinds of business, and it may properly be claimed that it is unfair to set the half billion dollars against the whole 50 billion. However, a scrutiny of ton-mileage freight movement and railroad revenue in 1921 does not indicate that the heavy and low-priced commodities suffered more than the very valuable commodities, in which freight rates cut little figure. Some heavy commodities, like coal and iron ore, had a restricted movement in 1921, but it could scarcely be shown that a mere reduction in freight rates would have produced a normal movement.

Further objection to the quantitative comparison may be made, that even if freight rates are not vital from the money standpoint, their remaining unliquidated has a bad psychological influence. That is another story, and there may be something in it, though scarcely a great deal.

On the other side of this question is the matter of railroad service. Greatly increased business activity in the United States cannot be expected if the railroads cannot handle the accompanying movement, and there is impressive testimony that the railroads as now physically constituted cannot stand any great increase in load.

From that angle the question is whether the people can spare something like 1 per cent of their income as insurance against a transportation breakdown in case business tries to become very active.

How Things May Look In a Hundred Years

WE CHILDREN OF LIGHT of these days are not so very wise, after all! Let's imagine ourselves living in 2022, and discussing in some library rich in contemporary documents the economic history of the first quarter of the twentieth century. One of our number might pick up an advertising brochure of an important chemical manufacturing concern dated 1922.

"Here's an interesting note!" he might exclaim. "It is a chapter headed 'Publicity Harmful,' and the vapid excuse given is that if it were known that they were busy in the development of any product, before they were making enough to supply all who ask for it, some one customer might gain an advantage over another. As an actual reason it is so frail that it is funny, but it is of value as showing that they recognized the need of some sort of an excuse for their secrecy.

"Secrecy was the bane of chemical industry in those days. The dye industry, for instance, was having a hard time to get started in the United States. Before the Great War Germany had practically a monopoly, and during the war there was pressing need to produce, although the Americans were without intermediates, except aniline. You'd think, with a whole industry eating its heart out for intermediates, for beta naphthol, H acid and a whole string of others, that they would have made common cause in research, wouldn't you? But that wasn't the way they did things in those days. The Sherman act threatened them with all the thunders of the law if they did not compete in selling. Any co-operation was thought to be dangerous, whether it was or not. And this worked against public interest, because its effect was to discourage manufacturers from working together to reduce their costs. There was really nothing to hinder them except that it was contrary to tradition.

"Tradition ruled throughout most branches of chemical industry. Everything was locked up tight in front with a constant but slow leakage going out of the back doors, while chemists were often actually forbidden to exchange ideas with other chemists. The veil of commercial tradition still covered nearly all kinds of manufacture. Why, do you know there were some concerns that used to pay $50,000 a year for legal advice and $5,000 a year for scientific guidance in chemical industry!" The speaker would then probably have to prove that he was not joking.

Another might refer to the farmers of the Middle West, who burned corn as fuel because they could not dispose of it, while millions were starving in Russia for lack of that very corn and many hundreds of steamships were laid up in idleness with plenty of coal available and seamen out of work. "That tragedy," it might be remarked, "was due to the fact that they were so tied up by system that they could not count anything but dollars. Not one man in ten thousand knew calculus or could integrate."

"Still another tragedy of those days," one of the company might say, "was the Lesser Antilles. Those jewels of the sea, the loveliest places on the globe—that LAFCADIO HEARN wrote about, for instance, in his classic 'Two Years in the French West Indies,' where everything will grow, where nobody need starve, where the sea swarms with fish, where both summer and winter breezes are the balmiest that blow—were practically out of use. Sugar in the lowlands could not compete with Cuba and Porto Rico; coffee in the uplands could not compete with Brazil, and the trade in citrus fruits was held elsewhere. It was not a question of costs; it was a question of facilities and transportation and co-operation and thought. All this time the natives were gradually drifting back to the condition of savagery that reigned in Haiti and Santo Domingo. The most beautiful islands in the world were relegated to the rubbish heap. "

"What was the matter?" one might ask.

"Well," another might reply, "my theory is that the principal trouble of those days was a curious delusion in which men undertook to do business as though they were lawyers trying a case in court. Everybody strove to put his competitors into a hole—and nearly everybody succeeded. It was the lazy way, to succeed by a trick. They hadn't learned the rule for industrial success: to aid the industry in which you are engaged by every possible means, to scorn secrecy as bad form and as the weapon of the incompetent, and then to have wit enough to keep ahead of the game. Only a few men engaged in industry had seen this light in those days."

Then we should all agree that the ways of 1922 were pretty crude.

Readers' Views and Comments

Electrolytic Iron a Commercial Product

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the article appearing in your issue of Jan. 18, page 128, "Electrolytic Iron a Commercial Product." This is extremely interesting, but I notice a statement at the bottom of column 2 of the article as follows: "For example, the circulation of the electrolyte, always maintaining it up to the desired standard of iron content . . . This is the novelty introduced by Frederick A. Eustis and Charles P. Perin." This I would point out is not novel. The utilizing of certain ores as raw material is, of course, beneficial and presents no difficulty. The precipitation of the copper, if any, by the usual and well-known method can also be easily effected.

The difficulty, of course, is not in any of these things, but principally in maintaining the electrolyte neutral on a large-scale plant and producing iron without the aid of trick methods free from hydrogen craters—every time.

Davenham, Cheshire, England. S. HUTCHINS.

An Outline of the Uses of Lime

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article under the above caption in your issue of Feb. 15 is likely to give rise to false impressions in the paragraph on stucco. This would give the idea that lime was added purposely to sorel cement, whereas it is an absolutely undesirable impurity and usually results in the quick disintegration of the sorel cement containing it.

This is recognized in the article by Messrs. Seaton, Hill and Stewart in your issue of Aug. 17, 1921, where they give the following tables:

TABLE I—EFFECT OF LIME CONTENT, AS DETERMINED BY ADDITION OF LIME

No. Lime added	Tensile Strength, Lb. per Sq.In. 3.70%	2.69%	1.68%	0.67%
1	329	364	486	826
2	328	320	470	653

TABLE II—EFFECT OF ADDITION OF $Ca(OH)_2$ TO CALCINED MAGNESITE

1 part magnesite, 2 silex, 5 sand, by weight, 22 deg. Bé. $MgCl_2$

Per Cent Ca $(OH)_2$	Tensile Strength Lb. per Sq.In. 7 Days	30 Days
0	490	882
1	397	562
3	347	473
6	150	247
10	207	230

and as noted in the same article was earlier discussed by Rourke.

In percentages a little greater than those tested by Mr. Seaton—that is, from 5 to 10 per cent of active CaO—I have had entire test briquets disintegrate into pieces not one of which would be more than ¼ in. along the edge. In smaller percentages the test briquets would swell and twist without actual disintegration and would become moist and soft in damp weather, even after standing 6 months.

Similar bad effects are caused by the use of excessive amounts of calcium chloride in the magnesium chloride solution with which sorel cement is set, or by the presence of large amounts of calcium chloride in the dry powder for water mix stucco. DONALD M. LIDDELL.

New York City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the points brought out in Donald M. Liddell's letter on the article "An Outline of the Uses of Lime," I wish to state that the use for lime which we had in mind in connection with the manufacture of sorel cement was not the addition of lime to the cement but the use of a dolomitic lime as the base for the cement. This is a subject which has received a great deal of investigation in many places and was the subject of a paper read by J. B. Shaw at the spring meeting of the American Ceramic Society in 1921. The subject of this paper was "New Developments in Oxychloride Stucco and Flooring." The process described consists of burning dolomitic lime at a temperature at which the calcium carbonate is not decomposed. The product is then treated with alkaline earth chloride solutions.

I believe it is generally agreed that the addition of lime to sorel cement, as ordinarily made, is not advisable. M. E. HOLMES,

Washington, D. C. Manager, Chemical Department, National Lime Association.

Cost of Analyses in State Laboratory

To the Editor of Chemical & Metallurgical Engineering

SIR:—The statement on page 521 of your March 15 issue showing the cost of chemical analyses made by the State Department of Chemistry, Harrisburg, Pa., is truly a most interesting one. If we analyze this statement we find that 2,876 complete analyses of a variety of materials are handled at a cost of $13,689.76, which expense covers overhead, rent, light, etc. This is an average of 9 samples per day, and if we assume 5 determinations per day at a total cost of approximately 90 cents per determination, as compared with a charge of $4 per determination made by the commercial chemist.

In view of the fact that it is our earnest endeavor to produce dependable analyses by well-trained and well-paid chemists, at the lowest possible price to our customers, we are at a loss to understand why we (the commercial chemists as a class) are compelled to charge four times the price for the same class of work as J. W. Kellogg, inferring that he is applying the same labor and overhead expenses which the commercial analysts must bear. If possible, we should like to pass on to our clients in the form of lower prices benefits of any information as to reducing expenses. At the same time it must be understood that we are not eleemosynary institutions and that a small profit at least must be allowed us.

We surely hope that more detailed statement as to the activities of the Pennsylvania State Department of Chemistry would not prove as disappointing to us as the reported profits covering the operations of the Emergency Fleet Corporation.

NEW YORK TESTING LABORATORIES,

New York City. L. R. SEIDELL.

A New Point of View

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having just read the Dec. 14, 1921, issue of your journal, I am very much astonished at the tone of the article headed "Haber, Nernst and the Amenities of Life." This article is in fact an insult against the eminent men who are members of the Svenska Akademien, an institution whose position above the hatred between nations which resulted from the war absolutely cannot be questioned. If the Svenska Akademien has seen fit to grant the Nobel prize to the great inventers Haber and Nernst, you can be assured that this has been done, not because their inventions have been used partly in chemical warfare, but because these inventions have served and will further serve mankind in the work for progress.

Your journal is remarkable for its often repeated hateful articles against Germany. When Germany was forced into the great war by aggressive Russia, I cannot understand why the Germans should not have the right to fight! But the Germans were far ahead of you in applied chemistry in all its branches, and that is possibly the cause for your campaign against them at all suitable and unsuitable times. I remember that some months ago you published an article against Germany, because that country made an attempt to apprehend the three chemical engineers (and only partly succeeded in it) who had been bought for money by the Americans to steal the secrets about some dye products of value to you and to cross over the sea with these papers or samples. I am sure, for myself, that it had been better for you not to mention that dirty affair at all. If you are such masters in chemistry, why did you engage the men to betray their country and their firm?

Domnarfvet, Sweden. HAROLD ALMQVIST.

It should be needless to add that our comment was in no sense intended as "an insult against the eminent gentlemen who are members of the Svenska Akademien." Our correspondent offers a novel and hitherto unpublished explanation of the cause of the late war. Evidently much depends upon the point of view.—EDITOR.

The Composition of Pine Oil

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the discussion between L. F. Hawley and C. M. Sherwood regarding the composition of pine oil, the accompanying chart may be of interest. This chart has been compiled from a study of the literature, including Schimmel & Co.'s semi-annual reports and the Forest Service bulletins, as well as the chemical periodicals. In this chart we have listed all the compounds we could find reported as found in oils obtained by steaming pine wood.

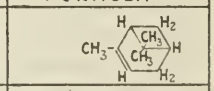
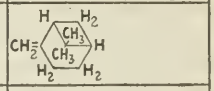
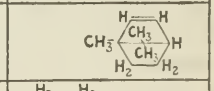
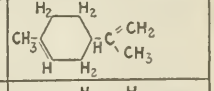
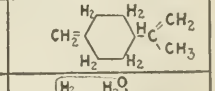
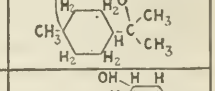
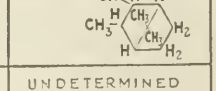
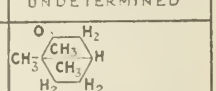
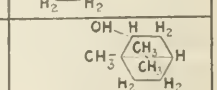
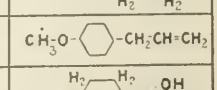
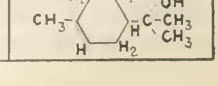
A consideration of the structural formulas of these compounds suggests that the terpineol might be derived from the dipentene by addition of water, and that the dipentene was an intermediate step between the alpha-pinene and the terpineol. Similarly the nopinene might conceivably rearrange to gamma-terpinene and the addition of water to the latter give rise to the cineol.

We should be very glad to have your readers' criticisms of this chart, as we feel that the subject is worth considerable study and discussion.

JOSEPH H. WALLACE & CO.
By R. H. Stevens, Chemist.

Stamford, Conn.

COMPOUNDS FOUND IN OIL FROM PINE

	NAME	BOILING POINT DEG. C.	MELTING POINT DEG. C.	SPECIFIC GRAVITY	REFRACTIVE INDEX	EMPIRICAL FORMULA	STRUCTURAL FORMULA
In Gum Spirits of Turpentine	α-PINENE	155-156		0.863/15°C.	1.4678/15°C.	$C_{10}H_{16}$	
In Gum Spirits of Turpentine	β-PINENE (NOPINENE)	162-163		0.874/15°C.	1.4724/15°C.	$C_{10}H_{16}$	
In Steam Distilled Wood Turpentine	CAMPHENE	160	50	0.850/48°C.	1.4851/48°C.	$C_{10}H_{16}$	
In Steam Distilled Wood Turpentine	d-LIMONENE, l-LIMONENE, DIPENTENE (RACEMIC ISOMERS)	175		0.849/15°C.	1.4710/15°C.	$C_{10}H_{16}$	
In Intermediate Fraction	γ-TERPINENE	179-181		0.847/20°C.	1.48458/20°C.	$C_{10}H_{16}$	
In Intermediate Fraction	CINEOL	176	-1	0.930/15°C.	1.4584/20°C.	$C_{10}H_{18}O$	
In Pine Oil	FENCHYL ALCOHOL	202-203	33-35	0.933/58°C.		$C_{10}H_{18}O$	
In Pine Oil	ISO-FENCHYL ALCOHOL	202-203	61.5	0.9613/15°C.	1.48005/20°C.	$C_{10}H_{18}O$	UNDETERMINED
In Pine Oil	CAMPHOR	204	175	0.985/15°C.		$C_{10}H_{16}O$	
In Pine Oil	BORNEOL	212	204			$C_{10}H_{18}O$	
In Pine Oil	METHYL CHAVICOL	215		0.9710/15°C.	1.51726/15°C.	$C_{10}H_{12}O$	
In Pine Oil	α-TERPINEOL	218	35	0.9391/15°C.	1.48132/20°C.	$C_{10}H_{18}O$	

Note: Names in heavy type are the chief components

Italian Chemical Industries

From Our Special Correspondent

Genoa, Italy, March 8, 1922.

During the last 5 weeks the different branches of the Italian chemical industry have been affected by the following economic factors: (1) The continued scarcity of electric power, which has been only in part compensated by the use of oil and gas engines and steam motive equipment. (2) The continued rise in the value of the Italian lira, which has caused considerable loss among the different producers and merchants, especially those who are dependent upon foreign raw materials. (3) The rise in the price of coal. (4) The diminishing demand for chemical products, due to financial difficulties and the smaller purchasing power of the consumers. And (5) the imminent danger of a strike in the principal chemical factories. Most of the works in the tartaric acid, citric acid, dye and heavy chemical industries have refused to continue the present wage scales, such as were arranged during last November. The strike will not be general, however, since the owners of the india rubber factories, the fertilizer works and the match plants have decided to continue their present policies as regards wages.

Sulphur Industry

During February there was a continuation of the campaign for a reorganization of the sulphur-mining industry in Sicily. It is hoped that the purchase of new mechanical equipment will serve to relieve the difficulty caused by the very crude methods of mining, as well as the lack of adequate transportation facilities. Some improvement in the industry has been noted since the organization of the Anglo-Sicilian Co.; however, this company took possession of only one-third of the sulphur mines in Sicily, and in the remaining two-thirds conditions remain practically unchanged. In 1916 the sulphur industry employed 11,732 workers and the output reached 1,672,571 tons of sulphur. In 1917, using practically the same equipment and employing 11,688 miners, production decreased considerably. Recently the prices for the different sulphur products have fallen to new low levels due primarily to the small demand and to the large stock which had been accumulated by the producers.

Tartaric Acid Industry

During the month the Italian Chamber of Deputies discussed the advisability of increasing the export taxes on raw materials, in order to raise the price of tartaric acid to that of the various foreign manufacturers. This arrangement would, of course, benefit the few Italian producers of tartaric acid and cream of tartar. However, the proposition was seriously opposed by the exporters of raw tartar and by the wine producers, and it is scarcely believed that any increase in the export duty will be effected.

Sugar Industry

The Italian sugar industry normally employs about 5,000 operatives in its thirty-eight sugar works. During the season in which the beets are harvested, which usually lasts from 60 to 80 days, 15,000 additional peasants are employed. The capital invested at present amounts to about 374,000,000 lire, and the annual production of sugar, when all the plants are operating at full capacity, is about 300,000 tons. During the past year, however, only about 205,000 tons was produced, notwithstanding the fact that the country consumed 250,000 tons. The reason for this is that only 74,000 hectares was cultivated for beets during the past year. There are nine sugar refineries in Italy, two of which are independent, while the others are controlled by the beet growers. Although at present there is a manufacturing tax of 2,161.50 lire per ton, and also a duty of 360 lire gold, it is possible to import foreign sugar at a price approximately equal to that of the product manufactured in Italy. It has recently been stated that a number of sugar works will be compelled to remain closed, if the government does not make some change in the present customs treatment of sugar.

Petroleum Industry

The dearth of water power has stimulated the search for petroleum in the different parts of the Italian Kingdom. It is reported that new deposits have been discovered in the Emilia region and that large resources were disclosed at San Giovanni Incarico, at Pico, in the Liri Valley. It is further stated that considerable resources are known to exist on the isle of Sicily.

Fertilizers

The rise in the value of the Italian lira and the small demand on the part of consumers have resulted in considerably lower prices for fertilizers. The season is already well advanced, and the stocks, especially those of nitrate of soda, are quite large and further cargoes are expected to arrive. For this reason additional reduction in the price of fertilizers is already foreseen. Sulphate of ammonia continues in good demand and it is stated that it is practically impossible to fill all of the orders. Germany continued to prohibit the exportation of sulphate of ammonia and all that could be secured came from either the United States or England. Ammonium nitrate could have been sold to good advantage, but very little was offered. The situation in regard to superphosphates remains unchanged. Imports of rock phosphate during last October reached 42,537 tons, as compared with 23,865 tons during the same month of the preceding year. During November the imports were only 21,834 tons, as against 25,983 tons in November, 1920.

Metal Imports

The Italian imports of metals during September reached 832 tons, during October 644 tons, and during November 5,434 tons. These, however, are considerably less than the imports in the corresponding months of 1920, when 11,512 tons was reported for September, 3,399 tons for October and 7,320 tons for November.

Swiss Demand for Copper Sulphate

Considerable quantities of blue vitriol are required in Switzerland for the spraying of the vines. Imports fluctuate between one and three million kilograms a year. In 1919 Great Britain supplied Switzerland with copper vitriol valued at 1,000,000 francs, or two-thirds of the total supply, but in 1920-21 Germany was the chief supplier. At the present time copper vitriol is a state monopoly in Switzerland. Free imports, however, would make the vitriol about 2,000 francs cheaper per truck, so that the abolition of the monopoly is demanded. It is probable that the monopoly will be abolished very soon.

COPPER MINE AT CHUQUICAMATA, CHILE

Minerals, Earths and Clays of Latin America—I

The First of a Series of Three Articles Describing the Mineral Resources of Latin America and Analyzing the Economic Factors on Which Their Development Is Dependent—Chilean Nitrates, Tin, Copper, Iron, Gold and Silver Are Discussed*

By OTTO WILSON
Former Chief, Latin-American Division, Department of Commerce

FROM the earliest years of exploration the countries of Latin America have been associated with the production of mineral wealth. It was partly in search of precious metals that Columbus and his successors set sail, and after such metals were found a continuous stream of them flowed across the Atlantic for 300 years. Their production meant slavery and death for great numbers of Indians, but at the same time it furnished the chief impetus to the settling of the territories south of the Rio Grande. Gold and silver are still mined to the extent of many millions of dollars annually, and silver, because of the Mexican output, continues to be one of the leading Latin-American minerals. But both are now recovered to a very considerable extent as byproducts in the mining of other metals, and in the last 30 or 40 years other minerals have passed them in total value of output.

The World War was particularly effective in stimulating the production of the so-called base metals, and the high prices during the war and immediately thereafter acted as an "open sesame" not only to many abandoned workings but also to entirely new sources of supply. The more recent fall of prices in turn relegated most of these new workings again to the wilderness, but they may be considered as an important part of the world's known reserve, to be drafted into service again whenever a special need arises or whenever the demand shall be sufficient to meet the costs of mining and transportation. These costs, so far as great areas are concerned, are prohibitive in normal times and will probably continue so largely because the mountainous mineral country is still so sparsely settled.

Dearth of Transportation Facilities

Of the three great mineral regions into which Latin America may be roughly divided—(1) Mexico and Central America, (2) the Andean and neighboring highlands, and (3) the rich Brazilian field centering in Minas Geraes—only the first can be said to be even fairly well provided with railways. Furthermore this is true only of parts of Mexico and is not at all true of Central America. The second region, extending along the entire western coast of South America, possesses the advantage of being near the seaboard, but this is partly offset in Colombia, Ecuador, Peru and Bolivia by the fact that the mines are found in the highest mountain country in either of the Americas, sometimes 10,000 to 15,000 ft. above the sea. This plateau region has been penetrated by only a few railways—viz., one leading up from Guayaquil to Quito in Ecuador, two or three others in Peru, and finally the two in northern Chile which furnish an outlet to Bolivia. Many of the rich Chilean mines lie in or near the lower coast ranges, and they are the most accessible of all South American mines, but even here the desert nature of the country

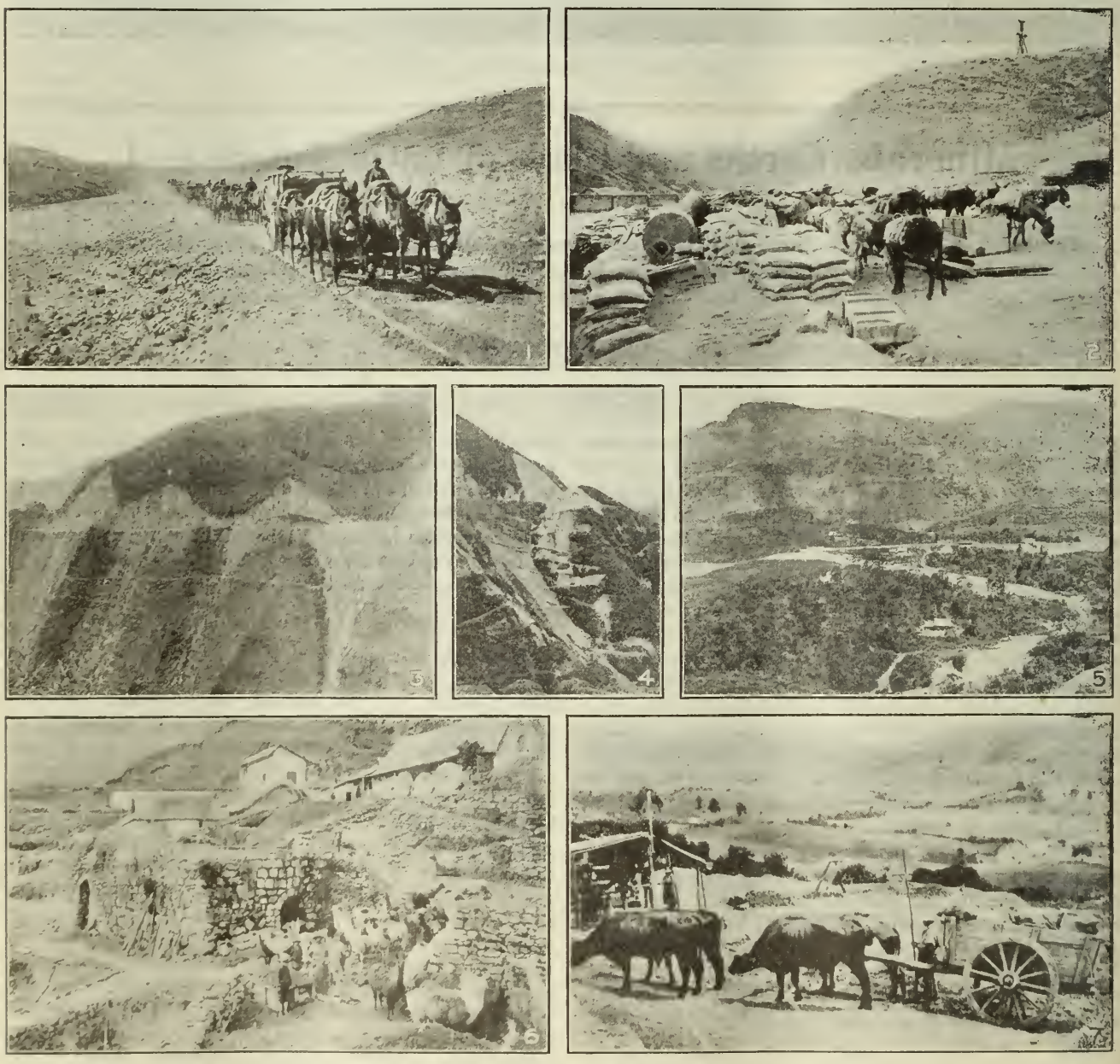
*The photographs for this series of articles were furnished by the Pan-American Union, Washington, D. C. For ore analyses, many figures of production and other detailed information the writer is indebted to "Mineral Deposits of South America," by Miller and Singewald, and to "Political and Commercial Geography," edited by J. E. Spurr. Both volumes are published by the McGraw-Hill Book Co., Inc.

and the lack of harbors have made their exploitation unusually difficult. The central section of the third region, the Brazilian State of Minas Geraes, is tapped by a single railway, whose grades and equipment are such that it can take care of only limited amounts of heavy ore. Throughout all of Latin America the great handicap, aside from a lack of railroads, is an almost universal absence of roads and highways. Mining machinery and supplies can be taken in and ore brought out only at great expense except in the few localities reached by the railways. Inadequate transportation thus prevents the working of many high-grade deposits, and as with other lines of South and Central American development, the exploitation of the mineral wealth must await the railway and modern means of transportation.

In point of total value the chief minerals which Latin America contributes to the world's markets are Chilean nitrates, copper, petroleum, silver and tin. The present review is interested not so much in these well-known products as in the minerals which have not yet been widely exploited, although some account of the present situation with respect to those named will be in order except in the case of petroleum, which will be covered in a later article.

The Chilean Nitrate Industry

Of all the varied products of the earth which Latin America yields, the one which constitutes the greatest source of wealth is in many respects the most curious. The nitrates of Chile form the only large deposit of such material in the world. They are invaluable both in peace and in war, furnishing a necessary constituent of fertilizers for peace-time agriculture and an equally essential constituent of explosives. In Chile this tremendous source of national wealth lies near the surface of the ground as a stratum of a barren, treeless and almost



FIGS. 1 TO 7—TRANSPORTATION DIFFICULTIES IN CENTRAL AND SOUTH AMERICA

Fig. 1—Carting tin ore to the railway in Bolivia. Fig. 2—Copper ores arriving at railway station, Corocoro, Bolivia. Figs. 3 to 5—New construction of Amagá Railroad in Colombia. Fig. 6—Llamas bringing copper ores to the mills in Peru. Fig. 7—Transporting coal from Colombian mines.

FIG. 8—OPEN COPPER ORE WORKINGS AT COROCORO, BOLIVIA

rainless desert, extending for about 500 miles over the northern end of the country. The layer of nitrate varies from a few inches in thickness up to 12 ft., the average being perhaps 2 ft. · It is loosened by blasting, and is prepared for shipment at local officinas or factories, of which there are about 175. Extraction usually takes about 20 to 24 hours, and the amount of nitrate actually recovered has in the past been only about 70 per cent, although more economical processes are now being introduced. The cost of producing and shipping a ton of nitrate in normal times, when the price runs about $44 at a North Sea port, has been estimated as follows: Production cost, $13.10; export duty, $11.92; transportation, $4.17; commercial expense and profit, $14.88. Exporting has been going on for a hundred years and has now reached a level of 3,000,000 tons a year, valued at a round $150,000,000. The life of the fields depends partly on how low a grade of nitrate may be worked, but estimates of 200 years are held to be conservative.

At the beginning of the war in Europe the Chilean nitrate industry was stagnant, and scarcely recovered during the succeeding year. But the war demand for nitrates for explosives and the clearing of the seas of German raiders brought the industry back to its former prosperity, and in 1918 exports, standing at 3,289,325 tons, were above normal. Since then the history of the industry has been one of ups and downs. In 1919 there was another heavy slump, followed by a great gain in 1920, but again by a severe depression in 1921. The supplies in Europe are controlled by an organization known as the Pool, and the Chilean exportation is almost wholly in the hands of a producers' association. On Oct. 27, 1921, an agreement between these organizations was reached by which prices are fixed until July, 1922, and this is expected to stimulate exports and relieve the depression. Early in March, however, it was reported that conditions in Chile during the first 2 months of the year were still quiet, awaiting an improvement in the movement of nitrates. Exports in 1921 were 1,100,000 metric tons, as compared with 2,750,000 metric tons in 1920.

Copper Mining and Its Latent Possibilities

This same region of northern Chile is the site of another mining industry which in value of output may in a few years surpass even the nitrate fields. Many years ago Chile led the world in copper production. She dropped back, but in the last 5 or 6 years she has advanced again to a position second only to the United States. Her enormous reserves make it possible that she will yet pass this country and again become the leading source of the world's copper. American capital amounting to tens of millions of dollars is being invested in development works, mostly by three companies, the Chile Copper Co., the Braden Copper Co. and the Andes Copper Co. The first-named has at Chuquicamata the largest known copper deposit in the world, its positive and probable ore, with the percentage of copper, being as follows at the beginning of 1921:

	Short Tons	Per Cent
Oxidized ore	329,306,106	1.91
Mixed ore	151,000,000	2.98
Sulphide ore	210,000,000	1.84

In the latter part of 1921 the monthly production was about 4,000,000 lb. of copper, about half the 1918 average.

Throughout northern Chile there are hundreds of small mines, many of them containing ores of high copper percentage. Some have been slightly worked and abandoned because of the heavy cost of transportation, and there appears to be a good opportunity for developing these mines if sufficient capital can be invested to meet this difficulty. The ore is mainly sulphide and oxidized ore, with some native copper. Other Latin-American countries producing copper are Mexico, Peru, Bolivia, Venezuela, Argentina and Cuba. Mexico has copper in nearly every state, but the output has been kept at a minimum by the disturbed state of the country. The biggest present mines are in Sonora and Lower California. The copper production of Mexico in recent years has been as follows: 1917, 50,986 metric tons; 1918, 70,223 metric tons; 1919, 56,172 metric tons; 1920, 46,057 metric tons.

FIG. 9—SILVER MINES AT ORURO, BOLIVIA
These mines have been producers since the days of the Spanish Conquest.

In Peru two companies, both of which are now under American control, have for many years been mining copper in the high Andes and apparently have rich reserves for future working. The larger of these companies, the Cerro de Pasco Copper Corporation, had a monthly production of copper of 63,128,000 lb. in 1920, as compared with 58,124,000 lb. in 1919, 81,906,000 lb. in 1918, and 72,675,000 lb. in 1917. Bolivia has only one copper-producing section, at Coro Coro, in the central part of the country and at an altitude of 12,000 ft., where a French company mines and concentrates normally about 4,000 tons a year. In recent years, however, exportation has been much above the average, copper ore

FIG. 10—ORURO, BOLIVIA, SEEN FROM THE MINES ABOVE THE CITY

to the amount of 23,000 tons, valued at over $2,000,000, being exported in 1919. Venezuela has many copper deposits in the northern mountains, but the mining property of Aroa, worked intermittently for centuries and now owned by an English company, is the only one that has been extensively developed. The ore mined for a long while has been sulphide.

In recent years a few other copper mines have been opened, but production has been small. The copper reserves of Cuba are said to be small, but the island has recently been shipping $4,000,000 to $5,000,000 worth of ore and concentrates to the United States annually. These are the products of two mines, one near Santiago and the other in Pinar del Rio. The island of Haiti and at least one Central American country, Nicaragua, have undeveloped copper deposits. Argentina ships a few hundred tons of blister copper each year from an English-owned mine and smelter in the western Andean region, in which are several important copper-bearing localities. The ore is found in veins and much of it contains high percentages of gold and silver. Uruguay has active copper mines and undeveloped deposits.

Gold and Silver of Declining Importance Because of High Costs

Gold and silver were of course the lodestones that attracted Europeans for centuries, but gold is now of secondary importance and silver keeps its position only because of the Mexican output. This, however, is not because the deposits are worked out, but because the costs of mining and transportation are too high as compared with corresponding costs in other parts of the world. Gold is found in nearly every Latin-American country, but its leading producer is Mexico, where it is obtained to a large extent as a byproduct in the mining of copper, silver, lead and zinc. Production amounts to about $12,000,000 worth yearly, the figures for recent years being as follows: 1917, 23,542 kilos; 1918, 25,313 kilos; 1919, 23,586 kilos; 1920, 23,370 kilos.

South America now furnishes only about 2.5 per cent of the world's gold supply, the chief producer being Colombia, with $4,000,000 to $6,000,000 a year. Colombia is followed by Brazil, whose $3,000,000 annual output is supplied largely by two English-owned mines, both of which have been worked for about a century. One of these long ranked as the deepest mine in the world. Peru, Chile, Bolivia and the Guianas each produce from $200,000 to over $1,250,000 worth of gold a year. The Central American countries contribute about $3,000,000, so that the gold mines of South and Central America together may be said to produce about $15,000,000 to $18,000,000 a year.

The recent troubled times in Mexico have served to cut her normal production of silver in half. Formerly she turned out 70,000,000 to 80,000,000 oz. a year, one-third of the world's total, but in 1915 she dropped to 40,000,000 oz. and has gone lower since. In the last 3 or 4 years there has been a considerable gain, as the following figures of production show: 1917, 42,019,000 oz.; 1918, 62,517,000 oz.; 1919, 65,904,000 oz.; 1920 (preliminary), 63,600,000 oz. Bolivia, the great silver center of colonial times, still produces some silver, but is far surpassed by Peru with about 10,000,000 oz. a year. In both countries most of the metal is obtained as a byproduct, in the former of tin and in the latter of copper. Chile has had some very rich silver mines and in her whole history has produced over $300,000,000 worth of the metal, but the annual output is now less than $500,000. Colombia has been mining silver for centuries and Central America adds over 2,500,000 oz. a year to the world's total.

Tin in Bolivia

Tin in Latin America is a one-country product, Bolivia being second only to the Federated Malay States in world production. From 21,000 to 28,000 tons (tin content) is the annual output, the ore being concentrated to about 60 or 65 per cent for exportation.[1] There is a little local smelting. The value of the tin exports reached $50,000,000 in 1918. Mexico has some stream tin, and produced 9 metric tons in 1917, 13.5 tons in 1918 and 1.5 tons in 1919, but none in 1920. It is recently reported that several tons of high-grade tin ore have been discovered near Sao Paulo, Brazil, but there are no details concerning it.

These are the most valuable of Latin America's minerals as far as past and present production goes. But the list of substances of secondary commercial importance which this section of the earth holds in reserve includes nearly all the minerals known to commerce, and among them are one or two which promise to take a place of foremost importance to the civilized world.

A Steel Industry Lacking Only Coal

In that valuable group of minerals around which the iron and steel industry centers, Latin-American coun-

[1] A trade report issued by the English company J. Blum gives the 1921 shipments of Bolivian tin from the west coast ports as 17,698 tons "fine," in 60 per cent concentrates.

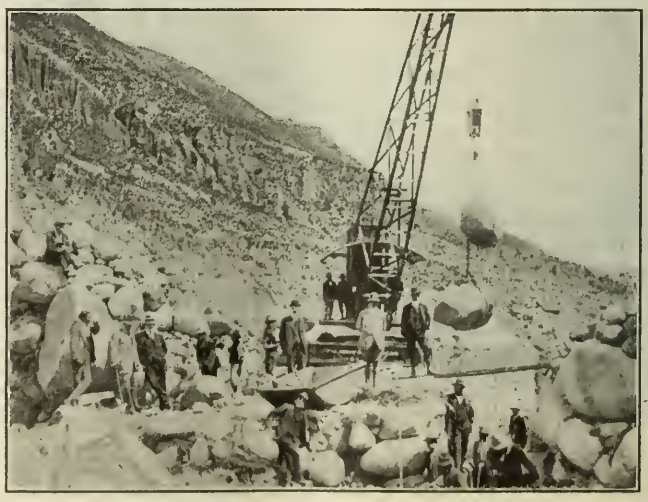


FIG. 11—GOLD MINING ALONG THE RIO CHUQUIAGUILLO IN BOLIVIA

tries are particularly rich. Yet in endowing them with this wealth Nature seems to have been in a rarely capricious mood. She has supplied immense stores of high-grade iron, and has thrown in the alloy metals, manganese, chromium, nickel, tungsten, vanadium, molybdenum, cobalt, titanium, zirconium, most of them in plentiful measure. But the one material which in the great steel-producing countries has been considered indispensable—namely, a good supply of coking coal—Nature has withheld entirely or has hidden away in mountainous regions so difficult of access as to remove the possibility of using the small deposits for iron smelting or steel making. There are coal deposits in southern Brazil which can be used for industrial purposes when mixed with imported coal, Chile has extensive beds of coal, and Venezuela has deposits of unknown extent, but this is nearly all lignite and is too soft and friable for coking. Colombia, it is estimated, has billions of tons of coal, some of which is hard coal, and Peru is said to have several million tons of anthracite; but in the case of the former country the difficulties of transportation are such that the deposits can serve only local uses, and in Peru the cost of mining and hauling is so great that that country imports much more than it produces. Only in Mexico can domestic supplies of both coal and iron be utilized to establish an iron industry, a good beginning of which has already been made.

The great iron fields of South America, in Brazil and Chile, may some day serve as a basis for a big steel industry, but if so it will probably be through the use of imported coke, brought back perhaps in the vessels that carry iron ore to foreign countries, or through the utilization of the water power which each of these countries has in abundance. In Chile the only serious attempt to establish a steel plant, using wood from the southern forests for fuel and carbon, ended in financial loss. In Brazil several attempts have been made, with the cordial support of the government, to establish plants for the production of steel with the aid of electricity derived from hydro-electric installations, but the cost has been found to be high. The latest enterprise of this character is one promoted by Brazilian interests, who are now erecting at Ribeirao Preto, in the State of Sao Paulo, two pig-iron furnaces, with a daily capacity of 60 tons, two bessemer converters, an electric refining furnace and two bar mills. The company expects to be producing steel by September. If this venture should prove continuously successful it would open the way to the building of other mills both for satisfying local demands and for exporting.[2]

FIG. 12—BAGGING TIN ORE FOR SHIPMENT, POTOSI, BOLIVIA

The iron countries of Latin America are Brazil, Cuba, Chile, Mexico and Venezuela, with deposits of apparently little economic importance in Argentina, Uruguay, Peru and Colombia. Brazil is the most important of all, and its fields may develop into the leading producing fields of the world, as geologists recognize the main deposits as constituting the world's greatest known iron reserve. The country is indeed a reservoir of iron, as ore has been reported from practically every state; but the section that holds the great deposits is a region about 100 miles square lying in the State of Minas Geraes about

FIG. 13.—OUTCROPPING BEDS OF IRON ORE, MINAS GERAES, BRAZIL

300 miles north of Rio de Janeiro. Estimates of the amount of ore in these deposits have ranged as high as 12,000,000,000 tons, but a more conservative estimate by E. C. Harder, of the United States Geological Survey, who has made a careful study of the region, is that there are 410,000,000 tons of bessemer ores with over 68 per cent iron and less than 0.02 per cent phosphorus, and about 3,000,000,000 tons of non-bessemer ore with over 50 per cent iron and 0.05 to 0.3 per cent phosphorus. This is for the main field alone and does not include many other deposits in Minas Geraes and other states which are known to be extensive, not to mention the possibilities of unexplored territory from which iron has been reported.

The ores of central Minas Geraes are hematites, and are contained in what is known as the Itabira iron formation, the material of which is a mixture largely of fine quartz sand and iron oxide. This material, "itabirite," is itself almost an iron ore, as it contains over 30 per cent iron. The best ores are a hard massive specular hematite which is found mostly in hills and which can be mined to the extent of millions of tons with almost no waste. (See Fig. 13.) Analyses by Harder show 69.65 per cent iron, 0.0125 per cent phosphorus and 0.24 per cent silica. The soft ore contains somewhat less iron and more silica. Between the hills and on their

[2] A good résumé of the various enterprises projected for the establishment of an iron and steel industry in Brazil will be found in a pamphlet just issued by the U. S. Department of Commerce as Trade Information Bulletin 6, "The Brazilian Iron and Steel Industry."

lower slopes is often found a layer of lower grade ore known as "canga," commonly less than 10 ft. thick and containing in the better grades 50 to 60 per cent iron and 0.1 to 0.3 per cent phosphorus, of which it is estimated there are about 2,000,000,000 tons.

This region is served at present by only one railway, which runs to Rio de Janeiro and is equipped to handle only limited amounts of ore. The logical port for this field is Victoria, and its development will probably be slow until it is connected by railway with that city. This can be effected by the construction of a branch to an existing line, the Victoria-Minas Railway, and a contract for the construction of this branch, and also another branch from the same line to the port of Santa Cruz, was signed in 1920 by officials of the government and by the Itabira Iron Ore Co., Ltd., which controls large ore deposits. The iron properties are owned by a considerable number of companies, mostly Brazilian, American and English. Hematite ores are found also in western Minas Geraes, in Bahia, in Goyaz and near the inland river port of Corumbá, in the far interior. Magnetite ores are also found, the best known deposits being in the State of Sao Paulo and containing, according to analysis, 64 to 71.3 per cent iron and 0.031 to 0.041 per cent phosphorus.

Chilean and Cuban Iron Ores

The only iron ores which the continent has supplied to external commerce to any great extent have come from Chile, where the Bethlehem Steel Co. has constructed extensive works, including a harbor blasted out of the solid rock. The Tofo deposits, which that company is working, comprise an estimated 100,000,000 tons of ore, mostly hematite, which analyzes 67.5 per cent iron, 0.2 per cent manganese, 0.011 to 0.05 per cent phosphorus, 0.01 per cent sulphur, 2.5 per cent silica and 0.8 per cent titanic oxide. It is said that when all improvements are completed the company will be able to ship in the neighborhood of 1,000,000 tons of ore a year. Chile has many other scattered deposits of both magnetite and hematite.

Cuba ranks as one of the great iron countries of the world, with deposits estimated at 3,000,000,000 tons of brown hematite on the north coast and minor deposits of several million tons of magnetite and hematite on the south coast. The former ore as mined is soft and wet, and it runs, when dry, about 46 per cent iron, 0.01 per cent phosphorus, and 1.7 per cent chromium. The Bethlehem Steel Co. is the principal owner. The iron deposits of Mexico are scattered over several states. The country manufactures pig iron, the largest plant, located at Durango, producing 50,000 to 100,000 tons yearly. Venezuela has several deposits of iron, but only one has been worked. This is the Imataca deposit, near the Orinoco River, about 75 miles from its mouth. The ore is a mixed magnetite and hematite and analyzes about 66 per cent iron, 0.031 per cent phosphorus, 0.045 per cent sulphur and 0.139 per cent titanium. Argentina smelts a small amount of iron ore yearly and Paraguay is reported to have abundant ore, including magnetite, hematite and limonite, and running as high as 50 per cent iron. There is a plant at Ibicuy for working the ore.

Part II, which discusses Latin-American resources of manganese, chromium, tungsten, vanadium, molybdenum, cobalt, titanium and zirconium, will appear in a subsequent issue.

Coke Production Statistics for 1921

The first convincing demonstration that the byproduct branch of the coking industry could maintain itself in a period of industrial depression more strongly than the beehive branch was made in 1921.

In 1921 the output of byproduct coke was almost 20,000,000 tons and that of beehive coke was about 5,500,000 tons, figures that show a striking contrast to those for 1920, when the output of byproduct coke was more than 30,000,000 tons and that of beehive coke was more than 20,000,000 tons. The output of beehive coke in 1921 was less than that in any other year since 1885. The output of byproduct coke in 1921 also showed a marked decline from that of 1920, but despite the extraordinary slump in business, which greatly lowered the output of byproduct coke, it was greater in 1921 than in any preceding year except 1917, 1918, 1919 and 1920.

TABLE I—ESTIMATED MONTHLY PRODUCTION OF BEEHIVE AND BYPRODUCT COKE AND OF PIG IRON IN THE UNITED STATES IN 1921

Month	Beehive Coke (Net Tons)	Byproduct Coke (Net Tons)	Pig Iron (Gross Tons)
Monthly average 1920	1,708,000	2,569,000	3,077,000
January, 1921	1,137,000	2,278,000	2,416,000
February	865,000	1,888,000	1,937,000
March	575,000	1,772,000	1,596,000
April	328,000	1,519,000	1,193,000
May	300,000	1,590,000	1,221,000
June	232,000	1,408,000	1,065,000
July	180,000	1,297,000	865,000
August	248,000	1,383,000	954,000
September	289,000	1,423,000	986,000
October	416,000	1,734,000	1,247,000
November	477,000	1,766,000	1,415,000
December	514,000	1,860,000	1,649,000
Total, 1921	5,561,000	19,918,000	16,544,000

TABLE II—SHOWS THE BYPRODUCT OVENS IN USE AT BEGINNING AND END OF 1921 AND UNDER CONSTRUCTION JAN. 1, 1922, BY TYPES

Type	In Existence Jan. 1, 1921	In Existence Jan. 1, 1922	Under Construction Jan. 1, 1922
Koppers	6,036	6,303	85
Semet-Solvay	2,415	2,463	..
United-Otto	1,513	1,413	..
Rothberg	282	282	..
Wilputte	206	206	..
Cambria-Belgian	250	310	.
Gas machinery	33	33	..
Klönne	42	42	..
Roberts	104	104	..
Piette	...	8	..
Total	10,881	11,164	85

Table I shows the production, by months, of each type of coke, and the output of pig iron.[1] The fluctuations in the output of coke evidently followed closely the fluctuations in the output of pig iron.

Capacity of Byproduct Ovens

The annual production of byproduct ovens in operation on Jan. 1, 1922, would be 44,275,000 net tons of coke if the ovens continued in operation without interruption 365 days in the year. As the average yield of coke for the industry amounts to 69.9 per cent of the coal used, this output represents a coal-carbonizing capacity of 63,340,000 net tons a year. However, operation at full capacity is impossible, even in periods of good demand for coke, and the figures for operation at 85 or 90 per cent of full capacity really represent a normal maximum for any considerable period. In other words, the byproduct coke ovens operable Jan. 1, 1922, can treat only about 55,000,000 net tons of coal a year.

[1]Figures on pig iron for 1920 from American Iron and Steel Institute; those for 1921 from *Iron Age*.

Legal Notes

By Wellington Gustin

Delivery f.o.b. Construed

In an action by the Partola Manufacturing Co. against the General Chemical Co., brought to recover damages for a breach of contract in the refusal to deliver blue vitriol, a judgment on trial was rendered favorable to the defendant, but this was reversed and a new trial granted. The sale in suit was made through a broker for the General Chemical Co., selling agent for Nichols Copper Co., to the Partola Mfg. Co., consisting of 150 tons Nichols Triangle brand 98-99 per cent, large crystals, blue vitriol, standard quality. A broker's memorandum was afterward amplified by written contracts. Goods were for consumption and not for resale. Plaintiff's factory was situated at 207 East Tenth St., and the delivery demanded by it upon Nov. 10, 1917, was for delivery at that place, or, if that were not practical, to any downtown New York pier. The brokers were the selling agents for the defendant, which had its factory in Long Island City, which is within Greater New York City.

The first question presented was the effect of a provision in the contract that delivery was to be in barrels "carload lots f.o.b. New York." Since the seller's works were at Long Island City, within Greater New York, and as the goods were sold for consumption by the plaintiff, whose factory was in Manhattan, this provision for delivery f.o.b. New York is ambiguous.

Some of the experts as to custom testified that the effect of this provision in such a contract has no significance. However, the court says an f.o.b. contract is recognized as placing the cost of transportation upon the buyer, and, while Long Island City is in Greater New York, a fair interpretation of this contract calls for a transportation of the goods to Manhattan at cost of the buyer.

The contract of sale required the buyer to give shipping instructions as to carrier and transportation, and as to whether the goods should be transported by truck or by water. Plaintiff failed to ask for deliveries in October and when it demanded deliveries on Nov. 10, the defendant replied that as October had passed it was not obliged to make deliveries upon the November demand. However, in view of the ambiguity of delivery, the court said delivery either to plaintiff buyer's factory or to some dock in New York City was not sufficiently specific.

Failure to Order Delivery of Installments

On the question of failure to order delivery of one or more installments under a contract providing for delivery by installment, section 126 of the personal property laws provides: "It depends in each case on the terms of the contract and the circumstances of the case whether the breach of contract is so material as to justify the injured party in refusing to proceed further and suing for damages for breach of the entire contract, or whether the breach is severable, giving rise to a claim for compensation, but not a right to treat the whole contract as broken."

The court said, assuming that there was unreasonable delay in sending shipping instructions and making demand for the installments which might be due in October, there is nothing in the case to show that such a failure on the part of the plaintiff was sufficiently material to authorize the defendant to renounce entirely its obligations under the contract. The court points out that it was only when the price of the product had risen somewhat and the execution of the contract would have been unprofitable to the defendant that it refused to perform, and then placed its refusal upon an entirely inadequate ground. In the written contract it is provided: "Each month's shipment to be treated as a separate and independent contract, but if buyer fails to fulfill terms of order, purchase or payment under this or other contracts, seller may defer further shipments until such default is made good, and may at its option treat such default as final refusal to accept further shipments hereunder." Refusal was not based on any such provision, so judgment was reversed and new trial granted.

No Recovery for Damage to Soda Lakes by Government Project

Suits involving Little Soda Lake and Big Soda Lake, located in Churchill County, Nevada, have been decided by the United States Supreme Court favorably to the federal government. Actions to recover $35,000 and $170,000 by the John Horstmann Co. and the Natron Soda Co., respectively, against the United States were begun in the Court of Claims. From judgments dismissing the actions the claimants appealed to the Supreme Court, which has affirmed the judgments.

Little Soda Lake and surrounding land were owned by the Horstmann Co., while Big Soda Lake was owned by the Natron Soda Co. and each was manufacturing soda from the waters of the respective lakes in 1906. This controversy turns upon the condition of the lakes at that time and their condition after an irrigation project was instituted by the government, called the Truckee Carson project.

The lakes are situated in an area known as the Carson Sink Valley, and in 1906 were dry bodies and the source of soda supply to the soda companies involved.

Level of Lakes Rise, Companies' Property Destroyed

From prior to 1867 to 1906 the level of the lakes had not varied more than 2 ft. In 1906 the United States Reclamation Service, acting under the authority of acts of Congress, constructed the Truckee Carson project, consisting of dams, canals and other structures whereby through the usual means large quantities of surface waters theretofore confined to the watershed of the Truckee River were in 1906 and thereafter each year transported to the watershed of the Carson River and distributed to various lands in the Carson River Valley, such that the volume of the water in the lakes has continually increased, and the level of the lakes has risen about 19 vertical feet up to 1916, in consequence of which the value of the companies' properties has been destroyed.

The government contended there was the absence of any causal connection between its works and the injury to the properties of the soda companies. The companies fought the governmental contention and deductions, and opposed to them the difference in conditions before and after the execution of the canal project, and their reasoning seems to have the support of the methods that the world employs in the investigation of its phenomena and instances, says the court. However, assuming that

there was causal connection between the work of the government and the rise of waters in the lakes and the consequent destruction of the soda properties, the court held that it did not follow that the government was under obligation to pay therefor, as for the taking of the properties.

Appropriation of Property Implies Contract to Pay

It was contended that the appropriation of property by the government implies a contract to pay its value; and it was further declared that there need not be a physical taking, an absolute conversion of the property to the use of the public, but that if by public works the value of the property of an individual is substantially destroyed its value is taken within the scope of the Fifth Amendment.

The court says while this is a general rule, still there are exceptions. To bind the government there must be implication of contract to pay, but the circumstances may rebut that implication. That is, what is done may be in the exercise of a right and the consequences only incidental, incurring no liability.

This Case Outside the General Rule

It further announced that it would border on the extreme to say that the government intended a taking by that which no human knowledge could even predict. It was found that there is obscurity in the movement of percolating waters, and that there was no evidence to remove it in the present case, and necessarily there could not have been foresight of their destination nor purpose on the government's part to appropriate the properties. Any other conclusion would deter from useful enterprises on account of a dread of incurring unforeseen and immeasurable liability. This comment is of especial pertinence.

Mississippi Anti-Gin Act Upheld by Supreme Court

In a suit testing the constitutionality of an act of the Legislature of Mississippi called the "anti-gin act" the Supreme Court of the United States has upheld that law and affirmed judgment against the Crescent Cotton Oil Co. This act prohibits corporations from owning or operating any cotton gin, when such corporation is interested in the manufacture of cottonseed oil or cottonseed meal. A proviso permits cottonseed oil companies to operate gins of a prescribed capacity, but only in the city or town where their oil plants are located. A penalty is provided for violation of the act, but corporations are permitted to operate their gins for a reasonable time until they may be sold.

The Crescent company, organized under the Tennessee laws, owned and operated a cottonseed oil mill at Memphis, Tenn., and two cotton gins in Mississippi. It disregarded the anti-gin act, and the Supreme Court of Mississippi affirmed a judgment against it, declaring its right to do intrastate or local business in Mississippi forfeited, and perpetually enjoining it from operating cotton gins in the state, as well as ordering it to dispose of its gins operated within the state within 90 days. A penalty was also imposed.

The case was argued before the U. S. Supreme Court upon the assumption that the anti-gin act was enacted in aid of the anti-trust laws of the state, under the conviction on the part of the Legislature that it was the practice of corporations operating oil mills and cotton gins to depress the price of ginning regardless of cost, until local competition was suppressed or brought to terms, and then to charge excessive prices for ginning and to pay unfairly low prices for seed.

Company Claimed Unconstitutionality

The company relied upon the unconstitutionality of the act, which it asserted upon two grounds—namely, first, that as to the company it imposes a direct and substantial, and therefore unconstitutional, burden upon an instrumentality of interstate commerce, and second, that the act, being applicable to corporations and not to individuals owning and operating cotton gins, it denies to the company the equal protection of the laws.

The basis of the first contention was the claim that it had become impracticable for the oil company to carry on its oil-manufacturing business successfully when purchasing its cotton seed supply from other ginners or from brokers, that for this reason the company acquired its two cotton gins in Mississippi and nine in other states to obtain the advantages of purchasing seed direct from the growers of cotton, and that all the cotton seed which it had purchased in connection with gins was shipped in interstate commerce to its oil mill at Memphis, the gins being in effect "feeders" to its oil mill, and therefore essential means and instrumentality of interstate commerce.

Manufacture Is Not Commerce

But the Supreme Court says manufacture is not commerce, and though an article, when in the process of manufacture, is intended for export to another state, this circumstance does not render it an article of interstate commerce.

It is only when the ginning of cotton is completed, and the seed, if sold for shipment out of the state, has been committed to a carrier for interstate transport, that it passes from the regulatory power of the state into interstate commerce and under the federal laws and power.

Again, it is said that since manufacturing operations are not commerce, cotton gins are not instrumentalities of interstate commerce; and the anti-gin act, prohibiting the ownership or operation of any cotton gin by any corporation interested in the manufacture of cottonseed oil or meal, does not impose a direct burden on interstate commerce in violation of the United States Constitution, though the corporation operating again ships all the cotton seed purchased in connection with its gins in interstate commerce. Further, the court says, the act does not deny the equal protection of the laws to foreign corporations owning cotton gins in Mississippi, because applying only to corporations, since, where a foreign corporation has no federal right to do business in a state, and no contract right is involved, and there is no employment by the federal government, the state may impose conditions in its discretion on the right of such corporation to do business, even to the extent of excluding it altogether, and in such case the inherent difference between corporations and natural persons sustains restrictions applicable to corporations alone.

Again, any reasonable classification, not arbitrary, adopted by a state in the exercise of police power will be sustained against an attack based upon the equal protection clause of the Fourteenth Amendment, and the anti-gin act, forbidding operation of cotton gins by corporations manufacturing oil or meal, does not make a classification so without reasonable basis as to be arbitrary, because applying only to corporations.

The Manufacture of Electrolytic Iron

General Data for a Commercial Plant Manufacturing Pure Iron for Electrical Purposes—Effect of Composition, Temperature and Circulation of the Electrolyte Upon the Physical Properties of the Deposited Metal

By G. F. McMAHON

ELECTROLYTIC IRON deposited from the ammonium sulphate-chloride-ferrous sulphate bath after treatment by special processes is suitable as a substitute for certain grades of sheet iron and iron wire in various types of electrical equipment. Up to within the last few years its use on a commercial scale made slow progress, its high cost delaying investigation and manufacture perhaps more than anything else.

There is a process in Grenoble,[1] France, now in commercial use manufacturing boiler tubes from a ferrous chloride electrolyte. The Eustis process,[2] a chloride process, promises to become commercial in this country. It is the purpose of these to produce a more or less ductile deposit by exercising special control of the electrolyte temperature and current densities used. It is the purpose of the process to be described to produce a brittle deposit, also by special means, that can be pulverized. The first two processes referred to in this paragraph differ from the third in purpose as well as in technical detail.

Electrolytic iron was first made in about 1860 by Bietz[3] for the purpose of making a few magnetic tests. Shortly after that more tests were made by numerous other scientists. Boettger[4] probably was the first man to make any commercial use of the material. He deposited iron from a ferrous ammonium sulphate solution for the purpose of facing printer's type.

C. F. Burgess and Taylor[5] tested electrolytic iron for its magnetic properties after being deposited and cut into rings. They found the material hard and brittle. Dr. Burgess and Carl Hambeuchen[6] produced about 1,000 lb., for experimental purposes only, about the year 1904 by using an aqueous solution of ammonium sulphate and ferrous sulphate as the electrolyte. Previous to these investigations Stotelow[7] in 1873 tested electrolytic iron for its magnetic properties after being deposited. He used a ring of soft electrolytic iron with two coils wound around it and obtained important results on the permeability of such material.

A very good bibliography on these earlier investigations is compiled by T. Yensen,[8] who has done noteworthy work on melting and alloying in vacuo, together with subsequent testing of the metals.

If a chemical analysis were made of the electrolyte used by O. P. Watts and M. H. Li[9] in 1914 in their experiments on the "Effect of Addition Agents in Electrodepositing Iron," it would be found to be nearly the same as that used in the operation of a large plant, although different chemicals are used to start. Ammonium chloride may be used in place of ferrous chloride to obtain the desired chlorine content. Whatever the electrolyte lacks in ammonia may be made up by adding the correct proportion of ammonium sulphate; the iron content is obtained by using the correct amount of ferrous sulphate (copperas). Ammonium chloride is more desirable to use than ferrous chloride, which is sometimes hard to obtain in large quantities.

Ammonium chloride had been used previous to 1886 and is mentioned by Alexander Watt in his book on Electrodeposition published in that year. He mentions that Gore had used that material successfully together with ferrous sulphate. I have found this to hold true in the operation of small baths, but in large volumes the ammonium concentration must be increased.

General Layout

In design, an electrolytic iron refining unit can be laid out on the same general principles as a copper, zinc or lead refinery—that is, the tanks are connected electrically in series-parallel and are approximately of the same size. Wooden tanks, inside dimensions of 3 ft. wide, 10 ft. long and 4 ft. deep, are built and assembled together on piers well above the basement floor. No lining is necessary.

The electrolyte is generally neutral or very slightly acid or alkaline in reaction. Lead piping gives the best service and withstands corrosion better than wrought iron, cast iron or bronze, although any of the latter may be used for some time before showing appreciable signs of wear.

The writer has found it necessary to filter the electrolyte continuously in order to keep the impurities at a minimum. Electrolyte flows through each tank at the rate of approximately 3 gal. per minute. The overflow is collected in a launder and carried to a pump tank, where it is mixed with Filter-Cel and pumped by a special type bronze centrifugal pump through a clam-shell Sweatland filter press.

It is advisable to have more than one filter press in operation to permit cleaning of the filter leaves periodically without delaying filtration. The use of diatomaceous earths promotes the formation of a porous cake on the filter leaves. Experimentally it has been found almost impossible to filter any great length of time unless such material is used, on account of the slimy nature of the solids which tend to fill up the pores of the filter cloth.

From the filter press the clear electrolyte flows to the head tank, whence it flows by gravity into the electrolytic tanks and again to the pump tank, the flow

[1] "Electrolytic Iron a Commercial Product," by Bradley Stoughton, CHEM. & MET. ENG., Jan. 18, 1922, vol. 26, p. 128.

[2] C. P. Perin and D. Belcher, *Mining and Metallurgy*, December, 1921.

[3] Bietz, *Phil. Mag.*, vol. 20, p. 458 (1860).

[4] "Electrodeposition," by Alexander Watt, 1886.

[5] Burgess and Taylor, *Trans.* Am. Inst. Electrical Engineers, vol. 25, p. 459 (1906).

[6] Burgess and Hambeuchen, *Trans.*, Am. Electrochem. Soc., vol. 5 (1904).

[7] Stotelow, *Phil. Mag.*, vol. 45, p. 40 (1873).

[8] Yensen, Bull. Univ. of Illinois, vol. 11, No. 28. Vol. 12, No. 29. Vol. 13, No. 12.

[9] Watts and Li, *Trans.*, Am. Electrochemical Soc., vol. 25 (1914).

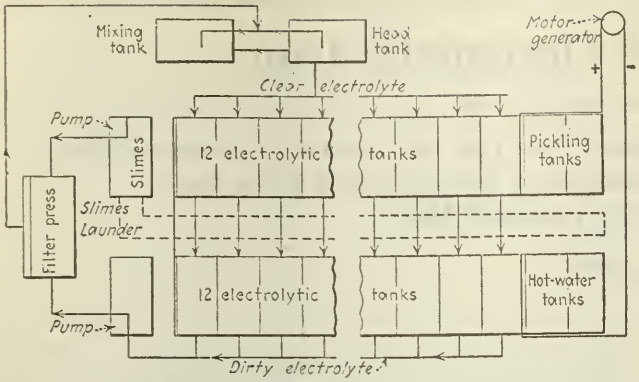


FIG. 1—SCHEMATIC LAYOUT OF ELECTROLYTIC IRON PLANT. CAPACITY 40 TONS PER MONTH

being a complete cycle. Provision is also made for the collection of anode slimes during clean-up periods and for their filtration. A traveling crane should be used, with capacity of 4 tons, for lifting sixteen electrodes at one time from a tank. Current is supplied by a 120-kw. d.c. generator, 3,300 amperes at approximately 36 volts. Pickling and hot water tanks are also installed, with the necessary steam and water lines. Fig. 1 illustrates the layout of tanks.

Anodes

Where a good grade of electrolytic iron is to be manufactured, the anode must be as pure as possible. For ordinary purposes bessemer or open-hearth steels can be used. Anodes generally used have the following approximate chemical analysis:

	Per Cent		Per Cent
Carbon	0.60	Manganese	0.30-0.50
Phosphorus	0.05	Sulphur	0.10
Silicon	0.23		

Anodes are cast to size, 3 ft. 8 in. x 3 ft. 5 in. x 2 in. thick, overall dimensions. The main body of the anode is 2 ft. 4 in. x 3 ft. 3 in. x 2 in. thick. The lugs are approximately 1 in. in thickness.

Sixteen anodes are generally used per tank on a spacing of approximately 7½ in. center to center. More anodes and cathodes can be used on closer spacing, but the current efficiency and quality of deposit are adversely affected.

Cathodes

The cathode starting sheets are made from cold-rolled steel $\frac{3}{16}$ in. thick x 2 ft. 6 in. x 3 ft. 8 in., riveted to solid hard-drawn copper bars, ½ in. x 1 in. x 41 in. long. In order to prevent the deposited iron from falling off the sheet steel blanks, which sometimes occurs, I found it advisable to drill several ¾-in. holes in the plate about 6 in. apart near the solution line. During deposition the metal nearly fills up these holes and binds the deposit to the blank sheet.

Fifteen cathodes are used per tank. The sheet steel cathode blanks before being used for deposition of the iron are pickled in dilute sulphuric acid, washed in hot water and coated with a light grade of mineral oil, preferably kerosene. Cathodes receive a 12- to 13-day deposit of iron and at the end of that time are removed, washed well in hot water and dried in an air blast. The iron deposit is then stripped, and is nearly ¼ in. thick. It has the following approximate chemical analysis:

	Per Cent		Per Cent
Carbon	0.014	Manganese	0.029
Phosphorus	0.013	Sulphur	0.003
Silicon	0.028		

It is an interesting fact that small tanks, containing 5 gal. or less, do not easily permit the formation of "trees" on the cathodes. The fact that treeing took place at an unprecedented rate during the early operation of a large unit caused the author a great deal of worry. After making slight changes in the electrolyte this undesirable condition was almost eliminated. It was found that the addition of only a trace of glue to the electrolyte rounded off the edges and sharp points, reducing the amount of treeing.

Electrolyte

The electrolyte used is composed of ammonium and ferrous salts dissolved in water. It has the following approximate chemical analysis:

Iron	60 grams per liter
Chlorine	25 grams per liter
Ammonia	25 grams per liter

The successful deposition of iron depends almost entirely upon the care used in maintaining this electrolyte.

While at first perhaps slightly acid in reaction, the electrolyte later becomes alkaline, and additions of sulphuric or hydrochloric acids in calculated amounts become necessary. Otherwise the deposit becomes full of suspended dark green ferrous hydrate. An electrolyte slightly acid in reaction produces a brittle, curly and mirror-like plate, although other conditions to be discussed later sometimes produce a similar result. If the electrolyte is neutral or very slightly alkaline, an excellent matte gray deposit is obtained which is not quite so brittle and is more adherent. The latter is the plate desired.

When cold the electrolyte is a poor conductor of electric current. It is advisable to warm the solution to about 45 deg. C. before turning on the current. An open steam jet is used. After the electrolyte becomes warm no further external heating is necessary. During summer months the temperature will rise somewhat above 45 deg. C. and unless good ventilation is resorted to the heat and humidity are oppressive to the workmen.

There is practically no loss, other than carrying-out losses, of ammonia, chlorine or iron during electrolysis. The iron, on the contrary, increases in concentration due to the addition of acids. Acid consumption is not high and does not add much to the cost of operation.

Power

A current density of between 12 and 15 amp. per sq.ft. of immersed cathode area produces satisfactory results. The actual yield of deposited iron at the above current density is approximately 90 per cent of the theoretical amount calculated according to Faraday's law; 3,300 amp. is used per tank at approximately 1.3 volts. The average output per kilowatt hour is approximately 1.5 lb. of refined iron.

Experimental Data

Unless otherwise stated, all experimental results noted in Table I were obtained at a current density of approximately 12 amp. per sq.ft. of immersed cathode area with the electrolyte at approximately room temperature, 25 to 30 deg. C.

The chemical analyses of the electrolytes are expressed in grams of Fe, NH_3 and Cl per 100 c.c. The capacity of the bath used was a little less than 10 gal.

Glue. A small amount is distinctly beneficial in the operation of large tanks, a fact which the early investigators, Watts and Li,[9] overlooked, or rather did not

perhaps have the opportunity to investigate. When other conditions are as they should be, glue forms deep solid ridges lengthwise of the cathode, which are very desirable when a solid plate, free from trees, is desired.

Stratification and Re-solution. Formation of different solution layers is caused by inefficient circulation of the electrolyte, a common occurrence in the electrolytic refining of several metals. Slow circulation is very apt to permit the acid additions to settle to the bottom of the tanks, while the top liquors become strongly alkaline in reaction. This of course affects the appearance of the cathode deposit, and an experienced operator can readily detect the condition by inspection.

Cathode re-solution is dependent on the purity of the deposited iron and on the ammonium concentration.

Ammonia. Low ammonia in the electrolyte causes the cathode to gas badly during deposition, due probably to re-solution of the iron from the resulting acid reaction, or from the decomposition of water, or both. If the ammonia concentration is not increased, the current efficiency is lowered and a rapid increase in the iron concentration of the electrolyte occurs, if acid additions are made in order to keep up the appearance of the deposit.

In large tanks the ammonium concentration of the electrolyte is therefore of great importance. Low ammonia also seems to reduce the magnetic permeability of the resulting iron, probably due to the greater amount of hydrogen in the immediate vicinity of the cathode. In small tanks no such wide variation occurs, on account of better electrolyte circulation.

TABLE I—SUMMARY OF TEST CATHODES

Grams Per 100 c.c. Fe	NH_3	Cl	Glue	Elec. Temp.	Remarks
6.00	1.30	2.50	None	Room	Good plate.
6.00	1.30	2.50	Trace	Room	Good plate.
6.00	1.30	2.50	Excess	Room	Bad plate, brittle.
6.00	1.30	2.50	Excess	Room	Bad, brittle, laminated.
6.00	1.60	0.10	None	Room	Rough plate.
6.00	1.60	0.80	None	Room	Fair plate.
6.00	1.60	1.50	None	Room	Fair plate.
6.00	1.60	2.79	None	Room	Smooth plate.
6.00	1.25	2.48	None	52 deg. C.	Good plate, soft.
6.00	1.25	2.48	None	23 deg. C.	Good plate, hard, brittle.
6.00	0.00	1.60	None	Room	Spongy.
6.00	0.40	1.60	None	Room	Slightly spongy.
6.00	0.75	1.60	None	Room	Good plate.
6.00	2.02	1.60	None	Room	Good, peeled at start.
8.00	1.60	2.75	None	Room	Rough.
3.50	1.34	2.50	None	Room	Good plate.

A high ammonia concentration improves the conductivity and increases the current efficiency, but it sometimes produces a shiny, brittle deposit similar to that from a slightly acid electrolyte. I am of the opinion that some slight impurity in the ammonium sulphate (the commercial grades do vary greatly from gas and coke-oven plants) is producing this effect, as this condition soon wears itself out and finally a good deposit is obtained. With no ammonia in the electrolyte, a soft mushy deposit of no apparent commercial value was obtained.

Sulphate. Another feature affecting the appearance of the iron deposit is a high ferrous sulphate concentration. This condition will increase the tendency of the cathode to "tree."

Chlorine. A high chlorine concentration is generally beneficial. If there is occluded chlorine or chlorides in the metal, rapid corrosion will occur on exposure to the atmosphere. Care must be exercised therefore in the control of the chlorine content of the electrolyte and in the cathode deposit.

Temperature and Hardness. The temperature of the electrolyte affects several things, the most important being the hardness and magnetic permeability of the metallic deposit. It must not be understood, however, that all variations in permeability are due to lack of temperature control. Some other causes have already been mentioned.

Iron deposited at a temperature over 50 deg C. from this electrolyte is softer than that deposited at 25 deg. C., other conditions being the same. The hydrogen content, which is quite difficult to determine, as well as the crystalline structure, may be affected by temperature of deposition. Hardness tests made on a Brinell machine, using 500 kg. pressure and a 10-mm. diameter ball, were not satisfactory, since the material was too brittle and cracked under the strain. Scleroscope hardness was 35 to over 40. A satisfactory method of determining the difference in hardness is by noting the time taken to pulverize a definite amount to a sized powder, say 80 mesh. Highly permeable soft material oftentimes takes several days to pulverize, while harder material may be easily reduced in a few hours.

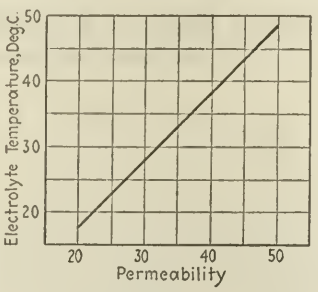


FIG. 2—EFFECT OF TEMPERATURE OF DEPOSITION ON PERMEABILITY. H = 1

Temperature and Permeability. If electrolytic iron be deposited at different temperatures under the same conditions with respect to current density and composition of the electrolyte, its magnetic permeability is almost directly proportional to the temperature of the electrolyte between the limits 25 and 50 deg. C. See Fig. 2.

The variation in the permeability of freshly prepared electrolytic iron has been known for some time and has been discussed by Terry.[10] Apparently he did not investigate the causes for such variation from the standpoint of electrodeposition, which is of importance. It has been the writer's experience that the rate of annealing and the permeability obtained is dependent largely upon the electrolytic baths and the changes occurring therein.[11]

Cement-Making Prospects in Ceylon

Some time ago several samples of clay and lime were sent from Ceylon to the Imperial Institute in London to ascertain if any of them were suitable for the manufacture of cement. It is now reported that some Jaffna clays are quite suitable for the purpose.

The commercial aspect of the manufacture of cement in Jaffna (an island separated by a very narrow channel from the northern extremity of Ceylon) is now being examined. The main difficulty, so the Ceylon correspondent of the *London Times Trade Supplement* reports, is the high price of coal. The possibility of developing a small hydro-electric scheme to operate the plant is now being studied. Experiments are also being made to find out if palmira or coconut shells could be used in place of coal.

The clays and limes of the island have not been studied systematically with a view to employing them for industrial purposes.

[10]Terry, *Phys. Rev.*, vol. 30, p. 133 (1910).
[11]Storey, *Trans.*, Am. Electrochemical Soc., vol. 25 (1914).

Introduction of Niter Into Sulphuric Acid Processes as Mixed Acid

A Description of a Successfully Operating Auxiliary Plant in Which Nitric Acid Is Made and Absorbed in Glover Tower Acid for Introduction Into the Main System

By E. L. LARISON

IN THE usual sulphuric acid plant the oxides of nitrogen are introduced into the process by potting nitrate of soda and sulphuric acid in open cast-iron pots set in the flue leading from the burners to the Glover tower.

A few plants make nitric acid in a separate apparatus and run it into the Glover tower as required. In some cases fuel-fired retorts are used, the vapors of which discharge into the gas stream entering the Glover tower. Introduction of water solution of nitrate of soda into towers or chambers is practiced to a certain extent also.

A somewhat different plan has been in use at Anaconda for the past 4 years, and it has worked out so smoothly and presents such economies that a description of it seems worth while. This scheme has also been used at Garfield and perhaps two or three other places. When the plant was installed at Anaconda it was believed to be a new departure, but since that time it has developed that one of the explosives companies tried out substantially the same arrangement for making mixed acid about 15 years ago. The scheme was not suitable, however, for the purposes of the company.

In brief, this plant consists of one or more standard nitric acid retorts, a condensing tower, a coil pipe acid cooler, a pump and the necessary tanks. Nitrate of soda and 60 deg. Bé. sulphuric acid are introduced into the retorts and heated by a coal fire to produce nitric acid vapor. This vapor is conducted into the base of a small masonry tower, over which is continuously circulated a definite charge of cool 60 deg. Bé. sulphuric acid. The nitric acid is condensed and the warm mixture of sulphuric and nitric acids issuing from the tower is passed through the cooler, pumped up and reintroduced into the tower. When the nitrate of soda has been completely decomposed, a mixed acid of definite composition has been made. This mixed acid is introduced as needed into the Glover towers of the chamber and packed cell plants.

Advantages of This Method Over Usual Practice

This arrangement presents several advantages over any of the others enumerated above. In the ordinary potting plant the vicinity of the pots is usually a mess, difficult to keep tidy and shipshape. There are, too, certain things wrong in theory about potting. The introduction of the charges is usually accompanied by an inrush of air which dilutes the gas. The evolution of the nitric acid is irregular, a fresh charge giving it off rapidly then slowing down to almost nothing. In starting up or in case of irregular running, just when it is desired to get in an abnormal amount of niter, the flue is cold and one must wait, sometimes a day or two, to establish a process, or else tap out incompletely decomposed charges. Potting must be done at rather frequent intervals. Except in very small plants, at least one man must be on duty all the time to charge and tap.

In the mixed acid scheme under discussion a clean little independent plant does the work. The nitric acid is introduced into the chamber process at an absolutely uniform rate which can be perfectly controlled. No false air is admitted. Starting up the chambers is accomplished in a few hours and irregularities in the flow of SO_2 are easily kept pace with. One man in one shift can make mixed acid corresponding to 4,000 to 5,000 lb. of niter.

The chief advantage over fuel-fired pots discharging into the flue is in the lower labor requirements. The advantages over the straight nitric acid plant lie in the simplicity and rugged character of the mixed acid plant and in the fact that this mixed acid can be handled in ordinary lead and iron pipes, pumps and tanks, just about as 60 deg. Bé. sulphuric acid can be handled.

An installation which has been in use for the past 4 years and which has given entire satisfaction is shown in plan and elevation in Figs. 1 and 2.

Retort Details and Setting

The retorts, Fig. 3, are of the usual design and are 6 ft. inside diameter and 6 ft. inside depth. They were cast at the local foundry and the metal mixture used was steel scrap 35 per cent, No. 1 pig 32.5 per cent, No. 2 pig 32.5 per cent. These retorts have a very long life, certainly more than 1,500 charges.

The construction of the brick setting is perhaps a little different from that ordinarily used. The tapping

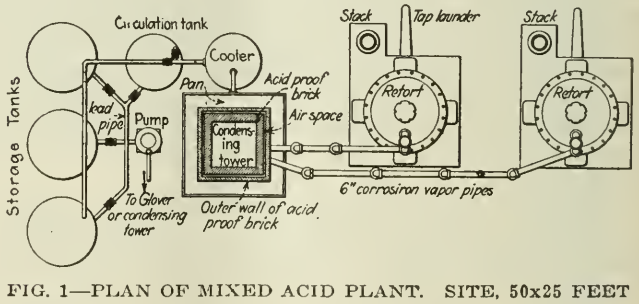


FIG. 1—PLAN OF MIXED ACID PLANT. SITE, 50x25 FEET

spout is on the opposite side from the fire and ash doors, an arrangement which is more convenient than having them on the same side. The fire gases are directed around the pots by corbeling in the walls as shown in Fig. 4. A solid 9-in. arch of firebrick covers the firebox, and the spout is protected from direct action of the flame by a small brick pier. The retort cover con-

tains the usual openings for charging and carrying away vapor, and is covered with brick.

The connections between the retorts and the condensing tower are of 6-in. Corrosiron pipe with horizontal bell joints. These pipes are apparently unaffected by 4 years service.

The Condensing Tower

The condensing tower serving these two retorts is of acid-proof brick laid in silica-silicate of soda mortar. The walls consist of 9-in. main wall with a 4-in. veneer

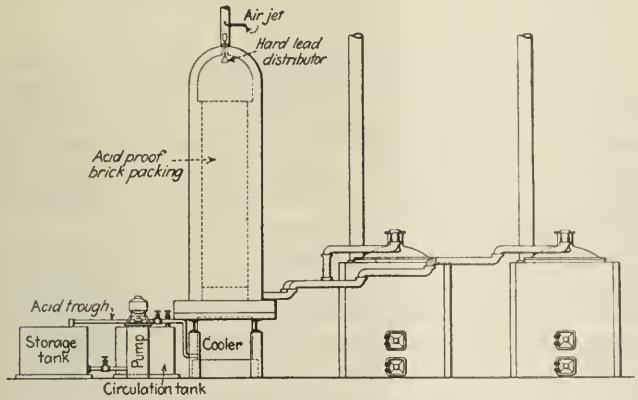


FIG. 2—ELEVATION OF MIXED ACID PLANT

course separated 2 in. from the main wall, but bonded to it in places. This construction makes the outside of the tower entirely clean and dry, as any acid which leaks through the main wall cannot cross the 2-in. space between the walls. The top of the tower is a hemispherical brick dome.

This tower is 20 ft. high and 4 x 4 ft. inside. The packing is of standard dimension acid-proof brick laid on edge and the column is 12 ft. high. The gross packed volume is therefore 192 cu.ft. The tower is built in a

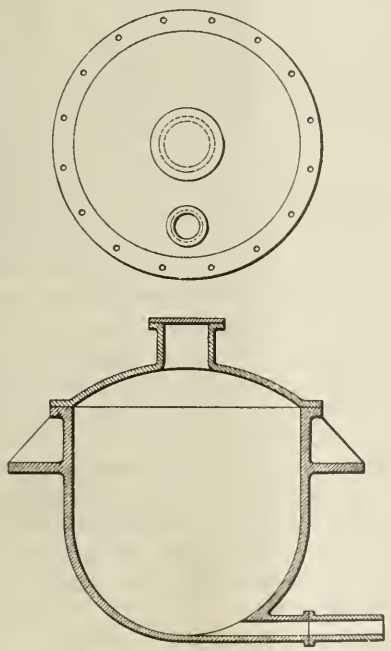


FIG. 3—TYPE OF NITRIC ACID RETORT USED

pan of 24 lb. lead with the upper part of the pan sides of Corrosiron plates. The sides of the pan are about 12 in. from the walls of the tower. This pan was originally of lead throughout, but it was found that the side walls from the acid level to the top were quickly corroded away. The lead was therefore cut down to a line a few inches below the acid level and Corrosiron plates were put in. This corrected the trouble. Beyond this no changes or repairs whatever have been necessary on this tower and it will probably require none for many years to come.

Acid is fed into the tower and distributed through a hard lead splash plate. A 6-in. Corrosiron pipe containing an air jet leads from the top of the tower to a point just above the roof. The air to this jet is so controlled as to maintain 0.25 to 0.50 in. of water suction at the retorts.

The acid issues from the tower pan into a circular lead tank 5 ft. in diameter and 3 ft. deep, containing two concentric coils of 1½-in. lead pipe through which cold water is circulated. This cooler is covered, and in operation is always full of acid. It discharges into either a circulation tank or a storage tank as desired. The tanks are connected to the boot of a cast-iron Lewis vertical centrifugal pump, which pumps to the top of the condensing tower or to the top of the Glover tower of the chamber plant. The performance of this pump has

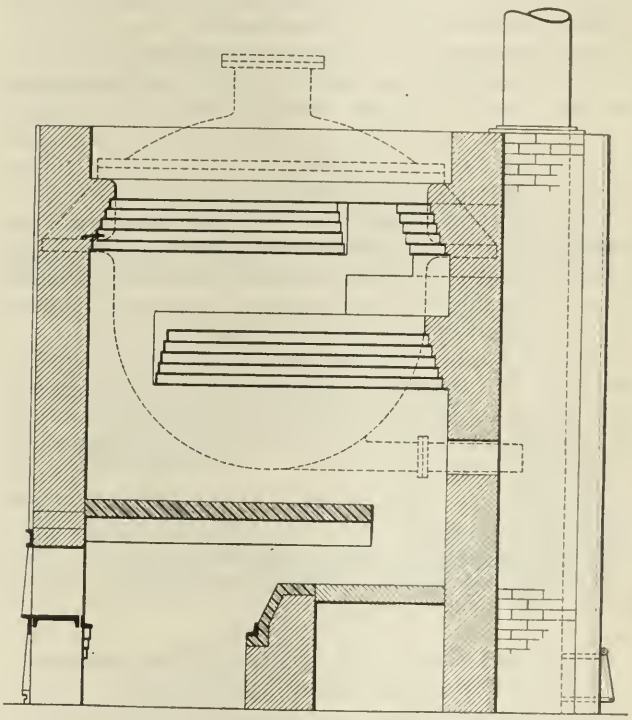


FIG. 4—RETORT SETTING

been rather remarkable. It has operated about 8 hours almost every day for over 2 years and not a cent has been expended upon it in the way of repairs.

Operation of Plant

Ordinarily the operation of this plant is conducted with the following routine. The operator comes on at 7:30 a.m. and with the help of one laborer puts 2,000 lb. of nitrate of soda into each retort, with 2,500 lb. of 60 deg. Bé. sulphuric acid. This occupies 30 to 40 minutes. The laborer is then released and the remainder of the run is conducted by one man alone.

Fire is started under the retorts and a charge of 60 deg. Bé. sulphuric acid for the condensing tower is drawn. For 4,000 lb. of nitrate of soda this acid charge amounts to 165 cu.ft., or about 8.8 tons. This acid is put into circulation over the tower, through the cooler and circulating tank and back to the pump. Once this

circulation is properly set it requires no further attention. The rate of acid flow is about 3 to 4 tons per hour.

Hourly temperatures are taken at the vapor exit of each retort and of the acid entering and leaving the condensing tower. The firing is conducted largely with these as a guide. A typical set of these temperatures is given in the following table.

TABLE I

Time	Temperature of Retort, Deg. F.	Temperature of Acid Entering Tower, Deg. F.	Temperature of Acid Leaving Tower, Deg. F.
8:00 a. m.	...	70	70
9:00 a. m.	230	70	78
10:00 a. m.	248	78	110
11:00 a. m.	256	85	122
12:00 m.	278	95	134
1:00 p. m.	290	95	150
2:00 p. m.	290	85	142
3:00 p. m.	240	82	118
3:15 p. m.	Retort tapped		

After tapping the retort the mixed acid is run to one of the storage tanks or to the tank at the top of the Glover tower. The niter cake is sampled as it runs out and the mixed acid is measured and sampled, the samples being tested in a nitrometer.

The niter cake almost invariably shows clean. The volume of mixed acid made is 220 cu.ft. It contains nitric acid and lower nitrogen oxides equivalent to 16.5 to 16.7 lb. $NaNO_3$ per cu.ft. The recovery is therefore about 96 per cent. Coal used amounts to 700 to 800 lb. per ton of niter decomposed.

The mixed acid is fed into the Glover towers through small gage boxes. Its flow is controlled by an ordinary small acid valve. The volume used is such that control is very convenient. For example, a 100-ton chamber unit will require about half a gallon per minute.

The installation described can handle up to 3,000 lb. per retort by taking an additional hour or two per run. That is, it can decompose up to 12,000 lb. of nitrate of soda per day of 24 hours, by working two 10-hour shifts or three 8-hour shifts.

The tower exit stack normally shows a very faint red. Any large air leakage into the retorts or at pipe joints is quickly indicated by more color at the stack.

The installation here described can be built for about $8,000 to $10,000.

Extraction of Corn Oil Treated in New Bulletin of Department of Agriculture

Because of the great increase in the manufacture of corn products, such as hominy, starch, glucose and sirup, the production of oil from the germ, which is removed in these various processes, has become a well-established industry. Up to the present the oil has been removed from the germs by pressure, a method that is used in this country in obtaining most kinds of vegetable oils. In European countries a good deal of vegetable oil extraction has been done with organic solvents, and recently the United States Department of Agriculture has made some trials with this method of extracting corn oil. The results have just been published in Department Bulletin 1,054, "Comparison of Corn Oils Obtained by Expeller and Benzol Extraction Methods," a professional paper by A. F. Sievers, chemical biologist.

The bulletin contains detailed comparisons of processes and of oils produced by pressure and by solvent extraction from the germ cake, a residue from the first process, and by solvent extraction from the germs themselves.

Determining Coefficient of Expansion With a Metallurgical Microscope

By Horace C. Knerr
Metallurgist, Naval Aircraft Factory, Philadelphia

THE METHOD of measuring thermal expansion herein described was developed in the course of an investigation of the physical properties of a small piece of a light alloy at the Naval Aircraft Factory. The sample, which was all that was available, was in the form of a bar approximately 3 $\frac{3}{16}$ in. long, $\frac{7}{16}$ in. wide and $\frac{5}{32}$ in. thick.

It was desired to determine as many of the properties of the material as possible, including chemical composition, specific gravity, tensile properties, hardness, resistance to corrosion, microstructure and coefficient of expansion. The expansion determination was the most difficult, but was performed with equipment available in almost any metallurgical laboratory.

As metallurgists and others may frequently have occasion to measure expansion coefficients of small samples within moderate temperature ranges without recourse to the more elaborate methods, a detailed description of this simple method may be of some service.

Method of Measurement

The determination was made with the aid of an inverted metallurgical microscope, by measuring the difference in expansion between the sample and pieces of steel and of duralumin, placed on each side, the temperature being regulated by a water bath. Observations were taken through glass windows in the bottom of the bath. Preliminary readings were taken at intervals, until a number of consecutive readings were identical, showing that the temperature of the specimen had become constant.

Accuracy

Since tensile tests had to be made on the same piece afterward, the temperature range was held to within normal atmospheric variations to insure that the physical properties of the material would not by any chance be affected. The lowest temperature conveniently obtainable in the laboratory was that of melting ice, 0 deg. C., and the total temperature range available was therefore about 40 deg. C. To determine the thermal expansion of a sample 3 in. long within a temperature range of 40 deg. C. necessitates measurements of a fairly high degree of accuracy. Take, for example, soft steel. A coefficient of linear expansion of 0.0000121 per deg. C. is given in the Smithsonian Physical Tables. Total expansion in 3 in. for 40 deg. C. is $0.0000121 \times 3 \text{ in.} \times 40° = 0.00145$ in. Likewise, duralumin (coefficient of expansion 0.0000226, according to Vickers) would expand 0.00271 in. The difference in total expansion between two 3-in. samples of steel and duralumin would be 0.00126 in., and the accuracy of the result of a method such as described above would depend upon the accuracy to which such a length could be measured.

The metallurgical microscope was provided with a micrometer eyepiece which was calibrated by means of a micrometer stage ruled to 0.1 and 0.01 mm. One division on the graduated head, using a 16-mm. objective, represented 0.0000330 in., or about 2½ per cent of the probable length (0.00126 in.) to be measured. It was possible to repeat readings to within plus or minus one

scale division. This, therefore, came well within the desired accuracy of plus or minus 5 per cent.

Preparation of the Specimen

A strip of annealed mild steel and a strip of duralumin were attached to opposite sides of the specimen, as shown in Fig. 1, the three pieces being pinned together at one end by a tight fitting pin and left free at the other end. Small spring clips were placed at the free end and at the middle, permitting longitudinal expansion or contraction of all the pieces, but preventing the strips from bowing out.

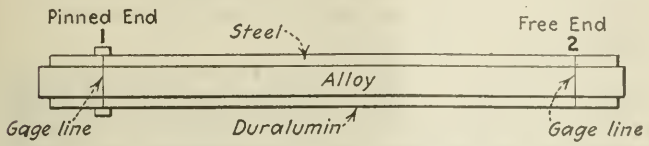


FIG. 1—ASSEMBLED BARS

The lower edges of the strips were made flush with the lower edge of the specimen, and this surface was polished smooth by emery cloth and paper laid on plate glass, finishing with No. 0000 Hubert paper.

Using the jaws of a vernier caliper for guides, gage lines were scribed upon the polished surface, one above the center line of the pin and the other 2½ in. away, both running transversely across the three strips. It was necessary to draw very fine lines, a feat which is perhaps the most difficult part of the entire experiment. A piece of microscope cover glass was shattered and a small sharp splinter selected with the aid of a magnifying glass. This was attached by means of a speck of beeswax to the end of a fairly stiff bristle about 2 in. long taken from a dust brush. This "scriber" was drawn across the polished surface of the three strips as gently as possible, using the vernier jaws as guides. These gage lines were barely visible to the naked eye, but were clear and definite under the microscope, and appeared in the image about three times as wide as the hairline of the micrometer eyepiece. It was easy to read to the center of this line. Heavier "marker lines" scribed near the gage lines facilitated determinations of direction under the microscope, which is otherwise very confusing.

The lines were ruled at room temperature, 24 deg. C. After ruling, a very thin coating of transparent varnish was applied so as to retard corrosion.

Temperature Control

A small watertight wooden box, open at the top, was constructed, as shown in Fig. 2. This was arranged to fit on the movable stage of the microscope. Holes cut in the bottom of this box were covered with microscope cover glass through which the gage lines on the specimen could be observed from below. To avoid cracking the cover glasses by unequal expansion, they were separated from the wood by means of rubber washers, the glass being attached to the rubber with Canada balsam.

For convenience, water was used as a heating and cooling medium. A 5-gal. can was placed on a high shelf above the microscope, and connected to the inlet tube of the bath with rubber hose. Overflow drained to a bucket on the floor. Flow was adjusted with a pinch-cock so as to cause a complete displacement of the liquid in the bath every 30 seconds. This insured excellent circulation about the specimen and permitted a continuous flow for about 1 hour and 20 minutes, which was ample time for the specimen to reach the temperature of the bath and for readings to be taken. The water in the 5-gal. reservoir was permitted to come to room temperature for the first set of readings, at approximately 24 deg. C. For the second readings, cracked ice was placed in the reservoir to cool the water to 0 deg. C., and for the third readings a small electric heater was arranged to warm the water to 40 deg. C. To insure uniform temperature in the reservoir, a motor-driven agitator was used.

The specimen was placed in the bath with the gage lines over the windows; it was raised slightly upon narrow strips of glass to permit circulation of water beneath it. With the water circulating, the temperature of the bath was measured with a thermometer at various places and was found uniform within about 0.2 deg. C.

Using the metallurgical microscope and micrometer eyepiece, readings were taken through the window at the pinned end of the relative positions of the gage line on the strip at both sides of the sample. The microscope stage, carrying the bath, was then moved so as to bring the other end of the specimen in position over the objective, and a reading taken of the relative position of the gage lines through the window at that end. The readings at the pinned end were for the purpose of taking care of any possible motion between the strips at this end, but it was found that none occurred.

Results

The necessary formulas and the results of the determination are given further below. Satisfactory readings were not obtained at 40 deg. C., as the water attacked the specimen very rapidly at this temperature in spite of the varnish, so that the gage lines were obliterated. The results obtained between 0 and 24 deg. C. showed the coefficient of expansion to be approximately that of magnesium. Other characteristics of the sample, determined later, disclosed that it was composed largely of magnesium.

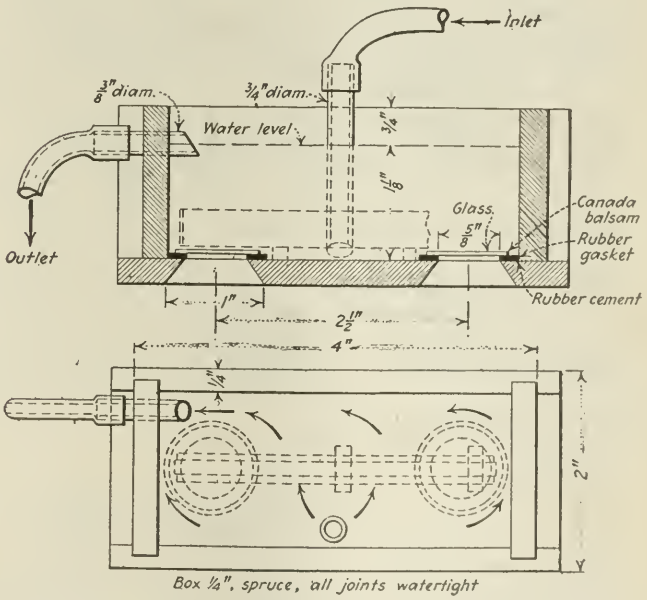
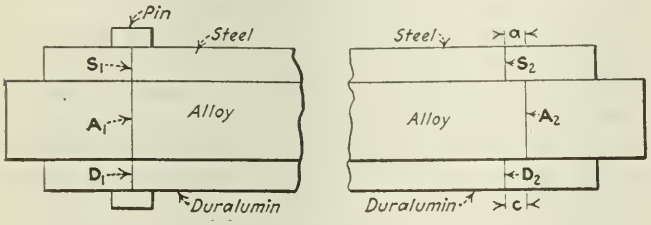


FIG. 2—THERMOSTAT FOR EXPANSION MEASUREMENTS

It will be noted that there was a considerable difference in the result determined by comparison with the steel strip and that determined by comparison with the duralumin strip. This inconsistency may be largely due to inaccuracy of the coefficients given for those metals

in the best available sources. There was no check upon the coefficient 0.0000226 given for duralumin from the Vickers' Bulletin, and the value 0.0000121 for steel was practically an average or approximation from several widely differing values given for steels and irons in the texts. In order to obtain accurate results by this method, it is essential to have for comparison a standard piece whose temperature coefficient is known to a



FIGS. 3 AND 4

Fig. 3 (at left)—Pinned end at normal temperature.
Fig. 4 (at right)—Free end at higher temperature.

greater accuracy than that required in the test. This is true of most methods of measurement—in fact, practically all measurements of length depend upon comparison with a previously measured standard.

As the standards of this experiment were not known to be correct, the results are of value chiefly for the sake of example.

Formulas

See Figs. 3 and 4

A movement of A_2 from S_2, to the right is plus a.
A movement of A_1 from S_1, to the right is plus b.
A movement of A_2 from D_2, to the right is plus c.
A movement of A_1 from D_1, to the right is plus d.
Difference in total expansion of alloy and steel $= a - b$.
Difference in total expansion of alloy and duralumin $= c - d$.

Let coefficient of expansion of alloy $= K_A$ (required)
coefficient of expansion of steel $= K_S$ (known)
coefficient of expansion of duralumin $= K_D$ (known)
$(T - t)$ = Temperature change
L = Gage length.

Then, total expansion of alloy $= K_A(T - t)L$
total expansion of steel $= K_S(T - t)L$
total expansion of duralumin $= K_D(T - t)L$
and $(a - b) = K_A(T - t)L - K_S(T - t)L$

therefore, $K_A = \dfrac{a - b}{(T - t)\,L} + K_S$

also, $K_A = \dfrac{c - d}{(T - t)\,L} + K_D$

Experimental Readings

Initial temperature	24.0 deg. C.
Temperature of bath	0.5 deg. C.
$T - t$	$= -$ 23.5 deg. C.

Microscope Readings
Pinned end still in line, b and $d = 0.00$
Free end,

Position of A_2	4.22
Position of S_2	4.39
$a =$	$-$ 0.17 change from steel
$=$	$-$ 0.000561 in.
Position of A_1	4.16
Position of D_2	4.22
$c =$	$-$ 0.06 change from duralumin
$=$	$-$ 0.000198 in.

$$K_A = \frac{0.000561}{23.5 \times 2.50} + 0.0000121 = 0.0000216 \text{ per deg. C.}$$

(compared with steel).

$$K_A = \frac{0.000198}{23.5 \times 2.50} + 0.0000226 = 0.0000260 \text{ per deg. C.}$$

(compared with duralumin).

Average 0.0000238 per deg. C.

This first test was hastily prepared and rather crudely performed, and the writer has not had an opportunity to repeat it with greater care. It is believed that the method has demonstrated its practicability, and improvements in detail can easily be introduced.

Some improvements which suggest themselves are:

(*a*) Use of a ruling machine or construction of a jig to facilitate the scribing of the fine gage lines. Tremors of the hand in the present method tended to cause irregular gage lines.

(*b*) Use of a light transparent oil as a heating and cooling medium, to avoid corrosion of the specimen (where this is likely to occur with water) and permit greater temperature ranges.

(*c*) Using greater ranges of temperature when possible, so as to reduce the percentage error introduced by inaccuracies in measurement.

(*d*) Use of two similar strips of a single metal or other substance of a known and preferably a low coefficient of thermal expansion as the standard of comparison. These would serve as a check against each other, and in case of warping or bending of the sample, the mean of the readings on the two sides would give the correct value. Invar would be an excellent material for this purpose.

Advantages of the Method

(*a*) The equipment is available in nearly any metallurgical laboratory.

(*b*) Results do not depend upon the accurate measurement of small changes in a relatively large quantity, but upon measuring a small *difference* between two quantities, one of which is known. A fairly accurate measurement of this small difference gives a relatively high percentage accuracy in the result.

(*c*) The determination may be made upon a small sample, the preparation of which is simple and requires no accurate machine work or grinding.

(*d*) Determinations may be made within ordinary atmospheric ranges or within any range which can be obtained with a fairly transparent liquid bath.

(*e*) The standard of comparison is subject to the same conditions of temperature, etc., as the specimen.

(*f*) The unit of length measurement (micrometer eyepiece) is entirely out of range and unaffected by variations of temperature in the heating medium.

(*g*) Displacements in various parts of the measuring apparatus do not affect the accuracy of the results.

(*h*) The length of the specimen between gage marks does not need to be measured with great accuracy. A good vernier caliper is suitable.

(*i*) The measurements are optical, avoiding the inaccuracies due to touch or to uncertain contacts, characteristic of micrometer or electric contact methods.

Japanese Experiment on Bread From Soya Bean Flour

Japanese food chemists are at work to produce a palatable bread from soya bean flour, and according to a report in the *Bulletin of the Japan Society*, tests thus far indicate that it is both palatable and digestible. It is also established that soya bean bread can be placed on the market at a price below that made from any other kind of flour. With the heavy protein content of the beans and a little butter or other fat, a ripe orange and a dish of boiled greens, it would seem that a very cheap ration—with vitamines included—was available from it. The soya bean cheese should also furnish an abundance of protein.

It is, of course, a question as to how the bread will take with the public. If it does find favor, however, it will worry the wheat grower.

Contributions to the Study of Ammonia Catalysts—IV

Discussion of the Behavior of a Type of Iron Catalyst Under Varying Conditions of Pressure, Temperature and Gas Velocity in Experiments on the Synthesis of Ammonia at the Fixed Nitrogen Research Laboratory*

By A. T. LARSON and R. S. TOUR

THE preceding articles of this series have described three types of apparatus for testing the activity of substances in catalyzing the synthesis of ammonia from nitrogen and hydrogen. The particular functions of each of these testing plants have been indicated in the separate articles. The purpose of the present article is to present data obtained by all of these methods of testing, on certain selected catalysts which have come to be regarded as typical, and to show to what extent correlation exists between the results of low, intermediate and high pressure testing, and between small and moderate scale operation.

It should be pointed out that the most important function of each of the three testing plants has been the determination of the comparative merits of a large number of catalysts rather than a logical study of the complicated phenomena involved in ammonia synthesis. Each plant has had a more or less distinct place in the general research program and has followed lines of investigation frequently differing from that adopted by the others. There are certain difficulties inherent in the problem which render almost impossible a complete identity of conditions in tests carried out upon different scales. Thus the reaction evolves a considerable amount of heat, and the heat evolution and distribution in a given volume of catalyst may vary greatly with the rate of flow of the gases and with the temperature and pressure, since these affect the reaction rate as well as the equilibrium concentration of ammonia. This means that it is inevitable that a certain temperature gradient must exist within the catalyst and although this is kept at a minimum by devices previously indicated, it is impossible to be certain that the recorded temperatures of the different testing plants operating under widely different conditions actually correspond to identical temperature conditions within the catalyst.

Again, although the catalysts are always tested upon a 1:3 nitrogen:hydrogen mixture of a high degree of purity, except when poisons are intentionally introduced, the methods employed for gas purification have not been identical and it is therefore impossible to be certain that the quality of the gas is always the same. There is reason to believe, however, that the variation in purity has been small enough to be of but minor importance and further, although the catalysts are fairly reproducible, still minor variations in activity or characteristics may appear in different batches of what is presumably the same catalyst.

It is therefore not to be expected that absolute concordance of results should have been achieved in studying substances so sensitive to conditions as contact catalysts are apt to be, nor that all results should be strictly comparable. Nevertheless, sufficient data have been obtained to warrant the statement of certain important generalizations concerning the behavior of characteristic ammonia catalysts under varying conditions of pressure, temperature, rate of flow of gases, purity of gases and other factors.

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*For Parts I, II and III see CHEM. & MET. ENG., vol. 26, Nos. 11, 12 and 13, pp. 493, 555 and 588, March 15, 22 and 29, 1922.

Nomenclature

Certain terms appearing in this paper are occasionally given a different meaning from that employed herein and it seems desirable, therefore, to define them.

Per Cent Ammonia. The per cent by volume of NH_3 in the gas, measured under standard conditions.

Ammonia Conversion. The *increase* in NH_3 per cent in the gas produced by catalysis.

Yield of Ammonia. The weight of ammonia produced by catalysis. When expressed in grams of NH_3 per liter of catalyst per hour, it becomes the *"space-time-yield"* ("S-T-Y").

Equilibrium or Theoretical. (Applied to per cent NH_3, conversion or yield.) This refers to the maximum theoretically possible for specified conditions of temperature, pressure, etc., assuming the correctness of Haber's measurements and calculations of the equilibrium constant for the ammonia synthesis.

Efficiency. The ratio of the actual per cent NH_3 in the gas to that theoretically possible under the conditions in question.

Space Velocity. The number of liters of gas passing over the catalyst per liter of catalyst per hour. The gas volume is measured under standard conditions regardless of the actual conditions of operation ("S.V.").

Time of Contact. The time in seconds for 1 liter of gas, measured under operating conditions, to pass over 1 liter of catalyst.

$$\text{"}t.c.\text{"} = \frac{3600}{S.V.} \times \frac{P \times 273}{T}$$

Here, P = operating pressure in atmospheres and T = absolute temperature, deg. C.

Optimum Temperature. The temperature at which (at constant pressure and space velocity) the gas after passing over a given catalyst contains the highest per cent of ammonia.

Nature of the Catalyst

The catalysts of the type selected for discussion consist essentially of metallic iron containing small amounts of a substance which influences very greatly the behavior of the iron and which is known as a "promoter." The amount of promoter in the particular catalysts used for illustration, which will be referred to as Nos. A, B, C and D, is from 2.5 to 3.5 per cent of the total weight, the remainder being metallic iron. These catalysts have been selected as a basis for discussion for various reasons. They are reasonably active, capable of

continued operation without marked deterioration, and sufficiently sensitive to poisons and overheating to permit their use in discussing these problems. Although they are not the most active catalysts which have been prepared by the Fixed Nitrogen Research Laboratory, they are nevertheless high-grade catalysts, more active than those which have usually been employed in commercial operation.

While the experimental data presented will be from the actual tests of these particular catalysts, certain generalizations will be made based upon more extensive results obtained with similar catalysts.

Preparation of Catalysts and Methods of Testing

These catalysts are first prepared as mixed oxides and are then heated in a current of nitrogen:hydrogen mixture, which reduces the iron oxide to metallic iron. The samples of catalysts employed for the small-scale apparatus, both for low- and high-pressure operation, are reduced at atmospheric pressure by placing them, usually in the form of 8 to 14 mesh granules, in a furnace and slowly heating them in a current of pure nitrogen:hydrogen mixture until reduction begins, as evidenced by the appearance of water in the outlet gas. The temperature is maintained at this point until the evolution of water ceases (usually several hours) and is then raised somewhat until water reappears. This process of heating at gradually increasing temperature is continued until practically complete reduction is effected, the final temperature being 400 to 450 deg. C.

In the moderate-scale testing plant the catalysts are prepared by reducing the oxide granules (6 to 8 mesh) *in situ* in the catalyst bomb by means of nitrogen: hydrogen mixture at 100 atmospheres pressure, with gradually increasing temperature.

After reduction the sample of catalyst is usually tested under varying conditions of temperature and space velocity, and with pure and poisoned gas.

Influence of Mesh Size of Catalyst

Since the size of the catalyst granules in the three testing plants varies from 8 to 14 mesh at the lower pressures to 6 to 8 mesh at high pressure, it is important to determine the effect of mesh size upon the catalytic activity. Tests carried out at 100 atmospheres and confirmed by data obtained at lower pressures indicate that the activity of the catalyst is independent of the size of granule, within fairly wide limits. These data are given in Table I.

TABLE I—INFLUENCE OF MESH SIZE OF CATALYST.

Catalyst	Pressure, Atm.	Temp., Deg. C.	Space Velocity	4 to 8 Mesh Eff.	8 to 10 Mesh Eff.	12 to 14 Mesh Eff.
C	100	475	5,000	0.950	0.980	0.940
C	100	475	10,000	0.878	0.891	0.880
C	100	475	20,000	0.683	0.717	0.727
C	100	475	40,000	0.514	0.547	0.550
D	100	475	5,000	0.904	0.900	0.897
D	100	475	10,000	0.742	0.730	0.700
D	100	475	20,000	0.567	0.590	0.540
D	100	475	40,000	0.408	0.460	0.380

The individual differences are scarcely greater than the limits of reproducibility of the catalysts. Furthermore, experiments have been carried out on the influence of the shape of the catalyst chamber and no evidence has been found of such influence. Apparently the yield of NH_3 is dependent only upon the amount of catalyst, other conditions being constant, and not upon the size of particle or shape of the container. These facts make possible the direct comparison of the results obtained at the different testing plants, in so far as these effects are concerned.

Influence of Previous History on Catalytic Activity

Chemical composition alone does not, of course, determine catalytic activity. Catalysts of identical composition but different previous history may exhibit widely differing behavior. Whereas the catalysts selected for discussion in this article have in general been subjected to similar treatment, occasional variations, intentional or otherwise, in the routine may have produced certain differences which are especially apparent at low temperatures, where catalytic activity is just beginning. Nevertheless sufficient data are available to enable the drawing of definite conclusions in most cases.

With proper attention to composition of materials and experimental technique, the catalysts selected as typical can be reproduced within reasonable limits. Their characteristics, therefore, may be taken as representing a certain class of catalysts rather than as individual preparations.

Basis of Comparison

In comparing the behavior of catalysts under different conditions of temperature and pressure it is a little difficult to decide upon a satisfactory basis of comparison. From a commercial standpoint either the per cent of NH_3 produced or the yield of NH_3 per hour is most important. On the other hand, in considering the actual activity of the catalyst it must be remembered that the per cent of NH_3 can never exceed that existing at equilibrium and this changes with both pressure and temperature. Comparisons of catalytic activity based upon per cent of NH_3 are therefore apt to be misleading unless conditions of pressure and temperature are identical. Therefore for the purpose of an analysis of catalytic activity under varying conditions of temperature and pressure it seems more logical to select the efficiency (as defined above) as a basis of comparison, although it must be kept in mind that the efficiency may also be a function of the variable conditions and a true comparison of catalytic activity of different catalysts is possible only when conditions are identical. In order to aid in an understanding of the factors which play a part in determining the suitability of a catalyst for commercial ammonia synthesis, the data have been also analyzed upon a basis of the per cent of NH_3 formed and the yield of NH_3.

The efficiency, the per cent of NH_3 and the yield of NH_3 are influenced by four separate variables—pressure, temperature, rate of flow of gases, and concentration of catalyst poisons. The methods used in analyzing the data is in general to plot the efficiency or the per cent of NH_3 as ordinate and one variable factor as abscissa, holding two factors constant. A family of curves is then drawn, each curve corresponding to a different value of one of the constant factors. It would, of course, be possible to construct many additional families of curves from the available data, but it is believed that those selected for illustration serve to indicate sufficiently the general nature of the principles involved.

It is understood, of course, that many other factors besides pressure, temperature, rate of flow and concentration of poison may impose necessary restrictions on the actual conditions of commercial operation. Among these factors are heat losses, ammonia removal, gas

purification, mechanical construction, etc., and no attempt is made to include them in the discussion. It should be emphasized, however, that the determination of the most favorable conditions for commercial operation is a problem of considerable complexity and cannot be intelligently decided upon without a careful consideration of such factors as are discussed in this paper.

Since the "equilibrium values" are referred to frequently, it seems worth while to include for reference a table of these values calculated from the data of Haber by means of the nomograph recently devised by Tour.[1]

TABLE II—EQUILIBRIUM PER CENT OF NH_3, BY VOLUME

Temp., Deg. C.	Pressure, Atmospheres 1	10	31.6	100
400	0.457	4.25	11.45	25.4
420	0.347	3.27	9.10	21.5
450	0.236	2.24	6.45	16.45
475	0.170	1.66	4.93	13.00
500	0.128	1.26	3.77	10.40
550	0.076	0.755	2.32	6.66

Experimental Data

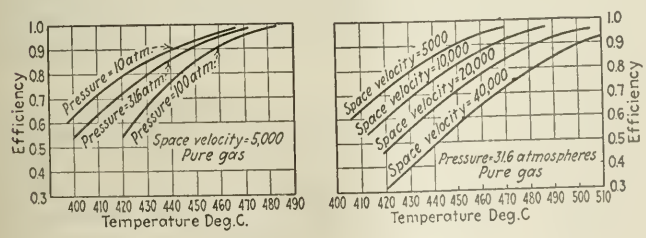
The experimental data which have been selected for analysis in this paper are given in condensed form in Table III. In some cases they represent the average of a considerable number of determinations, in others only a single observation. In any case they represent the best data available at the present time and although further experiment may result in some changes, it is not believed that such changes will necessitate any material alterations in the general conclusions drawn herein.

The Efficiency of Ammonia Formation

The Effect of Temperature at Different Pressures

Every catalyst, in general, requires a certain time at the beginning of a test, and to a lesser extent in changing from one temperature to another, before reaching a steady condition as to ammonia production. This time is naturally greatest at the lower temperatures, when many hours may be required, and much less at high temperatures. The steady condition may be maintained indefinitely if pure gas is being tested. Unless otherwise stated, all results given in this paper will be those obtained after the steady condition has been reached.

Catalytic activity for the type of catalyst in question begins at 400 deg. C. or less and increases with increasing temperature until the condition of equilibrium is approximated (for space velocities around 5,000) at 450 to 475 deg. C. and above, if pure gas is tested. At low



FIGS. 1 AND 2

Fig. 1—Effect of temperature on conversion at different pressures.

Fig. 2—Effect of temperature on conversion at different space velocities.

temperature, and especially at low pressure, the results obtained are apparently so dependent upon the previous history of the particular sample of catalyst that reproducible results are difficult to obtain. Nevertheless, reasonably certain conclusions can be drawn as to rate of change of the efficiency with changing temperature at pressures from 1 to 100 atmospheres. In general, the efficiency always increases with increasing temperature, the rate of change being almost independent of the pressure (Fig. 1). Between efficiencies of 0.4 and 0.85 the increase in efficiency with increasing temperature is nearly linear and the slope is not materially different at different pressures. At efficiencies of about 0.90 the rate of increase with increasing temperature diminishes somewhat, and the efficiency-temperature curves approach the value 1.0 rather slowly. The nature of the curves for low efficiencies is uncertain, owing to the irregularity of the results, but it is probable that a point of inflexion is shown and that the efficiency of zero is also approached slowly at low temperatures.

TABLE III—DATA ON TEST RUNS

Catalyst	Temp., Deg. C.	Pressure, Atmospheres	Space Velocity (× 1,000)	Per Cent NH_3 by Vol.	Efficiency	Composition of Gas
A	400	1.0	5	0.300	0.680	Pure
A	450	1.0	5	0.220	0.930	Pure
A	500	1.0	5	0.130	1.000	Pure
A	550	1.0	5	0.078	1.000	Pure
A	400	10.0	5	2.68	0.630	Pure
A	420	10.0	5	2.65	0.795	Pure
A	450	10.0	5	2.10	0.930	Pure
A	500	10.0	5	1.25	1.000	Pure
A	400	31.6	5	6.01	0.525	Pure
A	410	31.6	5	6.59	0.640	Pure
A	420	31.6	5	6.65	0.725	Pure
A	430	31.6	5	6.50	0.795	Pure
A	440	31.6	5	6.23	0.855	Pure
A	450	31.6	5	5.85	0.900	Pure
				(6.00)	(0.920)	
A	500	31.6	5	3.72	0.990	Pure
A	550	31.6	5	2.30	0.990	Pure
A	425	100.0	5	12.90	0.610	Pure
A	450	100.0	5	14.10	0.850	Pure
A	475	100.0	5	12.80	0.980	Pure
A	420	10.0	10	2.19	0.665	Pure
A	420	10.0	20	1.71	0.750	Pure
A	420	10.0	40	1.35	0.405	Pure
A	450	10.0	10	1.95	0.850	Pure
A	450	10.0	20	1.71	0.750	Pure
A	450	10.0	40	1.50	0.668	Pure
A	420	31.6	10	5.46	0.595	Pure
A	420	31.6	20	4.24	0.465	Pure
A	420	31.6	40	3.71	0.317	Pure
A	450	31.6	10	5.41	0.832	Pure
A	450	31.6	20	4.66	0.717	Pure
A	450	31.6	40	3.71	0.570	Pure
A	500	31.6	10	3.65	0.960	Pure
A	500	31.6	20	3.61	0.950	Pure
A	500	31.6	40	3.43	0.900	Pure
A	450	100.0	10	11.60	0.705	Pure
A	450	100.0	20	9.50	0.578	Pure
A	450	100.0	40	7.00	0.427	Pure
A	450	31.6	5	2.36	0.365	0.04 per cent H_2O
A	450	31.6	10	1.26	0.195	0.04 per cent H_2O
A	450	31.6	20	0.83	0.125	0.04 per cent H_2O
A	450	31.6	40	0.49	0.077	0.04 per cent H_2O
A	500	31.6	5	3.43	0.900	0.04 per cent H_2O
A	500	31.6	10	2.60	0.685	0.04 per cent H_2O
A	500	31.6	20	2.00	0.525	0.04 per cent H_2O
A	500	31.6	40	1.22	0.320	0.04 per cent H_2O
A	450	31.6	5	1.04	0.160	0.10 per cent H_2O
A	450	31.6	10	0.60	0.092	0.10 per cent H_2O
A	450	31.6	20	0.50	0.078	0.10 per cent H_2O
A	450	31.6	40	0.38	0.060	0.10 per cent H_2O
A	500	31.6	5	2.75	0.720	0.10 per cent H_2O
A	500	31.6	10	1.63	0.430	0.10 per cent H_2O
A	500	31.6	20	1.16	0.305	0.10 per cent H_2O
A	500	31.6	40	0.78	0.180	0.10 per cent H_2O
B	450	100.0	5	14.30	0.870	Pure
B	450	100.0	5	5.10	0.310	0.044 per cent CO
B	450	100.0	5	2.30	0.140	0.082 per cent H_2O
B	500	100.0	5	10.40	1.000	Pure
B	500	100.0	5	8.84	0.850	0.044 per cent CO
B	500	100.0	5	5.72	0.550	0.082 per cent H_2O

Effect of Temperature at Different Space Velocities

Curves illustrating the effect of temperature upon the efficiency at constant pressure but different space velocities are shown in Fig. 2. From these it appears that between space velocities of 5,000 and 40,000 the general nature of the curves is the same, the effect of an in-

[1] *J. Ind. Eng. Chem.*, vol. 13, p. 298 (1921).

crease in space velocity being largely to displace the curves along the temperature axis.

Effect of Temperature With Poisoned Gas

In Fig. 3, data are plotted illustrating the temperature coefficient of the efficiency at constant pressure and and space velocity, with pure gas and with gas poisoned with carbon monoxide and water vapor. The data are not altogether conclusive, but they indicate that the effect of poison is largely to displace the curves along the temperature axis.

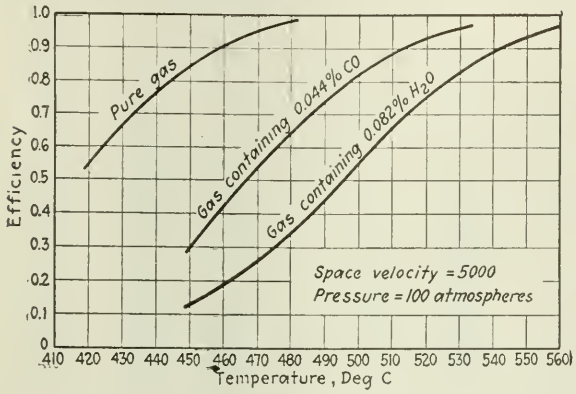
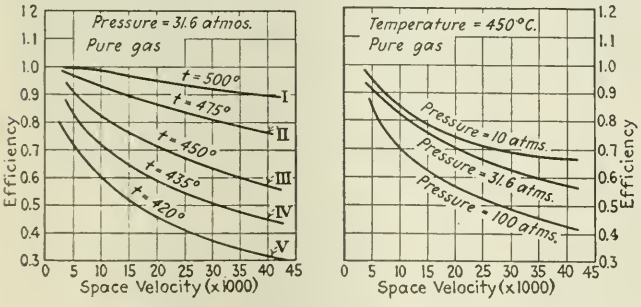


FIG. 3—EFFECT OF TEMPERATURE ON CONVERSION WITH POISONED GAS

Although the data are not sufficiently concordant or complete to permit a mathematical formulation, it is apparently true that the curves expressing the change of efficiency with temperature are always of the same type, showing a point of inflexion and slowly approaching the efficiency unity at high temperatures and zero at low temperatures. The effect of a change in pressure or space velocity or the introduction of poison is largely that of displacing the efficiency-temperature curves along the temperature axis.

Effect of Rate of Flow on Efficiency at Different Temperatures

The effect of the rate of flow of gas upon the efficiency can be predicted to a certain extent from *a priori* consideration. Thus at zero space velocity the efficiency

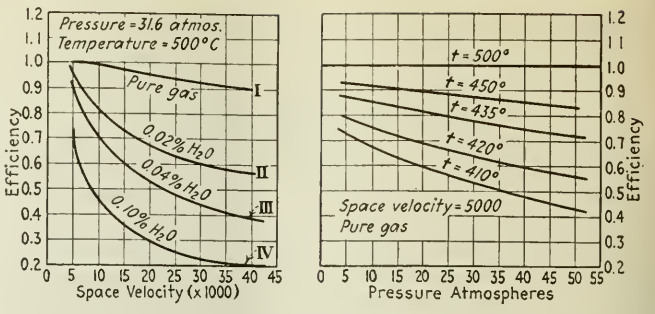


FIGS. 4 AND 5

Fig. 4—Effect of rate of flow of gases on conversion at different temperatures.

Fig. 5—Effect of rate of flow of gases on conversion at different pressures.

must be unity under any conditions and (excluding the possibility of complications arising from lack of turbulent flow at extremely low space velocities) as the space velocity becomes finite, the efficiency will in general remain approximately unity for a range of space velocities which will be greater the higher the temperature, the more active the catalyst and the purer



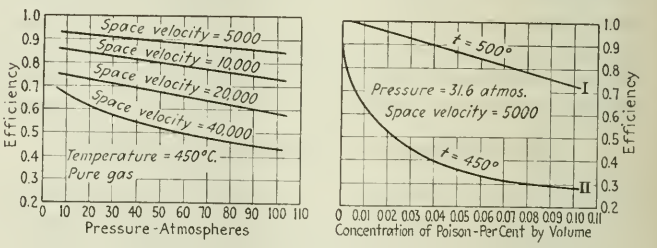
FIGS. 6 AND 7

Fig. 6—Effect of rate of flow of gases on conversion with poisoned gas.

Fig. 7—Effect of pressure on conversion at different temperatures.

the gas. Also, at very high space velocities the efficiency may be expected to approach zero asymptotically. Between these two extremes the nature of the efficiency-space velocity curves cannot be predicted, except that a point of inflexion must occur somewhere.

These considerations are in general borne out by the result of experiment. Thus data obtained at constant pressure (31.6 atm.) and different temperatures are expressed graphically in Fig. 4. It will be observed that at 500 deg. C. the efficiency is practically unity at space velocities up to 10,000, while at 420 deg. the efficiency



FIGS. 8 AND 9

Fig. 8—Effect of pressure on conversion at different rates of flow.

Fig. 9—Effect of poisons on conversion at different temperatures.

is far below unity even at 5,000 space velocity and begins to decrease much less rapidly at a space velocity of 40,000.

Effect of Rate of Flow at Different Pressures

Very little data are available on the effect of space velocity on the efficiency at atmospheric pressure, due to the fact that the increase of frictional resistance of the catalyst mass and the apparatus at high space velocities makes the exact pressure within the catalyst a matter of some doubt, and the rapid variation of the equilibrium with the pressure makes estimates of the efficiency uncertain.

Data obtained at 10, 31.6 and 100 atmospheres, however (Fig. 5), indicate that the effect of changing rate of flow of gases upon the efficiency follows the same general principles at all pressures. At any given temperature, however, the slope of the efficiency-space velocity curves increases somewhat with increasing pressure.

Effect of Rate of Flow With Poisoned Gas

Relatively little data are available upon the effect of rate of flow of gases with gas containing poisons. Characteristic data are illustrated by the curves plotted in Fig. 6. It is apparent that the general nature of the efficiency-space velocity curves is the same for pure and

for poisoned gas, the effect of poison being similar to that of a reduction of temperature (compare Fig. 4, curves I and V, with Fig. 6, curves I and III).

The Effect of Pressure at Different Temperatures

A great deal of catalyst testing has been done at low pressures, especially atmospheric, because of the ease with which such tests can be carried out, and for this reason it is a matter of great practical importance to determine to what extent results obtained at one pressure may be used to predict results at other pressures.

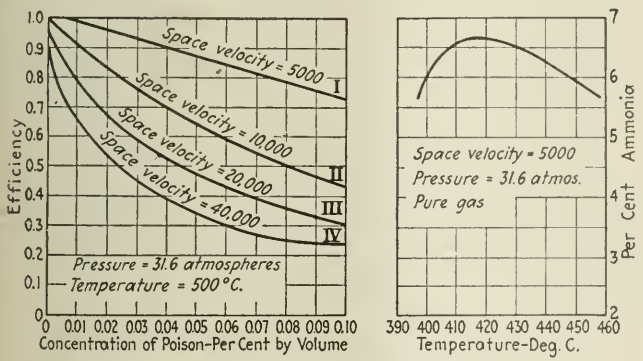
From the data plotted in Fig. 7 it appears that at constant temperature and space velocity the efficiency always decreases slowly with increasing pressure, the effect being greater the lower the temperature selected for test.

Effect of Pressure at Different Rates of Flow

Since, as indicated above, the decrease in efficiency with increasing rates of flow of gases is somewhat greater at high than at low pressures, it follows that the decrease in efficiency produced by increasing pressure must also increase with increasing space velocity. That is $\left(-\frac{dE}{dP}\right) S.V.$ increases with increasing space velocity within the range of space velocities for which data are available—up to 40,000. This is illustrated by the curves in Fig. 8.

Effect of Pressure With Gas Containing Poisons

The data on poisoned gas are somewhat irregular and inconclusive, their interpretation being made more difficult by the progressive permanent deterioration of the catalyst (discussed below) which may occur especially



FIGS. 10 AND 11

Fig. 10—Effect of poisons on conversion at different rates of flow.

Fig. 11—Effect of temperatures on ammonia content at constant space velocity and pressure.

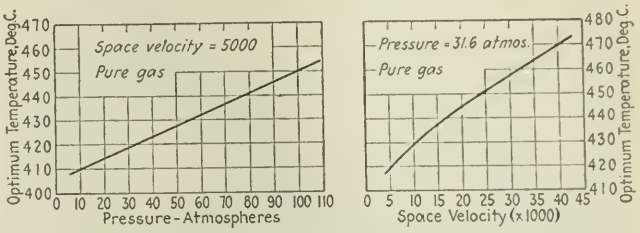
in long-continued tests. However, all of the available data point to the conclusion that the decrease in efficiency produced by increasing pressure is greater for poisoned gas than for pure gas.

In general it appears to be true that if the catalyst is operating under such conditions that the efficiency is close to unity $-\frac{dE}{dP}$ will be relatively small. For conditions under which the efficiency is somewhat lower, whether produced by low temperature, high space velocity or poisons, $-\frac{dE}{dP}$ will be greater. However, if the conditions are such that the efficiency is very low (approaching 0) the value of $-\frac{dE}{dP}$ will again become small.

All of these facts must be borne in mind in comparing results obtained at different pressures and in attempting to predict the behavior of a catalyst at one pressure from data obtained at other pressures. In particular, attention may also be called at this time to the fact that the decrease in efficiency with pressure has been found to be much greater for some catalysts than for those described in this paper. Hence tests which show a catalyst to be very active at 1 atmosphere pressure cannot in general be taken as indicating that the catalyst will be active under conditions suitable for commercial operation.

The Effect of Poisons at Different Temperatures

The only two catalyst poisons studied in any quantitative way are carbon monoxide and water vapor, these being the two impurities most difficult to remove from commercial nitrogen : hydrogen mixtures. Most of the



FIGS. 12 AND 13

Fig. 12—Effect of pressure on optimum temperature.

Fig. 13—Effect of space velocity on optimum temperature.

experimental data have been obtained with only one or two concentrations of poison and even these results are less reproducible than the data obtained when pure gas is used. The conclusions as to the variation of the efficiency with the concentration of poison are therefore more tentative than is the case with the data on pure gas. Nevertheless, certain generalizations seem reasonably certain.

In general, it may be noted that as far as the data are available, no difference can be detected between the effect of carbon monoxide and that of water vapor, if equivalent volume percentages of either gas are considered. This is perhaps to be expected, as at the temperatures in question carbon monoxide is readily converted into water vapor by the catalyst, according to the reaction

$$CO + 3H_2 = H_2O + CH_4$$

In the discussion, therefore, data obtained with either poison will be plotted upon the same curves and treated as though only one poison were being considered.

In general, either poison produces a lowering in the efficiency, this lowering always increasing with increasing concentration of poison. Comparing the results at different temperatures, it will be seen from the curves in Fig. 9 that the lowering in efficiency produced by any given concentration of poison is greatest at low temperatures and decreases with increasing temperature, so that at 500 to 550 deg. C. for low space velocities and low concentrations of poison the efficiency may be unity, as it is on pure gas.

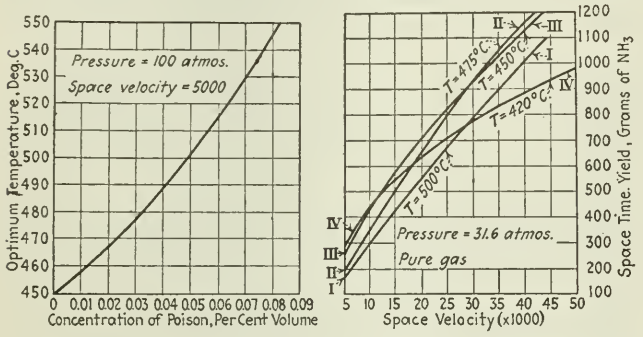
The rate of change in the efficiency with increasing concentration of poisons $\left(-\frac{dE}{dC}\right)$ is itself a function

of the temperature. Thus at high temperatures the efficiency decreases nearly linearly with increasing concentration of poison, while at low temperatures a large initial decrease in efficiency is followed by a much more gradual decrease (compare curves I and II, Fig. 9).

It should be noted that complete recovery of the catalyst occurs when again tested upon pure gas after treatment with poisoned gas, provided the time of treatment with poisoned gas was short. After more extensive tests on poisoned gas and especially at high pressures, permanent injury to the catalyst results. This is discussed further below.

The Effect of Poisons at Different Rates of Flow of Gases

The decrease in efficiency produced by a given concentration of poison in the gas alters greatly with the rate of flow of gases. A comparison of the curves in Fig. 10 with those in Fig. 9 shows that the effect of an increase in the space velocity is very much the same



FIGS. 14 AND 15

Fig. 14—Effect of concentration of poison on the optimum pressure.

Fig. 15—Effect of space velocity on space-time-yield.

as that of a decrease in temperature. At high space velocities the initial drop produced by a low concentration of poison becomes greater, while further increase in the concentration of poison produces less and less effect as the efficiency approaches zero.

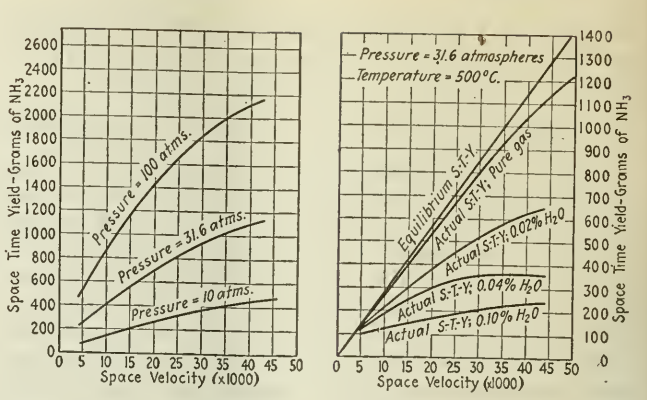
The Effect of Poisons at Different Pressures

The data obtained at different pressures with poisoned gas are scarcely sufficiently uniform to allow definite conclusions to be drawn, but all available data point to the conclusion that the decrease in efficiency produced by a given concentration of poison increases somewhat with increasing pressure. Whether this is true for all temperatures and space velocities cannot be determined from existing data, but it seems probable that the decrease in efficiency with increasing pressure is itself a function of both temperature and space velocity, or more probably, of the efficiency itself.

The Per Cent of Ammonia

The Effect of Temperature at Different Pressures

As pointed out above, the efficiency of NH_3 conversion always increases with increasing temperature, but since the equilibrium percentage of NH_3 decreases with increasing temperature the actual per cent of NH_3 in the gas does not always thus increase. In general, under conditions in which the efficiency is low and increase in temperature produces an increase in the per cent of NH_3, the increase in efficiency more than balances the decrease in the equilibrium value. As the efficiency



FIGS. 16 AND 17

Fig. 16—Effect of rate of flow on space-time-yield with pure gas.

Fig. 17—Effect of rates of flow on space-time-yield with poisoned gas.

approaches unity, however, its increase with increasing temperature is slower than the decrease in the equilibrium value, with the result that a decrease in the per cent of NH_3 results. For any given pressure, space velocity and concentration of poison there will be an optimum temperature, at which the maximum per cent of NH_3 will be obtained from the catalyst under consideration. This optimum temperature is of the greatest importance from an industrial standpoint, as it is an important factor in determining the most economical condition for commercial operation. This optimum (see Fig. 11) is affected by the pressure, the space velocity and the concentration of poison which may be present.

If we compare determinations of the optimum temperature made at different pressures, it appears that the optimum temperature is slowly increased by increasing

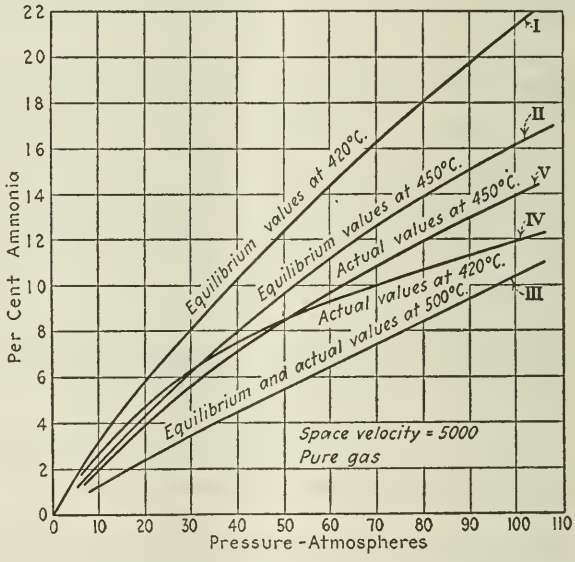


FIG. 18—EFFECT OF PRESSURE ON PER CENT OF AMMONIA AT DIFFERENT TEMPERATURES

pressure. This is illustrated in Fig. 12. Thus in order to obtain the maximum per cent of NH_3 with a given catalyst at a given pressure, the temperature of operation must be somewhat higher at high pressures than at low.

Effect of Temperature at Different Space Velocities

Determinations of the optimum temperature made at different space velocities show that in general at constant pressure the optimum temperature is increased

by increasing the space velocity. This fact is illustrated by the curve in Fig. 13. It follows therefore that the higher space velocity selected for operation the higher the temperature which must be selected in order that the catalyst may give its maximum percentage of NH_3.

Effect of Temperature With Gas Containing Poisons

Since the presence of water vapor or carbon monoxide produces a lowering in efficiency, it is to be expected that the optimum temperature will be higher with gas containing poisons than with pure gas. That this is

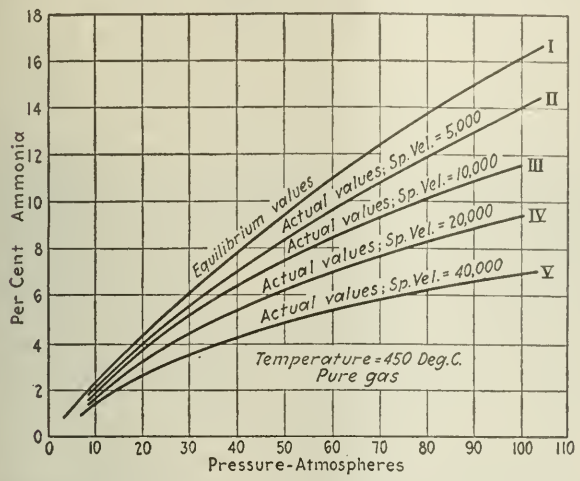


FIG. 19—EFFECT OF PRESSURE ON PER CENT OF AMMONIA AT DIFFERENT SPACE VELOCITIES

the case is shown by the data expressed graphically in Fig. 14, in which it appears that the optimum temperature rises rather rapidly with the concentration of poison in the gas. Thus if the gas contains poisons, it will be desirable to operate at a higher temperature to obtain the maximum output of ammonia than would be the case if pure gas were being used.

The Effect of Rate of Flow of Gas at Different Temperatures

Since an increase in the rate of flow of gas produces in general a decrease in the efficiency (see Fig. 4), at constant temperature and pressure, and since the equilibrium percentage of ammonia is constant under these conditions, it follows that the per cent of ammonia must likewise decrease similarly with increasing rate of flow of gas.

However, if the gas, after removal of the ammonia, is to be recirculated over the catalyst, as will be the case in commercial operation, the fact that the per cent of ammonia does not decrease as rapidly as the space velocity increases becomes of importance. Thus if we consider the space-time-yield (the weight of NH_3 per liter of catalyst per hour) we find that in general this increases with increasing space velocity. Data illustrating the increase in space-time-yield with increasing space velocity, at several temperatures, are expressed graphically in Fig. 15.

Consideration of the curves in Fig. 15 shows that at high space velocities, say 40,000, the yield of NH_3 is greater at 475 deg. C. than at any other of the temperatures investigated, while at 20,000 space velocity 450 deg. C. shows the greater yield, and at 5,000 space velocity the yield is greater at 420 deg. C.

It would appear at first sight that economical commercial operation would require the use of high space velocities, since the weight of ammonia produced per hour by a given mass of catalyst is highest under these conditions. This would undoubtedly be the case if high rates of flow of gas did not entail difficulty and expense. As higher rates of flow are considered, a point will be reached when the increased yield of NH_3 is more than offset by the increased cost of operation. It should be possible by experiment to determine the optimum rate of flow for any given installation.

Effect of Rate of Flow of Gas at Different Pressures

Data showing the increase of the space-time-yield with increasing space velocity at constant temperature and at different pressures are expressed graphically in Fig. 16. The effect of pressure upon the equilibrium values is so great that it masks any other effect, so that the space-time-yields at higher pressures are invariably greater than those at the lower pressures. This is better shown in Fig. 20 and discussed below.

Effect of Rate of Flow of Gas With Gas Containing Poisons

Since, as has been previously shown (see Figs. 9 and 10), the efficiency of NH_3 conversion is lowered at any space velocity by the presence of poisons in the gas and since the equilibrium values are not changed, it follows that the per cent of NH_3 will be correspondingly lowered by the poison, and no further discussion seems necessary. It seems desirable, however, to consider the effect of poison upon the space-time-yield, and data illustrating this effect are expressed graphically in Fig. 17. These data show that the rate of increase of the space-time-yield with increasing space velocity is much greater

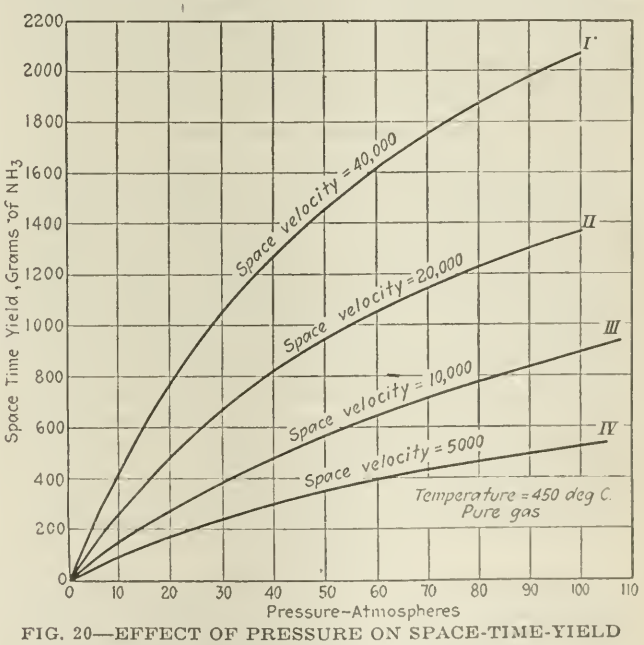


FIG. 20—EFFECT OF PRESSURE ON SPACE-TIME-YIELD AT DIFFERENT SPACE VELOCITIES

with pure than with poisoned gas, so that if high space velocities, say 40,000, are to be employed, thorough purification of the gas becomes more important.

The Effect of Pressure

As indicated above, the effect of pressure upon the equilibrium per cent of NH_3 is so great that an increase in pressure invariably produces an increase in the actual

per cent of NH_3. Figs. 18, 19 and 20 illustrate (*a*) the effect of pressure upon the per cent of NH_3 at different temperatures, (*b*) the effect of pressure upon the per cent of NH_3 at different space velocities, and (*c*) the effect of pressure upon the space-time-yield. Discussion of the curves seems unnecessary. Data on the effect of pressure with poisoned gas are insufficient to permit more detailed conclusions than that the rate of increase of the per cent of ammonia, or of the yield, with increasing pressure is in general much less for poisoned gas than for pure gas.

The Effect of Poisons

Since the presence of poisons does not affect the equilibrium values in any way, the per cent of NH_3 will decrease with increasing concentration of poison in exactly the same way that the efficiency decreases. Since this is illustrated above (Figs. 9 and 10), further discussion seems scarcely necessary.

The Change in the Behavior of the Catalyst With Time

At Different Temperatures

When pure gas is being tested the activity of the catalyst is apparently unaffected by prolonged treatment at temperatures not exceeding 550 deg. C. The tests at 1, 10 and 31.6 atmospheres are usually of only a few days duration at most, and are therefore inconclusive; but the tests at 100 atmospheres are frequently extended over 6 weeks or more, and it is characteristic of the type of catalyst under discussion that its activity is unimpaired at the end of that time, provided the temperature has not exceeded 550 deg. Temperatures above 550 deg. are apt to injure the activity of the catalyst, especially its activity at quite low temperatures. Thus a catalyst which has been injured by high temperature treatment may not show the injury at 500 deg., but may show a distinct loss of activity at 400 deg.

At Different Pressures

As mentioned above, the tests at low pressures carried out in this series of tests have not been continued over sufficient periods of time to be of value in considering the depreciation of catalytic activity with time. Tests carried out on other catalysts, however, which deteriorate more rapidly, have led to the tentative conclusion that deterioration is more rapid at high than at low pressures. This seems the more reasonable because of the fact that at high pressures the "work done by the catalyst" in synthesizing ammonia is much greater than at low pressures. The data, however, are scarcely sufficient to show the point conclusively.

The Effect of Poisoned Gas on the Behavior of the Catalyst

When gas containing carbon monoxide or water vapor is being tested, a slow permanent deterioration in the activity of the catalyst occurs—that is, the catalyst does not regain its original activity when again tested with pure gas. This is illustrated by the data in Table IV.

TABLE IV—RECUPERATIVE POWER OF CATALYST

Pressure, Atm.	Temperature, Deg. C.	Per Cent NH_3	Efficiency	Gas
100	450	14.31	0.878	Pure
100	450	6.04	0.309	0.05 per cent CO
100	450	12.26	0.708	Pure gas after CO treatment for 20 days
100	450	2.13	0.130	0.1 per cent H_2O
100	450	11.00	0.600	Pure gas after CO and H_2O treatment for 31 days.

The permanent deterioration produced by the poison is probably greater the higher the concentration of poison, the longer the time of treatment, the higher the temperature and the higher the pressure. At low pressures (10 to 31.6 atm.) complete recovery of the catalyst may follow several days treatment with poisoned gas, but at 100 atmospheres the original activity is scarcely ever regained.

The available data do not enable us to determine whether or not the progressive deterioration would continue indefinitely or whether it would approach some limiting value with continued testing. Indications favor the latter presumption, since the catalyst will usually give a constant per cent of NH_3 when treated with poisoned gas, even though it may be suffering deterioration—that is, the deterioration is shown by a failure to return to the original activity when tested on pure gas, and not by a gradual decrease in the activity toward poisoned gas.

In conclusion, it may be well to emphasize again that these data have been collected from tests on the three types of apparatus described in the preceding articles of this series. An analysis of the data has been made and tentative generalizations have been drawn, the conclusions being tentative because of the fact that the data are not always complete, and because of the uncertainty that an exact identity of conditions exists in the three plants in all cases.

A New Drop Frame Factory Truck

In handling barrels, bales, bags or heavy rolls, there has been a demand for an especially low loading platform electric truck. The Elwell-Parker Electric Co., of Cleveland, Ohio, has produced, and has had in operation for some time, a truck built up of 95 per cent standard

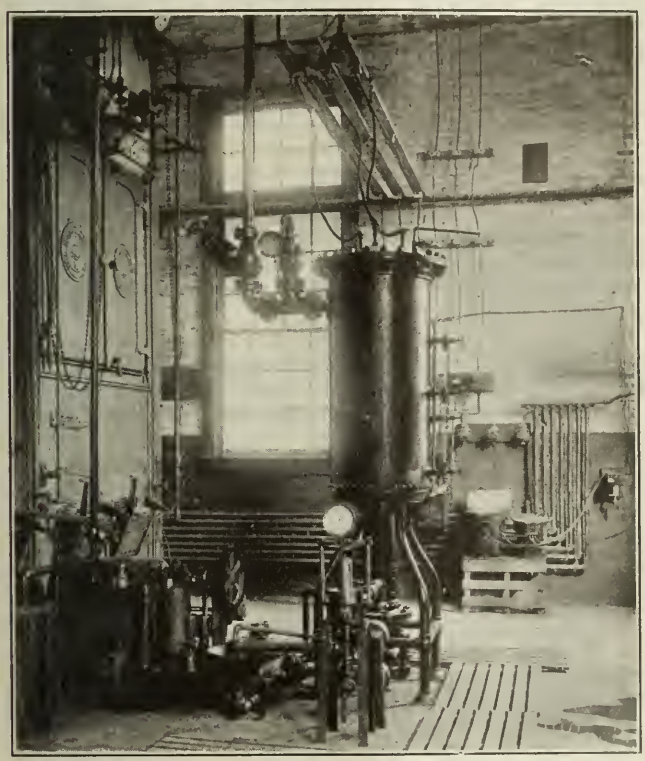
DROP FRAME FACTORY TRUCK WHICH SOLVES MANY PROBLEMS

parts on special frame. This equipment offers the solution to many annoying trucking problems, where hauls are so long that a man with a hand truck is too slow and expensive a means for the movement of materials. This truck carries a storage battery on the upper deck with motor and worm drive axle beneath. All four wheels steer. The "kick-up" on platform houses the rear wheels. Drive wheels are fitted with 21½ x 3½-in. rubber tires and the trailing wheels with 10½ x 5-in. tires. The truck will operate 15 to 20 miles on a single battery charge.

Electric Steam-Generator

AN ELECTRIC steam-generator utilizing the principle of heating produced by resistance to flow of electric current through water has recently been placed on the market by the Electric Furnace Construction Co., Philadelphia, Pa. In this apparatus steam is generated by high-tension alternating current led through the water to be evaporated by means of electrodes, placed in a vertical tank. The quantity of steam produced, the pressure at which it is generated and the consumption of current are governed by the height of the water in this tank, control being obtained through standard valves. Due to the elimination of the firebox and boiler setting, a great reduction in space required per boiler-horsepower is effected.

Any water that is suitable for the ordinary boiler is satisfactory and it is not necessary to install water-softening apparatus, as the salts in the water settle out as a sludge at the bottom of the tank instead of forming a scale, as in the ordinary type of boiler. This is because no part of the boiler is at a higher temperature than that of the steam. Corrosion is also eliminated for the same reason. The only part subjected to much wear is the electrode, which may be easily and cheaply renewed.



ELECTRIC STEAM-GENERATOR INSTALLED AT PLANT OF CANADIAN ELECTRO PRODUCTS CO.

The most important application of the electric steam-generator[1] is in industries located within the range of hydro-electric power plants, where use may be made of surplus power or "spillway" power. It is also possible in some cases to use the excess power at off-peak loads for generating steam and to store this supply of heat or utilize it when available, as a parallel to coal- or oil-fired boilers, thus reducing the fuel consumption. Conditions such as this occur at many paper and pulp mills, and in many other industries. In some districts where fuel is expensive and water power is available the complete substitution of electric steam-generators for boilers heated by other means should prove economical. Under such conditions similar electric steam-generators have already had wide and successful application in Italy, France, Switzerland, Norway and Sweden.

[1]Readers interested in the subject of electric steam-generation may find the following recent journal articles of value: *Engineering*, Feb. 6, 1920 (Revel and Brown-Bouveri type); *Power*, Oct. 12, 1920 (Swiss practice), March 8, 1921 (French practice—Revel type), May 10, 1921 (Swedish installation at Wärgon); *Electrical World*, Aug. 20, 1921 (Brown-Bouveri type), Nov. 19, 1921 (Swedish Forssblad type), Feb. 12, 1921 (Swiss practice—Revel type); *Power Plant Engineering*, Feb. 15, 1921 (Swiss practice—Revel type); *General Electric Review*, June, 1920 (general report); *Can. Chem. & Met. Eng.*, March, 1922 (installation at Shawinigan Falls).

Synopsis of Recent Chemical & Metallurgical Literature

Crystal Structure of Solid Solutions.—Using the X-ray spectrometer in the manner described in CHEMICAL & METALLURGICAL ENGINEERING, vol. 25, p. 657 (Oct. 5, 1921), and vol. 26, p. 82 (Jan. 11, 1922), Edgar C. Bain reported the results of studies on the "Crystal Structure of Solid Solutions" before the February meeting of the American Institute of Mining and Metallurgical Engineers.

The binary system Cu:Ni is of uninterrupted solid solutions. Since both these metals, when pure, crystallize in the face-centered cubic arrangement and have very similar dimensions (3.60 and 3.54 Angstroms respectively), the space lattices of the intermediate alloys should show the minimum distortion. Investigation of annealed specimens bears this out. All the alloys are face-centered cubes; the size decreases gradually with increasing nickel, an effect exactly similar to the change in a crystal space lattice with temperature.

Gold-copper alloys behave similarly, despite the great difference in size of their crystalline units (face-centered cubes of 4.08 and 3.60 Angstroms respectively). All the alloys are true face-centered cubes; the change in size is mostly confined to the middle half of the range. Thoroughly annealed 75:25 alloys in both of these systems gave some faint lines in the X-ray crystallogram which were identified with a cubic system just twice the size of the dominant one. Evidently this is what should occur in a 3 to 1 alloy if it were homogeneous—i.e., the atoms of the solute equally distributed among the atoms of the solvent.

Metals which crystallize in different crystalline types and yet form uninterrupted solid solutions act differently. The dominant partner or solvent absorbs a certain amount of the other with no measurable distortion of its space lattice. For instance nickel (face-centered cubic; 3.54 Ang.) will absorb 65 per cent of chromium (body-centered cubic; 2.90 Ang.) without distorting its space lattice. Alloys containing from 65 to 95 per cent Cr show space lattices of *both* constituents; chromium appears to be able to absorb only 5 per cent Ni into its normal structure. Copper and manganese act similarly. There is an overlap (where both crystallograms are produced in one alloy) between 60 and 90 per cent manganese. This series has a minimum melting point at 870 deg. C., at 30 per cent manganese.

Bain thinks that this "overlap" denotes the presence of crystals of both types (either pure metal or conjugate solutions) in the metal, despite the fact that microscopic examination shows only one phase. Annealed samples show a very coarse grain, and the dominant partner gives a "dashed" crystallogram characteristic of large crystals. The other metal simultaneously prints a finely penciled set of lines characteristic of a fine-grained sample,[1] and possibly exists in sub-microscopic particles.

Iron-nickel alloys exhibit the effect of allotropy. Alpha iron is body-centered cubic (2.86 Ang.) whereas gamma iron is almost exactly like nickel (face-centered cubic, 3.54 Ang.).

[1]"Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformation," by Bain and Jeffries, CHEM. & MET. ENG., vol. 25, p. 775 (Oct. 26, 1921).

Alloys up to 25 per cent nickel, even if annealed, show only the crystallogram of alpha iron. However, if the gamma state in iron is preserved by quenching, the pattern due to nickel is exhibited nearly to pure iron.

Soft Spots After Case-Hardening.—H. W. McQuaid and E. W. Ehn; metallurgists for the Timken Roller Bearing Co., presented an important paper before the February meeting of the American Institute of Mining and Metallurgical Engineers on "Effect of Quality of Steel on Case-Carbonizing." In the manufacture of roller bearings, the parts, made of low-carbon steel, are carburized and heat-treated with the utmost care and under strictest control, so as to produce greatest uniformity in the product. Yet often whole heats would show nearly 100 per cent rejections on account of soft spots discovered when testing the hardened pieces with a file. Chemical analysis failed to show any differences from other heats which acted properly, nor was the carbon in the case materially lower. Special attention to the cementation and hardening did not remove the trouble, nor did recarburization or change in the cement help any. Samples of this "off" steel, when packed in the same box with other steel known to be normal as far as carburization was concerned, would still be soft at final inspection, although the comparison pieces hardened perfectly.

It was found that the behavior on hardening could be predicted by microscopic examination of the carburized pieces, as indicated in Table I. A good case is shown in Fig. 4, while a bad one is shown in Fig. 1.

FIGS. 1 TO 4—HYPEREUTECTOID ZONE IN FORGED TEST INGOTS OF ELECTRIC STEEL TAKEN FROM VARIOUS TIMES DURING THE HEAT. × 70. ETCHED WITH PICRIC ACID

Fig. 1—Charge just melted. Fig. 2—Second slag made up. Fig. 3—Ferrosilicon added. Fig. 4—Finished heat.

TABLE I—MICROSTRUCTURE OF GOOD AND BAD STEELS

Zone	Good Steel	Bad Steel
Hypereutectoid case	Large uniform pearlite grains	Small pearlite grains
	Uniform thin Fe_3C network	Massive Fe_3C films
Eutectoid zone	Deeper and thicker than in bad steel	Surrounded by ferrite Shallower and thinner than in good steel
Hypoeutectoid zone	Coarse crystalline	Isolated fine ferrite areas
	Continuous bold ferrite network	
Core	Normal angular pearlite areas	Banded ferrite and with ghost lines

Pieces from each stage of manufacture were carburized, and a defective steel proved a poor carburizer back to the ingot. It was therefore concluded that the trouble originated in the furnace. It has been Messrs. McQuaid and Ehn's practice, therefore, to pour a small ingot at the middle of each cast, forge it down to a bar, and heavily carburize this bar. If the cementite near the surface appeared in divorced masses, the heat would not be accepted. Co-operation on the part of the steelmakers was obtained after the Timken company had demonstrated that this test was able to segregate a group of samples submitted by the steel company with secret marks and from heats some known to be bad, others known to be correctly made with great care.

While the exact mechanism of the pearlite divorce is unknown, it is thought by the authors to be a characteristic of oxide included in the metal. For instance, fairly good steel may have a ghost line here and there, and this ghost line will persist throughout carburization and be the locus of divorced cementite. No phosphorus bandings are developed in such steel by cupric reagents—indeed, 24 hours at 925 deg. C. in the carburizing pot should give ample time for equalization of soluble phosphides. If the surface of a small ladle of molten electric steel—a steel which carburized perfectly—is blown slightly with oxygen gas, that sample when carburized shows a complete breakdown of pearlite into massive ferrite and cementite. Figs. 1 to 4 show samples taken from an electric furnace at various times during the heat—it is evident that the microstructure of the case is not correct until after the charge has been deoxidized with ferrosilicon. Brearley thinks that soft spots on case-hardened work are due to low manganese in the stock, an idea which the authors harmonize by saying that low manganese means excessive loss of the ferro or spiegel added, and consequently an overoxidized heat of metal.

The Importance of Low Handling Costs.—In a paper on this subject in *Chemical Age* of London for Feb. 25, 1922, Herbert Blyth states that if the chemical industry is going to perform all the great things that are expected of it for the benefit of mankind, it will have to be invigorated by the sweeping away of inefficiencies and the employment of modern methods. He states that in nearly all chemical works the want of efficient unloading and conveying equipment is one of the chief causes of the high cost of production, it being an established fact that the cost of the product is almost directly proportional to the cost of simply moving the material into the works, through the plant, and out of the works again. Another factor is the speed of handling the material. If production is kept at full capacity by proper feeding of materials, cost will naturally be much less than with restricted delivery of material.

In the matter of unloading bulk materials from car or barge notice is taken of the convenience and economy obtained through the utilization of pneumatic methods. The advantage of this method lies in the continuous nature of the duty performed and the elimination of hand labor in trimming; but the method can be used only for a practically dry and fairly fine material. For coarse or moist materials the crane and bucket unloader is recommended.

For handling from the unloading point the belt conveyor is recommended when the route is straight, unobstructed, and not too long. For heavy material, or material discharged into a pit by bottom dump cars, which involves a lift as well as a horizontal movement, the monorail carrier is recommended. The final choice of the handling method used must rest on a study by the chemical engineer, the mechanical engineer and the financial man of the material to be handled, its tonnage, and the route over which the handling is to be done, together with the cost of the various methods available.

In conclusion, it is stated that the chemical industry has not hitherto properly investigated its handling problems or taken serious notice of the improved equipment available. The objects of every industry are to cut production costs, increase output and improve plant conditions, and a great deal can be done toward the achievement of these objects by the adoption of suitable methods of handling the raw materials and products.

Book Reviews

STEEL MILL BUILDINGS. Fourth Edition. By *Milo S. Ketchum.* New York: McGraw-Hill Book Co., Inc. Price $6.

In this book is found an old friend in a new flexible cloth binding well suited to constant and hard usage. The author has re-written much of the book and added a considerable amount of subject matter and many instructive drawings and diagrams, including very valuable data on a number of proved building materials developed since the earlier editions of this book, and a large variety of the newer type of building construction. In the preparation of drawings and diagrams, the work has been carried out in an exceptionally neat, orderly and well-arranged manner, using plain lettering of nearly uniform character throughout the book and offering a very excellent example to the student during his habit-forming years.

It is doubtful if some of the tables, those also found in the handbooks published by various steel companies, will prove of much value to or be often used by the experienced engineer, but since the work is also offered as a text book for students, they may well serve a useful purpose.

Special credit is due the author for putting in concise form the analysis of stresses in statically indeterminate structures of a wide variety, a subject hitherto involving so much sifting of chaff from the wheat that the busy engineer has shown a marked tendency to avoid many useful forms of structures entailing such calculations. L. W. EMERSON.

* * *

CONDENSED DESCRIPTION OF THE MANUFACTURE OF BEET SUGAR. By *Franz Murke, Ph.D., A.M.* 5 x 8½, v + 175 pages. New York: John Wiley and Sons, Inc., 1921. Price $2.50 net.

Dr. Murke's book directs more attention to the principal operations of beet-sugar factories than to the equipment used. This is an excellent feature. Another good feature is the running commentary on the mistakes and difficulties commonly encountered, including methods of avoiding or overcoming them. In this latter the author gives us a liberal helping from his own store of wisdom accumulated through years of experience and comparative study of the operations of several factories. The style is very concise and usually clear, but the brevity has been carried to the extremity of omitting illustrations, diagrams and even tables of analytical data showing the successive changes in the products as they advance through the process. The book therefore is addressed (in the preface) especially to readers who already have a respectable knowledge of the process. But since there is very little about the relations of the various operations one to another or to the process as a whole, one of its greatest potential values has not been developed. Treatment of the operations in flow-sheet sequence was perhaps thought sufficient.

Although the book was mainly written several years ago, it has been brought generally up to date. Some exceptions to this are the omission of modern devices applied to the cleaning and handling of beets, the recommendation of daneks for thin juice filtration (p. 50) and the treatment of reactions from the standpoint of the old chemistry rather than of modern colloidal and physical chemistry. The discussions of such obsolete practices as the bluing of sugar (p. 91) and the osmose process take up space that could have been given to more valuable features.

There is little to stimulate new thinking, or to indicate lines of probable future development. The style is usually one-sided and conservative. Some poorly constructed sentences and numerous awkward or half-Anglicized expressions such as "after-purification," "healthy juices," "maishing," "wagons . . . carried on rails" (for "dump-cars"), etc., mar the usual perspicuity. The frequent allusions to European practice would be more valuable if they were complete enough to give the reader a clear idea of what is most general there and how it differs from American practice.

The absence of an index will discourage the use of the book as a handbook. There is no bibliography or other guide to the literature of the subject of beet-sugar manufacture or of the individual operations used, and Claassen is the only other authority cited. The six tables and two or three formulas making up the last chapter are useful, but it would seem desirable to have included also some equally useful but less readily available data.

The book is very readable and should prove valuable to chief chemists, foremen and others who are in the stage of secondary training in the subject and interested especially in the operation rather than in the engineering side of it. In fact, it is surprising on the whole how much useful information of this type is included in the 155 pages of text proper. In some respects the treatment is often better than in most other books on the same subject. For example: (1) Without saying so, the author shows that the diffusion process is ordinarily one of continuous extraction with intermittent charging of fresh beets and discharging of exhausted pulp and that it is not intermittent counter-current extraction as some books would lead one to believe. (2) The saving in steam and condenser-water by the application of vapor-heating is shown. (3) The starting, operation and closing down of a limekiln is described so simply and yet so definitely that anyone who has read it would probably not make such blunders as we sometimes hear about in connection with this station.

Aside from the texts prepared by some of the sugar manufacturers for the instruction of their employees, which, however, are not readily available, it is the best book on American practice. M. J. PROFFITT.

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JOURNAL OF THE INSTITUTE OF METALS, vol. 26. Edited by *G. Shaw Scott.* 8vo. 760 pages. London: The Institute, 36 Victoria St., S.W.1. Price 31s. 6d.

Again the British Institute of Metals is to be congratulated upon a very attractive and useful book, published and in the hands of their members within 5 months after the autumn meeting. It contains not only the technical papers presented at that time, and 120 pages of discussion thereto, but the May lecture on "Casting of Metals," by Prof. Thomas Turner, 200 pages of abstracts from current metallurgical periodicals, and a considerable mass of society news. Indeed, the bulk of the volume is growing apace. However, in the opinion of the reviewer, the present volume could be compressed by 100 pages, partly by elimination of matter of purely temporary interest and which, on this side at least, would be placed in the hands of the membership through bulletins or circulars, and the remainder through a typographical rearrangement of the index.

A continuation of the notable papers on light alloys is noted in an extended discussion of constitution and age-hardening of Al:Mg:Si alloys by D. Hanson and Marie Gayler. Most of the other papers deal with the properties of worked metal (pure copper and zinc) cold drawing of bronze, and extrusion. G. D. Bengough also adds a summary of the findings of the Corrosion Committee, having special reference to methods which may be adopted to minimize corrosion of brass condenser tubes. Laboratory men will be interested in the papers on electro-etching and scleroscope tests on thin specimens. New copper alloys of promise with up to 8 per cent nickel and 10 per cent aluminum are discussed by A. A. Read and R. H. Greaves. Foundry practice is touched upon in papers on the effect of lead in Admiralty mixture, and the density of brasses. In this vein, R. Genders presented a very interesting note on the casting of brass ingots, wherein he notes that rejections due to pipe and inclusions in hollow drawn 70:30 brass articles were reduced from 25 per cent to nearly zero by using best steel-teeming practice. Long narrow ingots, 1½ in. square, 6 or 7 ft. long, were replaced by others 30 in. long, tapering from 3½ to 3 in. square. These were set big end up, the top surmounted by a hot fireclay top, a "dozzle," and the teeming slowed down so that when cast the ingot was solidified and much colder at the bottom than at the top. E. E. THUM.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Week's Testimony in Dye Investigation Brings No Substantiation or New Developments

The sensational developments which rumor had promised would be disclosed when the testimony of dye importers was heard before the Senate sub-committee have apparently fallen as flat as Senator King's original charges. The testimony of Herman A. Metz, importer and manufacturer, disclosed nothing more startling than a personal animosity between himself and Francis P. Garvan, former Alien Property Custodian.

For the rest, the King charges have been somewhat lost in the shuffle of witnesses entering an eleventh hour agitation for tariff protection. Charges and counter-charges which have characterized the entire investigation promise to pass into the record without substantiation. Senator Shortridge's comment on some of Mr. Metz's statements to the effect that his statement was "argument and inference" drew from the latter a reply which seems to summarize the situation. "That's all we've had from either side," said Mr. Metz.

Metz Continues Reading of Testimony

The testimony of Mr. Metz occupied four days of the hearing. He began the reading of his lengthy statement on March 23 and concluded March 29. In his testimony, Mr. Metz went into the details of his troubles with the Alien Property Custodian and attempted to defend his stand in opposition to the dye embargo. He seemed very bitter in his resentment of the action brought against him during the war by F. P. Garvan, declaring that the latter "sought to ruin me in the interest of those in whom he was interested."

"I was evidently German when it suited his purpose," he stated, "but was 100 per cent American when I took stock in his Chemical Foundation or was granted licenses by the Foundation under patents they claimed to own."

He had refused to surrender the stock of H. A. Metz & Co., and the H. A. Metz Laboratories, Inc., upon demand of the Alien Property Custodian, Mr. Metz said, and had obtained a temporary injunction in New York enjoining the Custodian from taking any action on the stock of those companies. Metz had instituted proceedings to recover the stock of the Farbwerke-Hoechst Company.

He had consulted Charles E. Hughes, now Secretary of State, he said. "Pending a hearing on the temporary injunction, Garvan tried to arrange by stipulation just under what conditions I was to deposit the stock, because I told Judge Hughes I positively refused under any condition to allow Garvan to put his directors into my salvarsan plant and if he did, I would close the plant and take every man out.

"Various stipulations were suggested but I refused them, all of them, even when Judge Hughes told me I was running risk of being indicted, as under the Alien Property Custodian law his determination was sufficient, and I had redress under section 9. I realized there was no redress after once my property had been taken. I had been damaged enormously by the reports of Garvan's seizure and the stories circulated by my competitors about being German, all of which was enough to condemn anyone in those days."

Criticizes Institute and Foundation

The witness brought Judge J. Harry Covington, a former member of Congress from Maryland, and now counsel for the American Dyes Institute, into his testimony, declaring that he had been active before Congress in support of embargo legislation for American dye manufacturers.

Mr. Metz went into much detail concerning his relations to the American Dyes Institute and the Chemical Foundation. He charged that the principal activities of the first had been in obtaining legislation and said that the second "posed as a quasi-public organization, whereas there is nothing public about it."

Mr. Metz told in detail of his manufacture of salvarsan, declaring that the service he had rendered in this connection would have been rendered if the Chemical Foundation, which holds a patent for its manufacture, had never been heard of, as he manufactures under a patent from the Federal Trade Commission.

In answer to questions from Chairman Shortridge, the witness declared himself in favor of protecting the domestic manufacture of salvarsan by an ad valorem rate of 50 or 60 per cent plus a specific duty.

"A specific rate of 7 to 10 cents a pound would protect us on dyes, but not on salvarsan," he said.

Touching on the value of the patents taken over by the Chemical Foundation, Mr. Metz declared that the salvarsan patent was "worth a million dollars to anybody"; that the indigo patent was very valuable and that the patents of the Bayer Co., seized and sold during the war, were worth several millions. Mr. Garvan, as Alien Property Custodian, knew that they were worth "a great deal more" than the $250,000 paid by the Chemical Foundation, he added.

The witness attacked the policy of the Dermatological Research Institute of Philadelphia. Although not run for profit, he said, the Institute sells its product in the open market in competition with those manufacturing for profit. The difference is, according to the witness, that he had to pay taxes to the government on his profits while the Institute did not. He declared that the Institute had made $500,000 in profits from its manufacture and had "presented" this to itself, not for profit, but for further research work.

No Dye Monopoly, Says Metz

"There is today no monopoly in the American dye and organic chemical industry, but the strongest kind of competition; everybody is trying to turn stocks into cash," Mr. Metz declared. "Banks are calling loans on stocks of dye companies," he continued, "prices are falling and you know when that is going on there is no monopoly."

He estimated that about twenty of more than eighty plants making dyes and chemicals in this country have been forced to close because of decreased consumption and competition. He declared that he had done everything possible to help the American industry, as he wished to see it prosper.

Tariff Would Protect Manufacturers

In answer to questions from the chairman, Mr. Metz said that a tariff can be written which would protect adequately 75 per cent of the dye products made here. The protection should be 50 per cent ad valorem and from 7 to 10 cents a pound specific duty on dyes and the same duties on intermediates. "With that protection, I'll guarantee that my plants will run and make all the products they make today," he added.

Mr. Metz said he had no criticism to make of the men in charge of the licensing system and that it had been administered fairly and well, but he objected to the system as inconvenient and costly to consumers of dyes. He said he was speaking solely in the interests of the consumers.

Textile Man Favors Embargo

Franklin W. Hobbs of Boston, president of the Arlington Mills, Lawrence, Mass., was the first witness following Mr.

Metz. Mr. Hobbs explained that his mills manufacture worsteds used in men's and women's wear and dye 350,000 yards a week. He announced that he would discuss the question of what is needed for adequate protection of the American dye and organic chemical industry as an American citizen and as a large consumer of dyes.

The substance of his testimony was an expression of confidence in the ability of American dye manufacturers to meet the needs of the textile trades if given proper protection. "We have no complaint to make whatever of American dyes. We use a few foreign dyes, for fancy shades, but I believe these shades will soon be made in this country," he said.

Mr. Hobbs expressed himself in favor of the licensing system, saying: "If we want to be absolutely sure about protection, we're going to get results with the licensing system. You may get it with a tariff, but we are sure of getting it with the licensing system."

H. J. Conn of the Agricultural Experimental Station at Geneva, N. Y., said the American scientific men are interested in the maintenance of the American dye and chemical industry, regarding it as necessary to proper research work. He said about ten American manufacturers have standardized their colors for biological research work. This witness had no opinion to offer as to the best means of protecting the American industry.

Schamberg Defends Dermatological Institute

Dr. Jay Frank Schamberg, director of the Dermatological Research Institute, Philadelphia, commented vigorously on testimony relative to his institution, given by Mr. Metz. Dr. Schamberg said he was at a loss to understand just what Mr. Metz meant by his statement. He said that if Mr. Metz meant that Dr. Schamberg and his associates turned over to an institute incorporated for philanthropic and scientific purposes money which they could legally have retained for themselves, Mr. Metz was correct, but that if he meant that one penny was retained for the personal profit of Dr. Schamberg or his associates, the statement was "a miserable and damnable calumny."

The witness explained that the Dermatological Research Laboratories were established in Philadelphia in 1912, through the generosity of P. A. B. Widener of Philadelphia, who financed their scientific work for four years. After his death further support from this source stopped. These laboratories, the witness explained, were engaged during this period in research work to develop new chemical compounds to combat germs causing infectious diseases.

Continuing, he went into the relations of the Laboratories with Mr. Metz during the war when there arose an urgent need for salvarsan. The primary purpose of his organization in manufacturing salvarsan was to meet this shortage, lower the price to the poor and supply physicians and hospitals. He believed, he said, that these purposes have been fulfilled, as the American product is selling today at about one-fifth the price the Germans received here for their product before the war, and the American product today is the superior, he declared.

"If the German product were allowed to come in, I believe the Germans would be able to close most of our laboratories by price competition," said Dr. Schamberg.

The witness explained that the production of salvarsan is only one of the activities of the Institute, which, he said, is constantly carrying on research work to discover drugs to cure infectious disease and has done so. All profits must be, he said, devoted to the research work.

Helium Research to Continue Despite Opposition

During consideration of the army appropriation bill by the House, Representative Green of Iowa sought to terminate experiments on helium. He took the position that it is not necessary to recover helium, as dirigibles are going out of use. Representative Lanham of Texas defended appropriations for conservation of helium. An amendment by Mr. Green to discontinue the investigation by striking from the bill authorization to acquire land to explore, procure or reserve helium gas as carried by the bill on committee recommendation was rejected, however.

Utilization of Water Power at Muscle Shoals by Haber Process Is Proposed

The Secretary of War has received a proposal for the purchase and operation of some of the Muscle Shoals property from Dr. Charles L. Parsons, representing a group which will organize a company called the Southern Nitrate Corporation. The company will be organized, if the proposal is accepted, and will in turn organize a corporation, the securities of which will be offered to the public.

Details of the Proposal

The company proposes to purchase the first 100,000 kw. of secondary horsepower developed at the Muscle Shoals Dam at a price of 0.75 of a mill.

It offers to purchase Plant No. 1 for $600,000, the purchase price to include everything except the designs acquired from the General Chemical Co. over which the government has jurisdiction. As a condition of the purchase the company will demand the option to lease the carbide plant, part of Plant No. 2, for $50,000 per annum and the option to purchase the Waco quarry property for $200,000 or to lease it for $20,000 per annum.

The company will agree to operate Plant No. 1 as an air nitrogen fixation plant, using as much of the power as is necessary to produce hydrogen for the ammonia process by electrolysis. It further agrees to produce calcium carbide or phosphoric acid and potash by electrothermal methods in the carbide plant. It will maintain a research laboratory and keep all leased property in good condition for the use of the government in case of emergency. It will also agree, in case the government leases the rest of the cyanamide plant, to supply the lessee with calcium carbide at 6 per cent profit as well as nitrogen and power at cost.

Advantages of the Haber Process

In presenting the proposal Dr. Parsons pointed out that the decreasing importance of the cyanamide process for nitrogen fixation was due to the rapidly increasing success of the Haber process. Already the General Chemical Co. has a very successful plant in operation at Syracuse, N. Y. A large plant for producing 100 tons of fixed nitrogen per day is under construction at Billingham, England. Prof. Claude has constructed a remarkable plant in France which operates on the same principle but under much higher pressures. In Italy and Japan similar plants are under construction. Finally, a large cyanamide plant in Odda, Norway, almost half as large as Muscle Shoals, was sold for the equivalent of $10,000, which is scrap value. This Norwegian company plans to install a Haber process plant. All of these data were presented with a view to substantiating the claim that the Haber process is more desirable than the cyanamide process—a better commercial possibility. This particular point has been the subject of a very important controversy which originated in the discussion of the Henry Ford offer.

The company which will be organized by Dr. Parsons is in no way connected with any of the other parties who have made proposals on the Muscle Shoals project. It is not primarily interested in the "philanthropic production of fertilizer," but claims to be a business organization organized to develop a profitable industry.

Such a plant, it is claimed, will be able to produce enough nitrogenous fertilizer at a relatively low cost to stabilize the price of the commodity in this country and lower the cost to the consumer. In addition to fertilizer it is planned to produce calcium carbide and acetylene for autogenous welding. Finally, if development work indicates that the process will be successful, phosphoric acid and potash will be produced by electrothermic methods in some of the carbide furnaces.

Date of N. J. Society Meeting Changed

The April meeting of the New Jersey Chemical Society will be held on the 17th, instead of on the second Monday as usual. The speaker will be Prof. W. D. Harkins of the University of Chicago, who will talk on "Isotopes and the Building of Atoms."

Revival of Patent Convention With Germany Delayed—Working Clause Proposed

The President is understood to be satisfied that it would be unwise to revive the patent convention of 1909 with Germany. The Senate recently authorized the President to revive this patent convention, but it is believed that the Senate action was taken without a thorough understanding on the part of most members that it would exempt German patents taken out in this country from any working clause that might be enacted. The convention also exempts American patents registered in Germany from any working clause which might be adopted in that country. There are certain American industries which are very anxious to have that safeguard, but the arrangement would be particularly harmful to the chemical industry.

The whole matter of a patent working clause is to be threshed out at once. Senator Stanley of Kentucky has introduced a bill which has been approved by the War Department. Public hearings on the bill have been called for April 5. The salient feature of the Stanley bill provides that "any patent or patents issued to any person or persons under the provisions of this act shall contain a proviso to the effect that if such patent so granted is not worked or put in operation so as to result in actual production in the United States of the article embodied in such patent in reasonable quantities within a reasonable time from the date of its issue, which in no case shall be less than 2 years nor more than 5 years, the United States reserves the right to license any person or persons for purposes of manufacture in the United States, and to use and sell the subject matter thereof subject to the conditions hereinafter provided."

In all probability the definition of a reasonable time will be altered so as to leave it to the discretion of the administrative officer.

Societies Co-operate in Work on Corrosion Under Committee of National Research Council

The National Research Council recently appointed a committee connected with its Division of Research Extension with the following membership:

W. M. Corse, chairman, Monel Metal Products Corporation, Bayonne, N. J.; Wilder D. Bancroft, Cornell University, Ithaca, N. Y.; John Johnston, Yale University, New Haven, Conn.; G. K. Burgess, Bureau of Standards, Washington, D. C.; D. M. Buck, American Tin Sheet & Tin Plate Co., Pittsburgh, Pa.; William H. Bassett, American Brass Co., Waterbury, Conn.; E. M. Chamot, Cornell University, Ithaca, N. Y., and Colin G. Fink, 101 Park Ave., New York City, secretary.

The purpose of this committee is to serve as a general clearing house and to devote its attention essentially to fundamental scientific study of corrosion. This committee desires to get in touch with all the work that is being done on corrosion whether through societies, associations, institutes, universities or private or industrial laboratories.

Various Societies Have Corrosion Committees

The American Society for Testing Materials has had a committee on corrosion of iron and steel for a number of years, known as Committee A-5. J. H. Gibboney, chemist of the Norfolk & Western R.R., Roanoke, Va., was designated as acting chairman of the committee, following the death of Dr. S. S. Vorhees of the Bureau of Standards, and the secretary is J. A. Aupperle, chief chemist of the American Rolling Mill Co., Middletown, Ohio. The committee is representative of both non-producers and producers of iron and steel, with four sub-committees, one an advisory committee, another a committee on preserving metallic coatings of metals, another a committee on inspection and the last a committee on total immersion tests. It has been decided to establish a further committee (Committee B-3) on corrosion of non-ferrous metals and alloys, representing non-producers and producers.

The American Committee on Electrolysis was organized in 1913 through the activity of some members of the American Institute of Electrical Engineers, representing, in addition to the Institute and the Bureau of Standards, the following organizations: American Electric Railway Association, American Gas Association, American Railway Engineering Association, American Telephone & Telegraph Co., American Water Works Association, National Electric Light Association, National Gas Association of America. This committee is made up of twenty-seven engineers, three from each of the organizations named. This general committee appointed a special research sub-committee of which H. S. Warren, 195 Broadway, New York City, is chairman, and H. C. Sutton, 1401 Arch St., Philadelphia, Pa., is secretary. The Bureau of Standards undertook the investigation of certain phases of the electrolysis problem in 1910 and has since then made important contributions to the subject. At the beginning of the co-operative work between the bureau and the research sub-committee a policy was agreed upon to the effect that the investigations are solely concerned with the accumulation of facts leading to the establishment of principles upon which conclusions and recommendations may ultimately be based. Burton McCollum, of the bureau, has recently proposed an extended series of tests of samples of many kinds of pipe buried in the soils of known special character in selected localities in many parts of our country.

The Engineering Foundation is giving preliminary consideration to a study of that form of corrosion of iron which has been called "graphitic corrosion."

The American Electrochemical Society at its recent meeting named Dr. Colin G. Fink as head of the committee on corrosion investigations.

The Bureau of Mines at its Pittsburgh station is investigating the corrosion of mine waters on metals.

The American Society of Civil Engineers has recently appointed a research committee of which Prof. A. M. Talbot at the University of Illinois, Urbana, Ill., is chairman, and F. E. Schmitt, Associate Editor, *Engineering News-Record*, 10th Ave. at 36th St., New York City, is secretary. The matter of corrosion has not yet been considered by the committee, but undoubtedly will be.

Problems in Corrosion Pointed Out by Colin G. Fink

In a statement designed to co-ordinate the corrosion problems of immediate importance, Colin G. Fink, secretary of the National Research Council committee, calls attention to the widespread importance of work on this subject.

"In spite of the general relaxation in chemical and metallurgical research throughout the country," says Dr. Fink, "a number of the corrosion problems are so very important and their solutions involve such large savings in capital and labor that a number of concerns and government laboratories felt the urgent need of furthering corrosion research during the past year.

"The corrosion problems have been attacked from two more or less different angles. In the one case every effort is being made to arrest the corrosion of the materials now in use; in the second case, new materials are substituted and tried out. There are today a series of distinct corrosion problems, in each instance centered about some specific material or article of manufacture. There is, for example, the problem of the corrosion of food containers and the problem of the corrosion of buried conduits and cables. Besides these specific problems, there are the general investigations on the causes of corrosion under varying conditions and of various materials.

"We cite below a few of the corrosion problems covering specific materials or products; and secondly, a few of the general topics, closely allied to the corrosion problem, which require further study and research:

"Condenser tubes, underground cables, buried iron pipes, posts, etc., fence wire, flues, stacks, stovepipes, steel ships and ship fittings, roofing materials, mine pumps and other mine equipment, atmospheric corrosion of brass, atmospheric corrosion of bronzes, alloys resistant to high temperatures, corrosion of zinc cathodes, contact metals or alloys, catalyzer metals or alloys, cutlery steels, acid tank linings, corrosion of nickel-plated ware, boiler tubes and fireboxes, automobile radiators, insoluble anodes and the

corrosion of iron as effected by the presence of small amounts of other elements.

"General problems include the velocity of corrosion as effected by (*a*) temperature fluctuations, (*b*) alternate dry and moist surface, (*c*) presence of foreign materials, (*d*) presence of oxide or carbonate of one or the other constituent of the alloy, (*e*) crystal structure and intercrystalline cement; the properties of the surface film, (*a*) coefficient of expansion as compared with that of the underlying metal, (*b*) its chemical composition, (*c*) porosity, (*d*) flexibility or ductility, (*e*) coefficient of adhesion, (*f*) speed of renewal of 'healing,' (*g*) relative hardness, (*h*) how affected during mechanical working and finally the general problem of corrosion and bacteria.

Suggests Lines of Endeavor

"A more complete micrographic investigation of the changes taking place in the film and the metal underneath, during the process of corrosion, is very desirable. Furthermore, we shall be able to progress more rapidly the sooner we agree upon standard tests used to determine the relative corrodibility of two samples. At present it is almost impossible to compare the results of one author with those of another, even when both have used the same materials in their tests.

"Within the last year decided progress has been made in cutlery steels, in metals and alloys for mine equipment, in cable sheath, in insoluble anodes and in alloys resistant to high temperatures and the corrosive action of molten metals such as zinc, tin, etc. But the corrosion problem, as a whole, in spite of its long past history, is still in its 'infancy' and it is only through co-operative effort and a free discussion of results (those suitable for advertising purposes as well as those usually suppressed) that consistent forward strides are possible."

Trade Associations Invited to Co-operate

Some associations, like the National Canners' Association, and certain corporations, like the New Jersey Zinc Co. and National Tube Co., have been making studies in corrosion. The committee of the National Research Council will be very glad to be informed of any work on corrosion that is going on or that is in contemplation. Communications should be sent to Paul Moore, secretary, Division of Research Extension, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Ratification of Gas Treaty Brings Forth Views of Senators on Its Effectiveness

While no vote was cast against the ratification of the submarine and noxious gas treaty, the futility of such an agreement was pointed out with great clearness by Senator Wadsworth of New York. Senator Lodge, in his effort to justify the treaty, said among other things:

"Undoubtedly the number of deaths in this war arising from poisoned wells was very small. Is that a reason for restoring to general use the poisoning of wells which has been driven out of use simply by the effect of public opinion?

"This clause in this treaty is not expected to prevent the use of poison gases at present. It is expected to do something toward crystallizing the public opinion of the world against it, and trying to make that public opinion more effective. I am aware that the losses of life in this war from poison gases were less than those from high explosives and other weapons, but it hardly seems to me an argument to say that because you kill more men with shells, it is well to add another method of killing them.

"It was obvious to the conference that it is impossible to make regulations for the production or the use of these poison gases because they are made in the production of dyes and in all sorts of chemical materials.

"If the world is cursed with another such war, I dare say poison gases will be used again, but there is always the hope that the opinion of the world may be so crystallized that it will prevent it, as public opinion alone practically has prevented the poisoning of wells and the giving of no quarter to prisoners."

Senator Wadsworth declared that "no nation in its senses will dare refrain from developing gases in research." In the debate attention was called to the fact that Great Britain intends to experiment actively with gases, not with the idea of precipitating their use, but with the idea of being in readiness in case another country should use them. Senator Wadsworth pointed out that we are doing the same thing. In that connection he said:

"We cannot stop the development of gases. It will go on inevitably, to the end of time, in my humble judgment. I will not be surprised if chemical warfare, developed to its highest point of perfection, will make war infinitely more merciful than it is today. It is quite within the realm of possibility that gases will be developed which will put an entire opposing force out of action and yet not injure permanently a man in that force. Not only will development go on inevitably in industry—we could not stop it if we were to try—but every nation will endeavor, in the open or behind closed doors, to continue its research under governmental auspices. No nation will dare take a chance. Poison gases have proved too effective a weapon to be ignored. I should be much discouraged if the army of the United States ceases to experiment in the perfection of gas masks on account of this treaty. The only way to perfect a mask is to experiment with the gases, so the entire research cycle is involved.

"I know I am speaking in contradiction of a very well-defined public sentiment, but nevertheless I think I am justified in making these observations. Can any weapon which in a great war accounts for one-third of all the casualties be definitely and finally barred from use in the wars of the future? It is easy to declare prohibitions against the use of weapons in warfare. The same protest was made against gunpowder many generations ago. I am not enthusiastic about entering into declarations concerning which there is a very strong probability of violation."

Senator Hitchcock of Nebraska made this observation: "While I rather sympathize with the argument of the Senator from New York, I suggest that after all the use of poisonous gases is only in its infancy. If we permit the cultivation and development of the poison gas science, it may be a much more terrific and destructive element in the next war."

Fate of Chemical Warfare Service in Balance—General Staff Favors Continuation as Unit

Decision as to the War Department's policy in the matter of chemical warfare has been vested in a committee of the General Staff. General Fries has made an extended presentation of his views before the committee. In addition, documentary evidence has been submitted. It is believed that it has been established to the satisfaction of the committee that the Chemical Warfare Service should be maintained as a separate entity within the War Department.

The General Staff at one time was very averse to the establishment of a separate Chemical Warfare Service. There was a tendency to minimize the importance of gas in warfare. It is believed, however, that changing personnel, as well as actual developments, has resulted in a very different attitude. A recent poll of officers of the General Staff showed that twenty-two favor the continuance of Chemical Warfare as a separate service, while only two voted to fuse it with Ordnance.

The attention of the Senate Appropriations Committee has been called to the reduction from $1,500,000 to $500,000 in the appropriation for the Chemical Warfare Service during the next fiscal year. It is understood that the Senate committee will make a careful study of the situation. There is reason to entertain hope that the Senate will increase the item.

Consider Calcium Chloride as Dust Preventive

At a meeting in Washington on March 24 of a committee of the American Society for Testing Materials with officials of the Bureau of Public Roads of the Department of Agriculture, to revise specifications for highway materials, a sub-committee was appointed which considered specifications for the use of calcium chloride as a dust preventive on gravel roads.

Large Attendance Expected at New York Convention of Paper Associations

The forty-fifth annual convention of the American Paper and Pulp Association will take place at the Waldorf-Astoria, New York, the week beginning April 10. Several of the meetings of the affiliated associations have been tentatively scheduled, and there is every prospect of a record-breaking attendance.

The dates for the meeting of the American Paper and Pulp Association have been definitely fixed, while the meetings scheduled by the affiliated associations are tentative, but will probably be unchanged in most cases. The list as at present announced follows:

Tuesday, April 11—10 a.m., Glassine and Greaseproof Manufacturers; 10 a.m., Book Paper Manufacturers; 10:30 a.m., Salesmen's Association; 2 p.m., Vegetable Parchment Manufacturers; 2 p.m., Salesmen's Association; 7 p.m., annual banquet of the Salesmen's Association.

Wednesday, April 12—10 a.m., Waxed Paper Manufacturers; 10 a.m., Writing Paper Manufacturers; 2 p.m., Sulphite Bond Division.

Thursday, April 13—10:30 a.m., annual meeting, American Paper and Pulp Association; 7 p.m., annual banquet.

Friday, April 14—11 a.m., Toilet Paper Converters; 2:30 p.m., Tissue Paper Manufacturers; 6 p.m., Tissue Paper Manufacturers and Toilet Paper Converters Association annual dinner. The meetings on Friday are scheduled to take place at the Hotel Astor.

T.A.P.P.I. Program

The seventh annual meeting of the Technical Association will be held in conjunction with the meetings of the American Paper and Pulp Association. The contemplated arrangements are as follows:

Monday, April 10—Meetings of executive committee and standing committees.

Tuesday, April 11—First general session. Reports of officers and committees.

Wednesday, April 12—Second general session. Discussion of committee reports and special papers. Election of officers. Continuation of papers and discussions.

Thursday, April 13—General business meeting, American Paper and Pulp Association. Completion of T.A.P.P.I. program.

Progress of Molding Sand Research Work—Universities and Industries Co-operate

The committee on Molding Sand Research under the guidance of Division of Engineering, National Research Council and American Foundrymen's Association, has made progress in its program of research. The U. S. Geological Survey and the various State Geological Surveys have promised to co-operate with the sub-committee dealing with this phase of the work under the chairmanship of Professor H. Ries, of Cornell University. This sub-committee has prepared a letter of instructions to the State Geological Surveys, which will standardize methods of making the surveys of molding sand resources.

Work on standardization of tests is well under way. Questionnaires have been sent out to gather information on the present methods of testing physical properties of sand. A digest or replies to these questionnaires is expected to be available shortly.

Many firms and universities have offered to co-operate in the research work. Every endeavor will be made to maintain their interest and to assign problems to those universities and industrial laboratories offering to co-operate, due regard being given to the facilities and talent available. A list of research subjects has been compiled, which is given in part below.

1.—Recovery of used molding sand through restoring bond to the sand by subjecting it to contact with water vapor under high pressure.

2.—The effects of additions of certain chemical reagents upon the physical properties of clays and clayey materials, such as molding sand.

3.—Effects of water content on the bond and permeability of a molding sand.

4.—Effects of different water per cents in molding sand on the milling and drilling speeds of light gray iron castings.

5.—Research on fusion quality of facings (function of "peeler").

6.—Tests of various kinds of clays for restoring bond to molding sand.

7.—Comparison of lives of different molding sands.

8.—Effects on plasticity of bond in molding sand and reduction of water content when using oil.

9.—Effects of wet and dry storing of sand on bonding quality.

International Chemical Societies Plan Summer Meetings in France

The third international chemical conference will be held at Lyon, France, June 27 to July 2. At the second congress of the International Association of Pure and Applied Chemistry, the arrangements for the 1922 conference were delegated to the National Federated Chemical Societies of France. The committee of this organization in charge of the plans includes prominent city officials, business men and educators. The general program includes a reception to the delegates by the city of Lyon at the city hall, a number of general meetings, council and committee meetings and a banquet to the delegates given by the Chamber of Commerce of Lyon. A boat trip down the Rhone is also planned. Visits will be made to the silk mills and tanneries in the vicinity of Lyon and to the factories of Jonage.

The last excursions planned will bring the delegates to the vicinity of Marseilles in time to attend the second Congress of Industrial Chemistry to be held in that city July 2 to 7, in the headquarters of the Technical Institute. The arrangements for this meeting are in charge of a committee of prominent business men and industrial chemists of southern France. Among the subjects scheduled for discussion are studies of the mineral resources of the French colonies and studies of fatty acids, soaps, etc. A series of visits to industrial establishments near Marseilles will conclude the program.

International Engineering Conference to Be Held in Rio de Janeiro in September

Plans are being laid for an international engineering congress to be held in Rio de Janeiro in September, 1922, the occasion of the centenary of independence of Brazil.

It is understood that representative engineers from all the American countries will attend the congress and that the principal subjects of discussion will be:

1. The utilization of fuel resources.
2. The best utilization of water power.
3. Recent advances in irrigation methods.
4. The elimination of waste through the standardization of supplies for agricultural and industrial purposes.
5. Coal as a factor in industrial development.
6. Essentials of a national railroad policy.
7. Intercontinental engineering co-operation.
8. Port developments.
9. Terminal facilities.
10. The iron and steel industry.

Exhibition of Technical and Industrial Photography Proposed

A conference for a proposed exhibition of industrial and technical photography will be held in Room 109 of the Waldorf-Astoria Hotel, New York City, April 10, 1922. The meeting is being held during the convention of the American Pulp and Paper Association, as many of the members of that organization are interested in the subject in connection with photomicrographic studies of pulp and paper fibers.

No Interstate Commerce Commission Decision on Reduction of Rates Before April 15

The decision of the Interstate Commerce Commission in the matter of a general reduction in rates, it now appears, will not be forthcoming before April 15. At present the case is being studied by the commissioners individually. If they should find themselves in substantial accord, the decision probably could be handed down as early as April 15, but should there be important differences between them, the time required for the consideration of the case would obviously be extended.

Senate Finance Committee Votes to Extend Dye Embargo

By a vote of 6 to 4 the Senate Finance Committee decided to extend the dye embargo and licensing system for a period of 1 year from the date on which the tariff bill becomes a law. The dye embargo is now authorized under the emergency tariff bill enacted at the last session and continues in effect until a revised tariff bill is passed. At the end of the 1-year period the duties provided in the tariff bill will take effect unless the dyestuff and organic chemical producers are able to convince Congress that the embargo should be continued.

The bill at present provides for 7c. a pound and 50 per cent ad valorem on unfinished dyes and 7c. a pound and 60 per cent ad valorem on finished dyes.

In this connection, however, an emphatic protest has been lodged with the Senate Finance Committee by about 200 smaller manufacturers of synthetic organic chemicals against the extension of the embargo for 1 year only. Their position as communicated to the committee by Dr. S. Isermann is that while 1 year's extension might be helpful to companies with large capital, as they can afford to gamble on future protection, 1 year's extension does not place the smaller manufacturer in a position where he can procure capital to keep his business going.

Russian Engineers Request Technical Publications

The Engineering Section of the Society for Technical Aid to Soviet Russia has been requested by the Russian Scientific and Engineering Societies for contributions of books, bulletins, pamphlets and current literature on the scientific and industrial progress in the United States, particularly since 1914. Individual members of the Society have donated toward a fund created by the engineering group in order to send such literature to Russia. The demand, however, is so great and the needs for the latest available scientific and technical publications are so urgent for Russia's industrial rehabilitation that they cannot be filled by the Engineering Section of the S.T.A.S.R. It is requested that literature of this nature be forwarded to the Engineering Section of the Society for Technical Aid to Soviet Russia, at 110 West 40th St., New York City.

New Chemical Laboratory Is Planned for Tufts College

Bids have been taken for the erection of a new chemical laboratory building at Tufts College, Mass., and work will be commenced on the structure at an early date. The estimated cost has not as yet been announced. Rockwell & Wright, Tufts College, are architects.

Personal

Dr. F. W. Aston of Cambridge University, England, delivered an address on "Isotopes and the Structure of the Atom" before the joint meeting of the Washington Academy of Sciences, Philosophical Society of Washington and the Chemical Society of Washington, March 29, 1922.

William H. Bassett, technical superintendent and metallurgist of the American Brass Co., Waterbury, Conn., a subsidiary of the Anaconda Copper Mining Co., is making a tour of inspection with other officials of the company at the last-named company's properties at Butte, Anaconda and Great Falls, Mont.

A. P. Blackstead, formerly chief engineer of the Camden Iron Works (R. D. Wood & Co.), Camden, N. J., and prior to that hydraulic engineer with the Henry R. Worthington Co., New York, has joined the engineering staff of the Dayton Dowd Co., Quincy, Ill. Mr. Blackstead has recently returned from Europe, where he spent 6 months studying conditions and investigating recent developments in hydraulic engineering.

Dr. Robert P. Calvert addressed the Southern California Section of the American Chemical Society on March 30. He spoke on "The Manufacture of Celluloid and Motion Picture Films."

L. B. Kruse has been elected treasurer and assistant secretary of the Empire Iron Co., Philadelphia, Pa., operated under lease by the Cambria Steel Co., Widener Building, Philadelphia, Pa. P. B. Burtis has been elected secretary and assistant treasurer, succeeding D. B. Gehly, resigned.

Dr. Charles Skeele Palmer, consulting chemical engineer, of Pittsburgh, Pa., and formerly connected with the Mellon Institute, addressed the engineering students of the Carnegie Institute of Technology of Pittsburgh, on March 29, on "Faith in the Order of Nature—Invention Is a Part of It."

O. A. Pickett of the Hercules Powder Co. spoke on "Colloids and Some of Their Applications" before the senior class of the Cooper Union Night School on March 23.

Frederick W. Sperr, Jr., chief chemist of the Koppers Co., Pittsburgh, Pa., has been awarded the Beal medal by the American Gas Association, in recognition of his work and paper, presented at the convention of the organization last November, entitled "The Seaboard Liquid Process of Gas Purification."

A. A. Stevenson, vice-president in charge of manufacture of the Standard Steel Works Co., which is a subsidiary of the Baldwin Locomotive Works, has, at the request of Herbert C. Hoover, been designated a special representative of the American Engineering Standards Committee, to work with the Department of Commerce in the co-operation between the Department's Division of Simplified Practice and the American Engineering Standards Committee.

Dr. E. W. Washburn of the department of ceramics, University of Illinois, will lecture before the Franklin Institute, Philadelphia, on April 6, on the subject "Physical Chemistry and Ceramics."

Obituary

Dr. Theodor Liebisch, late professor of mineralogy at the University of Berlin, died at his home in Berlin, on Feb. 9 after a protracted illness. He was born on April 29, 1852, and from about 1890 to 1900 he was professor of mineralogy at the University of Göttingen. During this period there were very many Americans studying for their degrees in chemistry who took mineralogy under Prof. Liebisch. It is scarcely too much to say that he was one of the most highly respected and best loved professors in the university. He perhaps did more in a personal nature for the American students in those days than any other professor. All Americans respected and admired him for his deep learning, his ability as a teacher, his inspiration for research work and his extremely kind and ever thoughtful nature. About the year 1900 he was called to the University of Berlin, and served there until about 1920, when he retired from active work. He was the author of many books, his most important being "Grundriss der Physikalischen Krystallographie."

Market Conditions

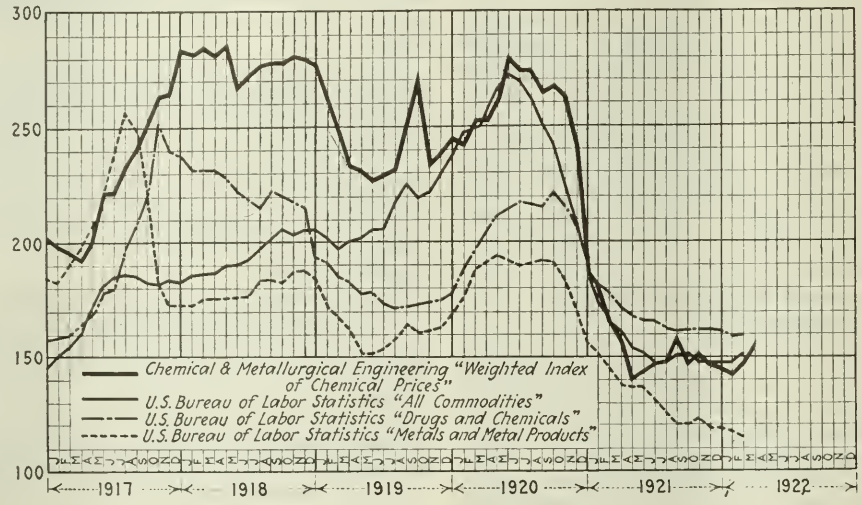
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Business Progress During March

It is often said that the trend of business during the first 3 months of the calendar year affords a reliable index of conditions to be expected in the remaining three quarters. If this be the case, certainly there is much to justify the restoration of industrial confidence. The worst of the period of business readjustment is now so definitely behind us that current historians are already beginning to refer to the "memorable depression of 1921."

Many of the factors of improvement noted in the underlying business conditions in the early months of the year are becoming better defined and their influence on business is now more apparent. Among these factors, or the conditions directly attributable to them, are included the following: (1) The upward turn in certain commodity prices, notably farm products and foodstuffs, has not only increased the purchasing power of the farmer but has helped to close up the unduly wide spread between producer and consumer prices. (2) The larger volume of production, particularly in the iron and steel industry, but also noted in the manufacture of paper, petroleum, and other basic commodities, has materially lessened unemployment. (3) The strengthening advance in the stock market and the coincident easing up of money rates are signs of returning confidence in the future of business. (4) The recent increase in car loadings are indicative of greater industrial activity, especially as regards consumption and distribution. (5) The progress being made toward lower costs and increased efficiency promises a healthier form of competition.



COMPARISON OF WHOLESALE PRICES, 1917-1922

The only clouds on the business horizon are the difficult problems now being solved in the coal mines of the country and in the New England textile mills. The textile strike, although in progress for over 10 weeks, is still at a deadlock. The mill owners are meeting serious obstacles in their attempts to lower costs and to get their industry on a basis to compete with the Southern mills, where wage reductions have already been accepted. The coal strike, involving 600,000 men in both hard and soft coal mines, has not as yet caused a great deal of anxiety among our industrial leaders—in fact, many feel that if the general walkout had to come, there could have been no more appropriate time. The Geological Survey has announced that on March 1 the general industrial consumers had on hand an average coal reserve of 56 days, electric utilities 54 days, steel plants 48 days, railroads 42 days and byproduct coke ovens 39 days. It was officially estimated that the reserve on April 1 was 63 million tons and that production at the non-union bituminous mines of the country would continue at the rate of 4,700,000 tons per week.

Of the favorable factors listed in a previous paragraph, perhaps the one most welcomed by the manufacturer has been the gain in wholesale prices. That the chemical and related industries have participated in this upward movement is clearly shown in the accompanying chart. During the last 2 months the CHEM. & MET. index number has risen approximately 14 points and during the month of March has averaged 156.19, the highest quotation since August, 1921.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	156.75
Last week	157.65
April, 1917	207
April, 1918 (high)	286
April, 1920	261
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

The Financial Situation

In the face of the adverse financial statements and the losses or lowered earnings noted in the annual reports of many companies, the stock market has maintained an unusually strong position. Since August of last year the *Annalist's* average for twenty-five industrials has shown an advance of 18 points. A similar average based on the stocks of twenty chemically controlled industries has also gained considerably during this period. From 46.1 on Aug. 1, 1921, this average rose to 59.0 on March 1. The ascent during the past month has continued, although at a somewhat slower rate. The increased activity in stocks can be attributed largely to the comparative ease in the money market. Call money in New York on March 18 got down to 2½ per cent, the lowest figure reached in recent years. Since then there has been a reaction, to be sure, and by the end of the month the rate was up to 4½@5 per cent. It is also interesting to record that on March 18 more separate stock issues were sold on the New York Stock Exchange during the day's business than on any other day in its history. For several days the number of shares handled exceeded a million.

A discussion of the financial market, however, is not complete without a reference to developments in the foreign exchanges. As the month started, sterling stood at the highest level since 1918. The quotation on March 1 was $4.44⅜. Toward the middle of the month and coincident with our demands on the Reparations Commission and the cessation of gold exports from London, the rate fell to $4.34. Since then there has been a slight recovery, bringing the value of the pound back to $4.37 on March 31. The sensation of the foreign exchange market, however, has been the sudden break in the German mark, which on March 27 had fallen to $0.0028⅝. This is the lowest quotation ever recorded for this currency and is generally believed to have resulted from the announcement of more stringent reparation policies on the part of the Allies.

The Chemical Market During the First Quarter of 1922

Developments of the first months of the current year have done much to encourage the growing feeling of optimism among the large producers and consumers of chemicals. The readjustments made throughout January were largely responsible for the general upward turn in prices which began in February and continued during the past month. The return to normal has not been entirely completed, but the process has left the chemical market in a much healthier condition than at any time in the past 2 years.

One of the outstanding features of the market during the last few months has been the recovery in the price of caustic soda—long regarded as the barometer of trading in the chemical industries. Domestic consumers, together with the foreign buyers, have forced the price of caustic from $3.25 per 100 lb. in February to $3.70 for 100 lb. in March. This has given an added impetus to the rest of the list, as may be noted from the accompanying tabulation of chemical prices. Large producers of caustic have been sold up until June, and in all probability the market will reach 4c. per lb. in the very near future. Other features have been the remarkable rise in barium chloride, prussiates of soda and potash, and sulphate of ammonia. Barium chloride opened the year at $52 per ton, recorded a decline in January to the extent of $4 per ton, but has steadily advanced since February from $50 to the present high level of $82 per ton for available spot material. Domestic producers are strongly of the belief that the market will reach $100 per ton before the summer months. Prussiate of soda has followed practically the same lines as barium chloride. Opening 1922 at 16½c. per lb., it recorded a steady advance throughout January and February. The first 2 weeks of March brought this commodity to a new high level of 18½c. per lb., but during the latter part of March the market declined slightly to 17c. per lb. Yellow prussiate of potash recorded a noteworthy advance since the beginning of the year. Opening at 23c. per lb., it continued to rise throughout the quarter and on March 31 was quoted at 26c. per lb. Stocks have gradually diminished on spot and imported goods have been difficult to locate. Domestic manufacturers report a sold-up condition for the next few months. It remained for the red prussiate, however, to show the greatest advance in the entire list. Prices quoted during the month of January were around 30c. per lb., but it has since become practically nominal, with only a barrel noted here and there at 70c. per lb. Dealers in sulphate of ammonia profited by large tonnage orders from Europe and Japan. The rise in this commodity did not take place until the latter part of February. It has since continued to advance, with quotations for limited supplies around $3.50 per 100 lb. Producers claim that the present market prices are not sufficient to net any substantial profits. There is no doubt that a higher market will be seen for this commodity in the near future. On the other hand, the quarter recorded a number of declines. Among them were formaldehyde, oxalic acid, glaubers salt, bleaching powder and cyanide of soda. In most cases these declines followed readjustments of costs, although some were the result of competition between domestic producers and importers. Bleaching powder manufacturers have also been hard pressed by importers, who have brought in large shipments of this material at extremely low figures. The result was that domestic bleach has declined since January to almost pre-war prices. The lower quotations for oxalic acid were the result of price-cutting among the domestic producers. This has caused a drop of 3c. per lb. since Jan. 1. Formaldehyde, cyanide of soda, fusel oil, granular zinc chloride, lead acetate, acetic acid and methanol were reduced by domestic manufacturers either to attract new business or to meet quotations on foreign materials.

A QUARTERLY REVIEW OF THE PRICES OF 45 IMPORTANT CHEMICALS, JANUARY–APRIL, 1922

Article	Unit	Price on Jan. 1	Average for Month of Jan.	Feb.	March	Price on April 1
Acetic acid, glacial	Lb.	$0.10	$0.10	$0.09	$0.09	$0.09
Muriatic acid, 20 deg.	100 lb.	1.25	1.25	1.15	1.15	1.10
Nitric acid, 40 deg.	Lb.	.06½	.06¼	.06¼	.06¼	.06
Oxalic acid	Lb.	.14½	.14	.14	.11¾	.11½
Sulphuric acid, 66 deg.	Ton	17.00	16.50	16.00	16.00	17.00
Acetate of lead	Lb.	.10⅝	.10⅝	.10⅝	.09⅝	.09⅝
Ammonia alum, lump	Lb.	.03½	.03½	.03½	.03½	.03½
Aluminum sulphate, iron free	Lb.	.02½	.02½	.02½	.02½	.02½
Sal ammoniac, white gran	Lb.	.07	.06¾	.06¾	.07	.07¼
Ammonium sulphate	Lb.	.02⅝	.02⅝	.02½	.03¼	.03½
Amyl acetate	Gal.	2.40	2.00	2.00	2.00	2.00
Arsenic, white powd.	Lb.	.06	.07	.07¼	.07¼	.07
Barium chloride	Ton	52.00	50.00	56.00	75.00	80.00
Bleaching powder	100 lb.	2.50	2.25	2.10	1.75	1.60
Calcium acetate	100 lb.	1.75	1.75	1.75	1.75	1.75
Camphor	Lb.	.91	.90	.92	.90	.89
Copperas	Ton	15.00	15.00	15.00	15.00	15.00
Copper sulphate, crystals	100 lb.	5.65	5.65	5.60	5.55	5.55
Epsom salts, U.S.P.	100 lb.	2.65	2.65	2.65	2.60	2.50
Formaldehyde, 40%	Lb.	.10½	.10½	.10	.08½	.08½
Fusel oil, refined	Gal.	2.50	2.50	2.50	2.50	2.50
Glaubers salt	100 lb.	1.30	1.25	1.15	1.00	.95
Glycerine, c.p.	Lb.	.16	.16½	.16½	.16	.15½
Methanol, 95%	Gal.	.62	.61	.59	.58	.58
Nickel salt, single	Lb.	.14	.12	.11	.11	.11
Phosphorus, red	Lb.	.45	.45	.45	.45	.45
Potassium bichromate	Lb.	.10½	.10½	.10⅝	.10⅝	.10⅝
Potassium bromide, gran.	Lb.	.15	.14	.13½	.18	.17
Carbonate of potash, 80-85%	Lb.	.04½	.04½	.04½	.04½	.04½
Chlorate potash, crystals	Lb.	.06	.05½	.05½	.05¾	.06½
Caustic potash, 88-92%	100 lb.	5.50	6.00	5.75	6.00	6.00
Permanganate of potash, U.S.P.	Lb.	.16	.14	.13½	.15	.15
Prussiate of potash, yellow	Lb.	.23	.25	.25	.26	.26
Salt cake, bulk	Ton	18.00	17.00	17.00	17.00	17.00
Soda ash, light, 58%	100 lb.	1.80	1.75	1.70	1.80	1.80
Bichromate of soda	Lb.	.07⅝	.07½	.07¾	.07½	.07½
Fluoride of soda	Lb.	.11	.10½	.09½	.09½	.09½
Cyanide of soda	Lb.	.27	.26	.23½	.23½	.22½
Caustic soda, solid	100 lb.	3.75	3.70	3.35	3.65	3.65
Nitrate of soda	100 lb.	2.30	2.37½	2.37½	2.85	2.85
Prussiate of soda	Lb.	.16½	.17¼	.18	.17½	.17
Sulphide of soda, 60%	Lb.	.04½	.04¼	.04¼	.04⅜	.04⅜
Sulphur, crude	Ton	18.00	18.00	18.00	18.00	18.00
Zinc chloride, gran.	Lb.	.09	.09	.09	.06	.05½
Zinc oxide, XX	Lb.	.07½	.07½	.07½	.07½	.07½

A QUARTERLY REVIEW OF THE PRICES OF COAL-TAR PRODUCTS, JANUARY APRIL 1922

Article	Unit	Price on Jan. 1	Average for Month of Jan	Feb.	March	Price on April 1
Benzene, c.p.	Gal.	$0.29	$0.29	$0.29	$0.29	$0.29
Cresylic acid, 95-97%	Gal.	.65	.60	.45	.45	.45
Dip oil, 25%	Gal.	.31	.31	.27	.24½	.24
Solvent naphtha, water wh	Gal.	.25	.25	.25	.25	.25
Toluene, water white	Gal.	.30	.30	.30	.30	.30
Xylene, pure	Gal.	.40	.40	.40	.40	.40
H acid	Lb.	1.00	.97	.90	.85	.85
Phthalic anhydride	Lb.	.37	.37	.37	.35	.35
Salicylic acid, tech	Lb.	.20	.20	.18	.20	.23
Alpha napthylamine	Lb.	.30	.28	.28	.30	.30
Aniline oil	Lb.	.17	.17½	.17	.16½	.16½
Aniline salt	Lb.	.25	.25	.24	.24	.24
Anthracene, 80%	Lb.	.75	.75	.75	.75	.75
Benzaldehyde, U.S.P.	Lb.	1.35	1.35	1.30	1.25	1.25
Benzoate of soda, U.S.P.	Lb.	.52	.52	.55	.55	.55
Benzidine, base	Lb.	.90	.85	.85	.85	.85
Benzidine, sulphate	Lb.	.75	.75	.75	.75	.75
Beta naphthol, tech	Lb.	.30	.31	.29	.27½	.28
Dichlorbenzene	Lb.	.06	.06	.06	.06	.06
Dinitrobenzene	Lb.	.21	.21	.21	.22½	.23
Diethylaniline	Lb.	.90	.90	.95	1.12	1.15
Dimethylaniline	Lb.	.40	.40	.41	.38	.38
Dinitrophenol	Lb.	.38	.38	.35	.34	.33
Diphenylamine	Lb.	.60	.60	.60	.59	.59
Naphthalene, flake	Lb.	.07	.07	.06½	.06¾	.06¾
Naphthalene, ball	Lb.	.08½	.08	.07½	.07½	.08
Nitrobenzene	Lb.	.11	.10½	.10	.10	.10
Ortho-nitro-toluene	Lb.	.15	.15	.15	.13½	.12
Para-phenylenediamine	Lb.	1.65	1.60	1.55	1.50	1.50
Para-amidophenol, base	Lb.	1.30	1.25	1.25	1.25	1.25
Para-amidophenol, HCl	Lb.	1.55	1.45	1.35	1.30	1.30
Para-dichlorbenzene	Lb.	.15	.16½	.17	.15	.15
Paranitraniline	Lb.	.77	.77	.77	.75	.75
Phenol, U.S.P.	Lb.	.11½	.11¾	.12	.11½	.11½
Resorcinol, tech	Lb.	1.50	1.45	1.30	1.30	1.30
Toluidine, mixed	Lb.	.35	.32	32	.32	.32

The New York Market

NEW YORK, April 2, 1922.

The general condition of the chemical market during the past week was fairly steady, although several dealers reported a slight improvement in the volume of business. Both advances and declines were noted in some of the more important items. Consumers have found some difficulty in obtaining certain chemicals, while for other commodities the market seemed oversupplied. The markets for barium chloride, caustic soda, sulphide of soda and sulphate of ammonia continued their recent activity and remained exceptionally strong. Caustic soda has attracted considerable attention. Consumers in Germany, Italy and Japan are sending inquiries for this material, and leading producers are quite firm in the belief that a much higher market will be seen in the very near future. Bleaching powder, on the other hand, has been somewhat notably weak. Barium chloride is maintaining its recent rise, with spot offerings relatively light.

General Chemicals

Barium Chloride.—Sellers quote the market exceedingly firm at $82 per ton on spot and $70 to arrive. Spot material is very scarce and dealers are not free in their offerings. Cables from abroad have been an important factor in the recent sharp advance.

Bichromate of Soda.—The market has shown very little signs of real live trading. Quotations are heard at 7½@7¾c. per lb., according to quantity.

Caustic Potash.—The market for this product showed considerable strength early in the week, but later slackened because of lack of interest on the part of the consumers. Although most quotations were around 6c. per lb., odd lots were recorded down to $5.65 per 100 lb.

Caustic Soda.—No real change of any importance was heard in this item during the week and the general condition of the market was reported fair. Resale lots were quoted at $3.65 per 100 lb. f.a.s. N. Y., for March-April shipment. Some producers reported their entire output sold until June. Quotations at the works are unchanged at 2½c. per lb., basis 60 per cent, on contracts in carload lots.

Chlorate of Potash.—Imported goods were quoted somewhat higher by leading sellers and late in the week 6½c. per lb. was named as the general quotation. Some sales were recorded a fraction below this figure. Domestic chlorate remained unchanged at 8c. per lb., f.o.b. works.

Chlorate of Soda.—Imported material is held firm at 6½@6¾c. per lb. Surplus stocks have disappeared to a noticeable extent and sellers are not eager to quote below these figures. Domestic quotations remain unchanged at 7c. per lb., f.o.b. works.

Bleaching Powder.—Another reduction was recorded in this item at producing quarters and first hands are quoting down to $1.60 per 100 lb., f.o.b. works, in large drums. Imported bleach is quoted at $1.85 per lb., ex-dock N. Y. The demand has not been active since large consumers covered their contract requirements.

Hydrochloric Acid.—A fair movement of this material into consuming channels is reported. Offerings, however, have been quite free of late. The best prices heard for the 18 deg. goods is $1.10 per 100 lb.

Sulphuric Acid.—There has been a decided change in this material among leading sellers and prices have been advanced to $17@$17.50 per ton for the 66 deg. goods in tank cars. The 60 deg. test is quoted at $11@$12 per ton. Contract requirements can be obtained at about $1 per ton under the regular quotations.

Linseed Oil

Linseed Oil.—Following a decline in Argentine flaxseed, the market on linseed oil was easier. Crushers lowered prices to a basis of 78c. per gal. in carload lots. The inquiry for shipment oil over the next 3 months has improved, but buyers were unwilling to pay any high figures and little business was transacted. The tariff situation attracted a good deal of attention. It is believed that the new duty will be 3c. per lb., equal to 22c. per gal. Imported oil was offered at 71c. per gal. for English material, April shipment, duty paid.

The St. Louis Market

ST. LOUIS, March 30, 1922.

While some of the present activities in the heavy industrial chemical market could be traced directly to the fear of the impending coal strike, we do not believe this to be entirely responsible, but that depleted stocks, resumption of industrial activities, firmness of prices and restoration of confidence are primarily the influencing factors. Statistics indicate that all industries have made an appreciable increase in their operations, some to the extent of 25 to 50 per cent. Price changes have been very few, with declines in the minority, and in general prices are much firmer than they have been for many months. Further, the market is practically devoid of any depressing selling pressure. Heavy importations are still reported, but at greatly enhanced prices, due to the continued rise in exchange, thus showing no demoralizing effect upon the market.

Alkalis

Caustic soda maintains the same price of 2 weeks ago and is moving in good volume to small buyers. Very little carload business being done. *Soda ash* is firm at $2.50 per 100 lb. in barrels and $2.30@$2.40 per 100 lb. in bags—this for less than carload lots. Carloads can be had for ¾c. under these prices. *Sodium bicarbonate* is moving slowly with no price variations. *Sal soda* is steady and in good demand at the prevailing price of last week.

General and Special Chemicals

The *heavy mineral acid* market is no longer being disturbed by the weak holders, who some time ago were willing to unload at very little or nothing, consequently there has been better interest and firmer prices. Furthermore, the acid market has been greatly benefited by the increased operations of the steel mills and many other large industrial plants where acids are required. *Citric acid* has shown more life during the past few weeks with a firm market. *White arsenic* is now on the easier side and spot lots are quoted at 6@7½c. per lb., f.o.b. producer's works. *Benzene* is moving in good volume with the market in producers' hands. Ruling prices are 37@40c. per gal. *Bromides* are very firm with a good demand. *Carbon bisulphide* has been rather quiet, prices remaining the same. There has been no change in price of *carbon tetrachloride*, and trading did not deviate from the routine. While the *copperas* demand is still beyond production, conditions have eased to some extent owing to the fact that during the past 60 days the steel mills have been operating more extensively. Prices quoted by one manufacturer for granular in bulk are 90c. per 100 lb. by the carload, and for the *flour copperas* $1.80 per 100 lb. in carload lots and $1.90 per 100 lb. in less than carload lots, all prices f.o.b. producer's works. *Epsom salts* has firmed up considerably, prices ranging from $2.70@$2.87½ per 100 lb. for less than carload lots, supplier's warehouse. *Glycerine* has not changed in price, though the demand has slackened a bit and 16c. is being asked by all producers, but one or two transactions have been made recently at 15½c. *Sulphur* is moving in good volume and maintaining a good steady price. *Zinc sulphate technical* has been rather quiet since our last report, prices, however, prevailing the same.

Vegetable Oils and Naval Stores

Castor oil retains its standing in the price list at 13¼c. in drums, and a commission of 1c. is being made to customers purchasing quantities of 200 gal. or more. *Linseed oil* is quoted today at 84c. basis raw oil, a decline of 3c. since our last report. *Turpentine* is quoted at 89½c., a variation of ½c. since last report.

Paint Materials

Red oxides remain stable and in fairly good demand. *Whiting* ranges in price from $11@$15 per ton, depending on quality and brand. Domestic *lithopone* is moving in fair volume at 6½c. in preference to imported goods at 6c.

The *barytes* market is about $23 per ton for high-grade material.

The Iron and Steel Market

PITTSBURGH, March 31, 1922.

There is an upward swing in prices in the iron and steel industry, manifested by actual advances in market prices for some commodities and by a stiffening in others. The disposition among sellers to advance prices is general and the opportunity is embraced as rapidly as it presents itself. Among buyers a disposition to buy seems equally manifest.

Bars and shapes are now fairly quotable at 1.50c., against 1.40c. a week ago and 1.35c. about 3 weeks ago. A price of 1.50c. is not rigidly maintained, as some particularly desirable orders have been going at less, while small orders have brought 1.55c. and in occasional instances 1.60c.

Hoops and hot-rolled strips are up $2 a ton, being quite firm at 1.90c. Wire nails continue very firm at $2.40, while price concessions in tubular goods are less extensive.

Many of the sheet mills have in the past 10 days announced that on April 1 their prices would be advanced $3 a ton, to 3.15c. for black sheets, 4.15c. for galvanized and 4.50c. for automobile sheets. There seems to be no doubt that within a few days all makers will have advanced prices.

There is no uncertainty as to the amount of buying that has occurred, the rate of production, the prices, the volume of shipments or payment for the shipments made. The buying has been heavy, production of ingots has increased from a rate under 18,000,000 tons a year at the end of December to a rate of about 29,000,000 tons at the end of February and to a rate of probably 31,000,000 or 32,000,000 tons at the present time. Substantially all the steel made has been shipped. Prices have been firming up, with some advances, and more advances are probable.

UNCERTAINTY AS TO ACTUAL CONSUMPTION

These things are well established, yet there is uncertainty as to the future, whether demand and production will continue to increase or will soon begin to decrease. The uncertainty lies in the relation between steel received by buyers and steel passing into actual consumption. Experienced observers are a unit in declaring that ultimate consumption is well below the rate of producing and shipping. Perhaps the condition resembles that which has obtained at certain times in the past, when demand exceeded consumption through buyers replenishing stocks and afterward consumption rose so as to balance production, the increase in stocks having been necessary to provide facilities for jobbers and manufacturing consumers to conduct their business in an orderly and efficient manner.

A particular element of uncertainty is injected into the situation by the fact that at midnight tonight begins the coal-mining suspension. The suspension promises to be a very serious affair, yet the current estimates are that consumers of coal have well fortified themselves. If one assumes that buyers of steel have been influenced by the prospective mining suspension to lay in stocks of steel, then there is a possibility of demand decreasing once the suspension has begun.

Producers of steel are particularly keen to make the most of their limited opportunites in advancing prices. Before the war it was held that steel prices were unlikely to advance except with the steel industry operating at 80 or 85 per cent of its capacity. At 32,000,000 tons of ingots a year the nominal operating rate would be a trifle over 60 per cent, but counting out some capacity that cannot be reckoned when prices are so extremely low, the practical operating rate is probably nearer 70 per cent.

COKE AND PIG IRON

Connellsville coke has weakened somewhat, it being possible to pick up odd lots of spot furnace coke at $3.25, though for regular shipment over a week or two last week's price of $3.50 would probably have to be paid. Connellsville coal has gone to remarkably low levels, well below cost of production with the Frick scale. A number of operators have been paying less than the scale, and it is far from impossible that strikes will occur at such mines.

Pig iron shows a stronger tone, but with prices still quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0 40 – $0 42
Acetone	lb.	$0 11½ – $0 12	12½ – 12
Acid, acetic, 28 per cent	100 lbs.	2 50 – 2 60	2 65 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb	11 – 11½	11½ – 12
Boric, powder	lb.	11¼ – 11½	11½ – 12¼
Citric	lb.		46 – 46½
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	11 – 11½	11 – 12
Lactic, 44 per cent tech.	lb.	09½ – 10	10¼ – 12
Lactic, 22 per cent tech	lb.	04 – 04½	04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg.	lb.	06 – 06¼	06½ – 07
Nitric, 42 deg.	lb.	06½ – 06¾	07 – 07¼
Oxalic, crystals	lb.	11½ – 12	12½ – 13
Phosphoric, 50 per cent solution	lb.	08 – 08½	08¾ – 09
Picric	lb.	23 – 25	26 – 32
Pyrogallic, resublimed	lb.	—	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	11 00 – 12 00	—
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	—
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	—
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20 00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	—	60 – 75
Tannic (tech.)	lb.	40 – 45	46 – 50
Tartaric, imported crystals	lb.	—	26½ – 28
Tartaric acid, imported, powdered	lb.	—	27½ – 30
Tartaric acid, domestic	lb.	—	— 30
Tungstic, per lb. of WO	lb.	—	1 00 – 1 10
Alcohol, ethyl	gal.	—	4 75 – 5 50
Alcohol, methyl (see methanol)			
Alcohol, denatured, 188 proof No. 1	gal.	—	32 – 34
Alcohol, denatured, 188 proof No. 5	gal.	—	32 – 34
Alum, ammonia, lump	lb.	03½ – 03¾	04 – 04½
Alum, potash, lump	lb.	03½ – 04	04½ – 05
Alum, chrome lump	lb.	07½ – 08	08½ – 08½
Aluminum sulphate, commercial	100 lb.	1 65 – 1 85	1 90 – 2 40
Aluminum sulphate, iron free	lb.	02½ – 02¾	03 – 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ – 07¾	08 – 08¾
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30 – 30¼	31 – 33
Ammonium carbonate, powder	lb.	07 – 07½	08 – 09
Ammonium nitrate	lb.	06½ – 07	07¼ – 07½
Amylacetate tech	gal.	—	2 00 – 2 40
Arsenic, white, powdered	lb.	07 – 07½	07½ – 08
Arsenic, red, powdered	lb.	12 – 12½	12½ – 13
Barium chloride	ton	80 00 – 85 00	86 00 – 90 00
Barium dioxide (peroxide)	lb.	20 – 21	21½ – 22
Barium nitrate	lb.	06½ – 07	07½ – 08½
Barium sulphate (precip.) (blanc fixe)	lb.	03½ – 04	04¼ – 04½
Blanc fixe, dry	lb.	04 – 04½	—
Blanc fixe, pulp	ton	45 00 – 55 00	—
Bleaching powder	100 lb.	1 60 – 1 75	1 80 – 2 75
Blue vitriol (see copper sulphate)			
Borax	lb.	05½ – 05¾	06 – 06¼
Brimstone (see sulphur, roll)			
Bromine	lb.	27 – 28	28½ – 35
Calcium acetate	100 lbs.	1 75 – 2 00	—
Calcium carbide	lb.	04½ – 04¾	05 – 05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	01½ – 02	02¼ – 02½
Calcium peroxide	lb.	—	1 40 – 1 50
Calcium phosphate, tribasic	lb.	—	15 – 16
Camphor	lb.	—	89 – 91
Carbon bisulphide	lb.	06 – 06½	06¾ – 07½
Carbon tetrachloride, drums	lb.	09½ – 10	10½ – 12
Carbonyl chloride, (phosgene)	lb.	—	60 – 75
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chalk, precip.—domestic, light	lb.	04½ – 04¾	—
Chalk, precip.—domestic, heavy	lb.	03½ – 03¾	—
Chalk, precip.—imported, light	lb.	04½ – 05	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	06 – 06½	06¾ – 07
Chloroform	lb.	—	37 – 40
Cobalt oxide	lb.	—	2 00 – 2 10
Copperas	ton	15 00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	19 – 20	20½ – 21
Copper cyanide	lb.	—	58 – 60
Copper sulphate, crystals	100 lb.	5 55 – 5 65	5 70 – 6 25
Cream of tartar	lb.	—	23½ – 25
Epsom salt (see magnesium sulphate)			
Ethyl acetate com. 85%	gal.	—	60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	—	93 – 1 00
Formaldehyde, 40 per cent	lb.	08½ – 09	09¼ – 10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	—
Fullers earth—imported powdered	net ton	30 00 – 32 00	—
Fusel oil, ref.	gal.	—	2 50 – 3 00
Fusel oil, crude	gal.	—	1 40 – 1 75
Glauber's salt (see sodium sulphate)			
Glycerine, c. p. drums extra	lb.	—	15½ – 16
Iodine, resublimed	lb.	—	4 05 – 4 15
Iron oxide, red	lb.	—	12 – 18
Lead acetate	lb.	—	09½ – 12
Lead arsenate, powd	lb.	14 – 14½	14¾ – 15½
Lead nitrate	lb.	—	15 – 20
Litharge	lb.	07½ – 07¾	08 – 08½
Magnesium carbonate, technical	lb.	06 – 06½	06½ – 08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	—	1 60 – 1 80
Methanol, 95%	gal.	—	57 – 58
Methanol, 97%	gal.	—	59 – 60
Nickel salt, double	lb.	—	11 – 11½
Nickel salt, single	lb.	—	11 – 11
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	45 – 46	47 – 50
Phosphorus, yellow	lb.	—	30 – 35

		Carlots	Less Carlots
Potassium bichromate	lb.	10½ – .10¾	.10½ – .10¾
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04½ – .04¾	.05 – .06
Potassium chlorate, crystals	lb.	.06½ – .06¾	.07 – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6 00 – 6.25	6.30 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07⅞ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	26 – .26½	.26¾ – .27
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07¼ – .07½	.07¾ – .08
Salammoniac, gray, granular	lb.	.07¼ – .07½	.07¾ – .08
Salsoda	100 lb.	1.50 – 1.60	1.65 – 1.90
Salt cake (bulk)	ton	17.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04¼ – .04½	.04¾ – 05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07⅝	.08 – .08¼
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bi-sulphite powdered, U.S.P.	lb.	.04½ – .04½	.04½ – .05½
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12 00 –13 00	..... – .....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.65 – 3.70	3.75 – 4.25
Sodium hyposulphite	lb.	.03¼ – .03½	.03¾ – .04
Sodium nitrite	lb.	.08½ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.17 – .17¼	.17½ – .17¾
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.50 – 2.60	2.65 – 3.00
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.10	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¾ – .04½	.04¾ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.10 – .11	.11½ – .15
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18 00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18 00 –25 00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06¼ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.15 — 1.20
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — 18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — 75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38
Phenol, U. S. P., drums	lb.	.11½ — 15
Pyridine	gal.	1.75 — 2.75
Resorcinol, technical	lb.	1.30 — 1.35
Resorcinol, pure	lb.	1.75 — 1.80
Salicylic acid, tech., in bbls.	lb.	.23 — .24
Salicylic acid, U. S. P.	lb.	.25 — .26
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 — .12
Sulphanilic acid, crude	lb.	.25 — .27
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.32 — .38
Toluene, in tank cars	gal.	.25 — 28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — .....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.26 — .28
Beeswax, refined, light	lb.	.30 — .32
Beeswax, white pure	lb.	.35 — .40
Candellila, wax	lb.	.25 — .26
Carnauba, No. 1	lb.	.45 — .46
Carnauba No. 2, North Country	lb.	.25 — .25½
Carnauba, No. 3, North Country	lb.	.16 — .16½
Japan	lb.	.17½ — .18
Montan, crude	lb.	.04½ — .04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02⅜ — .....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 — .05¼
Stearic acid, single pressed	lb.	.08¾ — .09
Stearic acid, double pressed	lb.	.09¼ — .09½
Stearic acid, triple pressed	lb.	.10¼ — .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.15 —	5.20
Rosin E-I	280 lb.	5.25 —	5.30
Rosin K-N	280 lb.	5.90 —	6.65
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.86½ —	.87
Wood turpentine, steam dist	gal.	.84 —	.....
Wood turpentine, dest. dist.	gal.	.68 —	.70
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.38 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.50 —	3.75
Blood, dried, f.o.b., N. Y.	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.85 —	2.87½
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	.....

Crude Rubber

Para—Upriver fine	lb.	$0.17½ —	.17¾
Upriver coarse	lb.	.12 —	.13
Upriver caucho ball	lb.	.12½ —	.13
Plantation—First latex crepe	lb.	.14¾ —	.15
Ribbed smoked sheets	lb.	.14½ —	.15
Brown crepe, thin, clean	lb.	.13 —	...
Amber crepe No. 1	lb.	.15 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.14 —	.14½
Coconut oil, Ceylon grade, in bbls	lb.	.08½ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09½ —	.09¾
Corn oil, crude, in bbls.	lb.	.11¼ —	.11½

Cottonseed oil, crude (f. o. b. mill)	lb.	09½ —	10
Cottonseed oil, summer yellow	lb.	11½ —	12
Cottonseed oil, winter yellow	lb.	13½ —	13¾
Linseed oil, raw, car lots (domestic)	gal.	78 —	79
Linseed oil, raw, tank cars (domestic)	gal.	74 —	75
Linseed oil, in 5-bbl lots (domestic)	gal.	81 —	82
Olive oil, denatured	gal.	1 12 —	1 15
Palm, Lagos	lb.	.08 —	.08¼
Palm, Niger	lb.	.06¾ —	06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls	lb.	.12 —	.13
Rapeseed oil, refined in bbls	gal.	.85 —	85
Rapeseed oil, blown, in bbls	gal.	.87 —	88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11 —	
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¼ —	

FISH

Light pressed menhaden	gal.	$0 54 —	
Yellow bleached menhaden	gal.	57 —	
White bleached menhaden	gal.	.56 —	
Brown menhaden	gal.	.61 —	

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$800 00	$1,000.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70 00	—120 00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	12 50	— 17 50
Barytes, ground, white, f.o.b. mills	net ton	17.00	— 23 00
Barytes, ground, off color f.o.b. mills	net ton	13.00	— 21 00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	— 24 00
Barytes, crude f.o.b. mines	net ton	6.00	— 7.00
Casein	lb.	.10½	— .12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	— 8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	— 10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	— 20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13 00	— 20.00
China clay (kaolin), imported, lump	net ton	14.00	— 20.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, No. 1 pottery grade	long ton	6.50	— 6.75
Feldspar, No. 2 pottery grade	long ton	5.75	— 5.90
Feldspar, No. 1 soap grade	long ton	7 25	— 7 50
Feldspar, No. 1 Canadian, for mill	long ton	22 00	— 22 50
Graphite, Ceylon lump, first quality	lb.	.04½	— 06½
Graphite, Ceylon chip	b.	.03½	— .05
Graphite, high grade amorphous crude	lb.	.00½	— .02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—
Kieselguhr, f.o.b. N. Y.	per ton	55.00	— 60.00
Magnesite, calcined (crude)	per ton	12.00	— 15.00
Pumice stone, imported	lb.	.03	— .40
Pumice stone, domestic, lump	lb.	.05	— .05½
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	86	— .87
Shellac, orange superfine	lb.	.88	— .89
Shellac, A. C. garnet	lb.	.68	— .69
Shellac, T. N.	lb.	.83	— .84
Silica, glass sand, f.o.b. Indiana	per ton	1.25	— 1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	— 4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	14.00	— 14.50
Silica, building sand, f.o b. Pa	per ton	2.25	— 3.00
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	8.25	— 13.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	— 20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in.	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o b. works)	net ton	53–55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	27–30

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6–8% carbon, carlots	lb.	.11 —	
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.11½ —	
Ferromanganese, 76-80% Mn, domestic	gross ton	62.50 —	
Ferromanganese, 78-82% Mn, English and German c. i.f. Atlantic seaport	gross ton	59 00 —	62.50
Spiegeleisen, 18-22% Mn	gross ton	30 00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.37 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.55 —	3.75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6 00 —	$12 00
Chrome ore, Calif concentrates, 50% min Cr_2O_3	t	19 00 —	20 00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	to	19 00 —	20 00
Coke, foundry, f.o.b. ovens	net ton	4 25 —	4 75
Coke, furnace, f.o.b. ovens	net ton	3 25 —	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22 00
Ilmenite, 52% TiO_2, per lb. ore	lb	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.25 —	.25½
Manganese ore, chemical (MnO_2)	ne ton	55 00 —	60 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.40 —	.42
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27 00 —	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 —	12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2 50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2 25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12 75
Aluminum, 98 to 99 per cent	19 00
Antimony, wholesale lots, Chinese and Japanese	4 25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	35 00
Monel metal, ingots	38.00
Monel metal, sheet bars	40 00
Tin, 5-ton lots, Straits	29 125
Lead, New York, spot	4 75
Lead, E. St. Louis, spot	4.425–4.50
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.625–4.65

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90 00
Iridium	oz.	160.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.25
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	20 75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.63	$2.38
Soft steel bars	2.53	2.28
Soft steel bar shapes	2.53	2.28
Soft steel bands	3.13	2.88
Plates, ¼ to 1 in. thick	2.63	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

Rubber.—The Electric Hose & Rubber Co., Wilmington, Del., has added a night shift at its plant, giving employment to about 100 additional men.

The Rubber Production Co., Morgantown, W. Va., has reopened the local plant of the Armorcord Rubber Co., recently acquired under lease. The plant has been closed for about a year past.

The Hood Rubber Co., Watertown, Mass., has adopted a capacity operating schedule in the tire department at its local plant.

The Allen Tire & Rubber Co., Allentown, Pa., has adopted a 20-hour day schedule at its plant at Rittersville, Pa., adding a 10-hour shift, with additional employees, to the former production basis.

Glass.—The Macbeth-Evans Glass Co., Elwood, Ind., is arranging for the early resumption of operations at its local plant, and preparatory to production is rebuilding the No. 1 furnace, adding a new battery of lehrs and making other improvements to cost about $25,000.

The Henryetta Glass Mfg. Co., Henryetta, Okla., has commenced manufacture at 24 shops of its local plant, primarily for the production of lamp chimneys. Other departments will resume at an early date for the manufacture of tableware, lantern globes, etc.

The Interstate Window Glass Co., Kane, Pa., is increasing production at its Wheeling, W. Va., and Lancaster, O., plants.

Ceramic.—Practically all of the sanitary ware potteries at Trenton, N. J., are operating on a full-capacity basis.

The Acme Brick Co., Denton, Tex., has resumed operations at its plant, following a shut-down for several months past. Initial production will be on a basis of about 40,000 bricks per day, with employment of about 100 men.

Leather.—The American Hide & Leather Co., New York, N. Y., has resumed operations at full capacity at a number of its tanneries.

The Deford Tanning Co., Luray, Va., has resumed operations at its local plant, following a shut-down of a number of months.

Iron and Steel.—With the blowing in of the No. 1 blast furnace at the Carrie furnaces of the Homestead Steel Works, Homestead, Pa., March 22, seven of the eight furnaces at the plant are now in operation.

The Carnegie Steel Co. has resumed production at its Farrell (Pa.) works, which have been idle for about a year past. Two blast furnaces will be blown in early in April, and 11 open-hearth furnaces placed in service. Employment will be given to about 1,500 men. The company has blown in another furnace at its Isabella plant, Etna, Pa., and another stack will soon be placed in service at this works.

The American Sheet & Tin Plate Co., Cambridge, O., has started operations at the four remaining mills at its local plant, placing the works on a full operating basis for the first time since last November.

The Wheeling Steel & Iron Co., a subsidiary of the Wheeling Steel Corp., has adopted a 100 per cent operating schedule at its Benwood, O., plant.

The Republic Steel Co., Youngstown, O., is running full in the open-hearth department at its plant, including the entire battery of 14 furnaces.

The Youngstown Sheet & Tube Co., Youngstown, O., has blown in a fifth blast furnace at its local works, making but one idle stack at the plant. This will be placed in service at an early date.

The United States Steel Corp. has placed its Aetna-Standard plant, Aetnaville, O., on a 100 per cent operating basis.

Coke.—The H. C. Frick Coke Co. has fired 200 additional ovens at its Leith plant, near Greensburg, Pa., following a shut-down of more than a year.

Metals.—The Bartlesville Zinc Co., Blackwell, Okla., has resumed production at its smelting plant.

The American Smelting & Refining Co., New York, N.Y., will soon resume operations on a large scale at its smelting plant at El Paso, Tex., for the smelting of lead ores from the mines of the Erupcion Mining Co. and the Ahumada Lead Co., both of Chihuahua, Mexico, with which contracts have been made.

The Michigan Copper & Brass Co., Detroit, Mich., has adopted a 100 per cent operating schedule at its local plant, giving employment to about 800 men. A night shift is being operated until 9 o'clock every evening during the work-week.

Miscellaneous.—The Wilmington Fiber Specialty Co., New Castle, Del., is operating on a full production basis, with incoming orders in excess of capacity.

The Corn Products Co. has commenced operations at its plant at North Kansas City, Mo., recently completed at a cost of about $7,000,000. Employment will be given to 600 persons.

Construction and Operation

Arizona

GLOBE—The Magma Copper Co. has preliminary plans under way for the erection of a new smelting plant and copper mill. A bond issue of $4,000,000 is being arranged, a portion of which will be used for the project.

California

OAKLAND—The California Pottery Co. is perfecting plans for the removal of its local plant to Merced, Cal., where another plant is now being operated by the company. The latter works will be extended to accommodate the equipment from the Oakland plant, and 16 new kilns will be constructed. A complete general line of manufacture will be carried on, including firebrick, face brick, tile, sewer pipe, etc. Frank A. Costello is president.

INGLEWOOD—The Smoot-Holman Co., Los Angeles, comprising a recent reorganization of the American Enameling & Stamping Works of the same city, has acquired a tract of land at Inglewood, totaling about 5 acres, and has preliminary plans under way for the erection of a new plant, to consist of a number of 1-story buildings.

SELMA—The Fresno Tire & Rubber Co., Fresno, Cal., is arranging plans for the immediate erection of its proposed new local plant for the manufacture of tires and other rubber products. It will be 3-story, 60 x 250 ft. John S. Bates, Rowell Bldg., Fresno, is engineer.

COLTON—The Bach Reduction Co., Los Angeles, has acquired property at Colton, and plans for the erection of a new 1-story plant for the manufacture of fertilizer products.

Connecticut

HARTFORD—Fire, March 16, destroyed a portion of the auxiliary plant of the Johns-Pratt Co., manufacturer of compounds, etc., Homestead Ave. and Burton St., with loss estimated at about $15,000. The fire was caused by overheating or short-circuiting in a large enameling oven.

Florida

TAMPA—The Pineapple Products Co., Curry Bldg., recently organized with a capital of $50,000, is planning for the construction of a plant for the manufacture of fertilizer products, in connection with a new local factory for the production of syrups, phosphate, vinegar and kindred specialties. Henry O. Page is president; and William B. Hill, general manager.

Illinois

MT. VERNON—The Mount Vernon Car Mfg. Co. has awarded a contract to the Hughes-Foulkrod Co., Pittsburgh, Pa., for the construction of a 1-story foundry for the production of iron and other metal castings, 132 x 550 ft., estimated to cost about $250,000, including equipment. W. C. Archer is president.

WAUKEGAN—The Board of Works is having plans completed for the construction of a new filtration plant at the city waterworks, estimated to cost about $600,000, including pumping station. Hoad, Decker & Drury, 303 South State St., Ann Arbor, Mich., are consulting engineers.

Kentucky

PAINTSVILLE—The Paintsville Oil & Refining Co. will commence immediately the erection of a new topping plant, with extensive tankage department. A site has been selected near the city. Ralph Stafford heads the company.

Maryland

BALTIMORE—The Liberty Yeast Corp., 4400 O'Donnell St., will build a 1-story addition, 30 x 65 ft., to its ferment department. Equipment will be installed for the production of industrial alcohol. W. A. Boykin, Jr., is manager.

BALTIMORE—The Public Improvement Commission, City Hall, has plans under consideration for the establishment of a plant for the production of alum for the filter beds at the city waterworks, estimated to cost about $12,000. Robert Garrett is chairman.

Massachusetts

MITTENEAGUE—The Strathmore Paper Co. has awarded a contract to the Ernest F. Carlson Co., Springfield, Mass., for the erection of a 4-story addition to its plant, 25 x 200 ft. Work will be commenced at an early date.

SALEM—The Park Leather Co., Mason and Grove Sts., has commenced the enlargement of its plant. Equipment will be installed for increased capacity.

ASSONET—The New England Oil Refining Co., Purchase St., Fall River, Mass., has acquired property at Assonet, to be used as a site for the erection of a new distributing plant.

Michigan

HOLLAND—The De Pree Chemical Co. has awarded a contract to the Frank Dyke Co., Holland, for the erection of a 3-story addition to its plant, estimated to cost about $500,000, including equipment.

CADILLAC—The Cadillac Malleable Iron Co. has broken ground for the erection of a new 1-story foundry, 120 x 200 ft., and annealing building, 90 x 224 ft., for the production of iron and other metal castings. Additional units will be constructed at a later date. The Indiana Bridge Co., Muncie, Ind., has the building contract.

KALAMAZOO—The City Commission, C. L. Miller, city manager, has preliminary plans under way for the erection of a new municipal gas plant, comprising six buildings, estimated to cost in excess of $1,250,000. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., are engineers.

MANISTEE—The Ruggles & Rademaker Co. is making rapid progress in the erection of its new local salt plant, and expects to have a portion of the works ready for service at an early date. The plant has been designed for a capacity of about 8,000 bbl. a day, or approximately 60 carloads, and will give employment to close to 300 men. It is estimated to cost approximately $2,000,000, complete. The company is an outgrowth of the Buckley & Douglas Lumber Co. salt plant, which was destroyed by fire about a year ago.

Missouri

JOPLIN—The Wilhoit Oil Co., Springfield, Mo., E. M. Wilhoit, president, is planning for extensions and improvements in its refinery at Joplin, estimated to cost about $100,000. The present plant will be remodeled.

New Jersey

ELIZABETH—Fire, March 22, destroyed a portion of the plant of the Atlantic Chemical Works, Bayway, near Elizabeth, with loss estimated at about $200,000, including equipment.

TRENTON—The Essential Oil Co., a subsidiary of the American Linseed Co., 297 4th Ave., New York, N. Y., has work under way on the remodeling of the local plant of the American Brass & Lamp Co., recently acquired, and plans to commence production early in June, giving employment to about 50 persons. The plant will be devoted to the manufacture of terpineol (synthetic lilac oil), camphor, terpin-hydrate and other volatile oils. Gustave Mahlck heads the company.

KEASBEY—Fire, March 21, destroyed a portion of the plant of the Carborundum Co., manufacturer of refractory products, saggers, etc., with loss estimated at about $50,000. The plant comprises the former works of the Didier-March Co. Headquarters of the company are at Niagara Falls, New York.

New York

BROOKLYN—Paul Uhlich & Co., 11 Cliff St., New York, N. Y., manufacturers of dry colors, etc., have filed plans for the rebuilding of the portion of their plant on Herkimer Place, Brooklyn, estimated to cost about $20,000.

ONEIDA—The Maxwell Steel Vault Co., 4 Warner St., has completed plans for the erection of the first unit of a new local plant, 1-story, 60 x 90 ft. Work will be commenced in April.

Oklahoma

COLLINSVILLE—The Collinsville Brick Co., has work under way for extensions and improvements in its plant. The capacity will be increased.

MUSKOGEE—The Muskogee Refining Co., South Cherokee St., is planning for extensions and improvements in its local refinery to cost about $200,000, including equipment.

Pennsylvania

PHILADELPHIA — The Continental Leather Co., 311 North 3rd St., recently organized under Delaware laws with a capital of $2,500,000, has acquired the former tanning plants of Janney & Burroughs, Inc., at a receiver's sale. The tanneries are located at Philadelphia, Augusta Springs and Elkton, Va., and will be placed in operation by the new owner at an early date. Perry E. Wurst, vice-president of the Alpena Leather Corp., Alpena, Mich., is president and general manager of the Continental company; Joseph Wayne, Jr., is vice-president and treasurer.

PHILADELPHIA — Montgomery Bros., Inc., 45 South 2nd St., manufacturer of rubber products, has filed plans for the erection of an addition to its plant at Packer and Penrose Sts.

PHILADELPHIA—The Wittman Moriarty Co., 4th and Vine Sts., manufacturer of leather, has taken title to property at B and Westmoreland Sts., 240 x 314 ft., for a consideration of about $30,000, and will commence the immediate erection of a new tanning plant on the site, 1- and 2-story, 77 x 105 ft., estimated to cost about $75,000.

WAYNESBORO—The Frick Co. will build a new foundry at its local agricultural implement plant, to be equipped for an output of about 60 tons of castings per day.

Tennessee

MEMPHIS—Fire, March 18, destroyed a portion of the oil plant of the Royal Refining Co., Hollywood, a suburb of Memphis. An official statement regarding the amount of estimated loss has not been made.

Texas

DALLAS—The Daniels' Chemical Proof Ink & Paper Co., 2212 Live Oak St., is planning for the erection of a new plant for the manufacture of chemical-proof ink products.

HOUSTON—The Humble Oil & Refining Co. is planning for the rebuilding of its tankage plant, destroyed by fire, March 21, with loss estimated at about $500,000

DALLAS—The Trinity Paper Mills Co., 3010 Williams St., has acquired a local site and plans to erect a new plant for the manufacture of waxed papers. J. Y. Webb is president.

Virginia

NORFOLK—The Robertson Chemical Corp., Board of Trade Bldg., is perfecting plans for the rebuilding of its plant in the Money Point section, recently destroyed by fire. It will be 1-story, 75 x 300 ft., and is estimated to cost about $60,000. W. H. Robertson is president.

CHATHAM—The City Council is planning for the installation of a filtration plant at the waterworks. A bond issue of $20,000 is being arranged.

West Virginia

HUNTINGTON—The Liberty Airless Tire Co., Parkersburg, W. Va., C. Lewis Wilson, president, is considering the erection of a new plant for the manufacture of automobile tires at Huntington. Negotiations are said to be under way for a local site.

GRAFTON—The City Council is planning for the installation of a filtration plant at the waterworks. Bonds for $100,000 will be voted.

Capital Increases, Etc.

THE OCEAN LEATHER CO., 40 Beaver St., New York, N. Y., has filed notice of increase in capital from $41,000,000 to $41,750,000.

THE COLAC CHEMICAL CO., Glens Falls, N. Y., has filed notice of increase in capital from $25,000 to $300,000.

THE CONTINUOUS CASTING CORP., Garwood, N. J., has filed an involuntary petition in bankruptcy.

THE MICHIGAN PORCELAIN INSULATOR CO., Hastings, Mich., has filed notice of dissolution under state laws.

WERBELOVSKY BROS., INC., 1160 Flushing Ave., Brooklyn, N. Y., manufacturer of glass products, has filed notice of increase in capital from $200,000 to $300,000.

THE STAR VARNISH WORKS, INC., Hamtramck, Mich., has filed notice of dissolution under state laws.

THE MINER EDGAR CO., Blanchard St., Newark, N. J., manufacturer of chemicals, refined clays, etc., has arranged for a bond issue of $1,000,000.

H. Snowden Marshall and Arthur J. Stevens have been appointed receivers in equity for the ISLAND OIL & TRANSPORT CORP., 55 Liberty St., New York, N. Y.

The General Oil Co., Houston, Tex., has been reorganized as the GENERAL PETROLEUM CO., with a capital of 11,000,000 shares of preferred stock and 1,000,000 shares of common stock, no par value.

THE E. I. DU PONT DE NEMOURS EXPORT CO., 120 Broadway, New York, N. Y., a subsidiary of E. I. du Pont de Nemours & Co., Wilmington, Del., has been dissolved, effective March 31.

New Companies

THE PULP PRODUCTS CO., 405 East Main St., Kalamazoo, Mich., has been incorporated with a capital of $100,000, to manufacture paper pulp and byproducts. The incorporators are Charles E. Taylor, Rossville, Ill.; George C. McCann, Danville, Ill.; and John E. Carey, Otsego, Mich.

THE CORAL CHEMICAL CO., Buffalo, N. Y., has been incorporated with a capital of $60,000, to manufacture chemicals and chemical byproducts. The incorporators are G. D. Fogarty, R. H. Robinson and J. T. Penfield. The company is represented by Stephen V. O'Gorman, Mutual Life Bldg., Buffalo.

THE MEDUSA CEMENT PAINT CO., Augusta, Me., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture special cement paints and affiliated products. E. M. Leavitt is president and treasurer; Frank E. Southard, Augusta, represents the company.

THE BLUE GRASS REFINING & PRODUCING CO., Lexington, Ky, has been incorporated with a capital of $50,000, to manufacture refined petroleum products. The incorporators are A. V. Smith, Jr., Walter R. Powell and J. F. Whorton, all of Lexington.

THE SWEDISH CHARCOAL STEEL PRODUCERS, INC., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture steel products. The incorporators are F. Sandelin, W. L. Batt and J. A. Vaughan, New York. The company is represented by F. J. Knorr, Albany, N. Y.

THE CAVE CITY OIL CO., 133 West Washington St., Chicago, Ill., has been incorporated with a capital of $30,000, to manufacture oil products. The incorporators are Edward M. Craig, Irl G. Hipsley and William H. Craig.

THE KONIKOW CHEMICAL LABORATORIES, Boston, Mass., have filed notice of organization to manufacture chemical products. The company is headed by William M. Kent, 52 Chamber St., Boston.

THE ARTCRAFT BRONZE CO., Detroit, Mich., has been incorporated with a capital of $20,000, to manufacture bronze and brass products. The incorporators are George B. Wood, George D. Ostergren and John M. Motschall, 1497 East Grand Boulevard, Detroit.

THE E. L. SMITH OIL CO., Wilmington, Del., has been incorporated under state laws with a capital of $5,000,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

LYNN & CO., INC., Syracuse, N. Y., has been incorporated with a capital of $10,000, to manufacture soaps and kindred products. The incorporators are J. Lindner, H. J. Wilson and A. V. Moliski. The company is represented by Gerber & Winkelstein, Syracuse.

THE HAMILTON OIL CO., Orange, Tex., has been incorporated with a capital of $5,000,000, to manufacture petroleum products. The company will succeed to the business of the Oil Issue Co. W. R. Hamilton is president; H. P. Ingles, first vice-president; and James N. Kincaid, secretary.

THE STATE FERTILIZER CO., Claremont Hotel, Union Stock Yards, Baltimore, Md., has been incorporated with a capital of $50,000, to manufacture fertilizer products. The incorporators are John W. Dasher, Robert S. Collier and J. Bradley Zepp.

THE AMERICAN INDUSTRIAL ALCOHOL CO., Jersey City, N. J., has been incorporated with a capital of $100,000, to manufacture industrial alcohol products and kindred specialties. The incorporators are William K. Faber and Francis Covner, 15 Exchange Pl., Jersey City.

THE FIDELITY RUBBER CO., New York, N. Y., has been incorporated under Delaware laws, with a capital of $250,000, to manufacture rubber products. The incorporators are E. E. and C. R. Allison, New York; and A. K. Dohrmann, Jersey City, N. J. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE HARBOR TANNING CO., Lynn, Mass., has been incorporated with a capital of $10,000, to manufacture leather products. Manuel Ross is president; and Arthur C. Stewart, Medford, Mass., is treasurer.

THE FLAXO CO., Saginaw, Mich., has been incorporated with a capital of $25,000, to manufacture chemicals, chemical compounds and affiliated products. The incorporators are Louis Kuehl, Saginaw; and Philip Catsman, Flint, Mich.

THE PENN-JERSEY FOUNDRY CORP., Camden, N. J., has been incorporated with a capital of $100,000, to manufacture iron, steel and other metal castings. The company is represented by the Corporation Trust Co., 328 Market St., Camden, N. J.

THE KINGSTON OIL CO., Kingston, N. Y., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are P. A. Black, J. P. Mack and M. H. Herzog, Kingston. The company is represented by Fowler & Loughran, 293 Wall St., Kingston.

THE UTILITY RUBBER CO., New York, N. Y., has been incorporated under Delaware laws, with capital of $1,000,000, to manufacture automobile tires and other rubber goods. The incorporators are Guy E. Norwood, New York; F. Haskell Smith, Bloomfield, N. J.; and James H. Coghill, Morristown, N. J. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE NEWARK COLOR & DYE WORKS, INC., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals, colors, etc. The incorporators are Irving Rauchberg, Mordecai Segal and Samuel M. Hollander, 790 Broad St., Newark, N. J.

THE GAST-O-PINE CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture chemicals and affiliated products. The incorporators are M. Gast, W. S. Rising and W. C. Cartwright, New York. The company is represented by H. S. Goodspeed, 522 Fifth Ave., New York.

THE GRAND RAPIDS CLAY PRODUCTS CO., Grand Rapids, Mich., has been incorporated with a capital of $25,000, to manufacture brick, hollow tile and other burned clay products. The incorporators are Isaac M. Hamilton, W. E. Brimstin and O. E. Merley, 168 North Michigan Ave., Chicago, Ill.

THE UNITED STATES WAXED & COATED PAPER CO., East Orange, N. J., has been incorporated with a capital of $50,000, to manufacture waxed and other special papers. The incorporators are Colin G. Fink, Walter E. Koerner and Oscar J. V. Aschenbach, 227 Elmwood Ave., East Orange.

THE WEST POINT SHALE BRICK CO., Norristown, Pa., has been incorporated under Delaware laws, with capital of $100,000, to manufacture brick and other burned clay products. The incorporators are George Wagner, Norristown; S. Swigler, Lansdowne, Pa.; and M. M. Sweeney, Philadelphia, Pa. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE LUBRICO OIL REFINING CO., Indianapolis, Ind., has been incorporated with a capital of $50,000, to manufacture refined petroleum products. The incorporators are W. S., R. F., J. T. and Fletcher Johnson, all of Indianapolis.

THE USONA BIO-CHEM LABORATORIES, INC., Wilmington, Del., has been chartered under state laws, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE DUNN-GRENET OIL CO., Pittsburgh, Pa., has been organized under state laws

by P. H. McGuire, W. F. Campbell and V. P. Keefe, Pittsburgh, to manufacture petroleum products. The company is represented by Russell J. Esler, 811 Frick Bldg., Pittsburgh.

THE BLOCHEM LABORATORIES, INC., Brooklyn, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals, industrial alcohol and kindred products. The incorporators are J. E. Gauthier, A. E. Daub and H. Whyman. The company is represented by David Geiger, 286 5th Ave., New York, N. Y.

THE METROPOLITAN CHEMICAL & NOVELTY Co., Philadelphia, Pa., has been incorporated under Delaware laws, with capital of $500,000, to manufacture chemicals and affiliated products. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

THE FIBRO CHEMICAL Co., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by E. V. Little, 113 Lincoln St., Boston.

THE GRAYCE OIL Co., Wichita Falls, Tex., has been incorporated with a capital of $150,000, to manufacture petroleum products. The incorporators are W. K. and S. J. Campbell and Carl Pursel, all of Wichita Falls.

THE CENTRAL PERU COPPER Co., New York, N. Y., has been incorporated with a capital of $100,000, under Delaware laws, to operate a copper smelting and refining works. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE ANSON BRICK & TILE Co., Lilesville, N. C., has been incorporated with a capital of $30,000, to manufacture brick, tile and other burned clay products. The incorporators are S. H. Clark, B. R. Wall, both of Lilesville; and C. P. Stewart, Pee Dee, N. C.

THE RANDOLPH MICA DEVELOPMENT Co., Birmingham, Ala., has been incorporated under Delaware laws, with capital of $150,000, to operate mica properties and manufacture mica products. The incorporators are Glenn S. Matthews, W. Alfred Gillespie and Andrew C. Roberts, all of Birmingham. The company is represented by the Corporation Service Co., Wilmington, Del.

Manufacturers' Catalogs

THE BINKS SPRAY EQUIPMENT Co., Chicago, Ill., has ready for distribution a short bulletin, No. 4-C, illustrating and describing the Binks spray tower, a water-cooling device suitable for small ice machines, oil engines, water-cooled electrical transformers and other apparatus requiring the cooling of small quantities of circulating water.

THE STEERE ENGINEERING Co., Detroit, Mich., is issuing a sheet on "Use Direct Condensation."

JOSEPH T. RYERSON & SON, Chicago, Ill., has added the magazine feature to its stock list, which will be known as the *Ryerson Journal and Stock List*. The list was formerly published monthly, but will now be published bi-monthly. The January-February issue contains a 30-page magazine section, increased space for new steel products and a section on small tools and machinery.

THE BOWKER INSECTICIDE Co., 49 Chambers St., New York, announces, in a 4-page folder, the establishment of a field service division and of a research chemical division. Dr. M. D. Leonard is director of the field service division and Firman Thompson is director of the research chemical division.

THE DESCHANEL ENGINEERING CORP., New York, N. Y., in an 8-page booklet illustrates and describes Deschanel cableway, hoists and buckets.

THE KAY MFG. Co., Norwalk, Conn., calls attention to its new bulletin entitled "Whitney Free Floating Coupling," which is designed to transmit power from one shaft to another, though the shafts are not in alignment, without causing strains in the shafts or bearings. Disassembled couplings are shown, dimensions are given and also a price list.

THE JEFFREY MFG. Co., Columbus, O., has issued three new catalogs. In Catalog 345, on coal and ashes handling machinery, twelve distinctive type of power house equipments are illustrated and described. Catalog 359 features the Jeffrey single roll crusher. This crusher, which is built in five sizes ranging from 18 x 18 in. to 36 x 54 in. is especially adapted for the power house, to insure a constant supply of stoker or small coal where stock sizes cannot always be obtained direct from mines and only run-of-mine or lump coal is available; or for the coaling station, to reduce run-of-mine and lump coal to proper firing sizes; or for the coal mine to reduce lump coal to small sizes to meet the demand for a uniform stoker coal and to dispose of surplus lump coal. Besides crushing coal the crusher lends itself to the reduction of salt, alum, bone and similar substances. The catalog illustrates and describes the construction and operation of the crusher, including typical installation in service, a table of capacities of the different sizes of machines for use in crushing various grades of bituminous coal, and other information for crusher users. Bulletin 360 features the Jeffrey portable car unloader for unloading coal from hopper-bottom or gondola types of railroad cars. It is designed to enable it to meet various conditions of unloading. It requires a minimum of space and can readily be placed in between the car hopper door and the rails, or, where conditions permit, a more permanent arrangement can be had by placing the unloader underneath the rails and thus eliminate the necessity of resetting it for each car.

THE OLIVER-SHERWOOD Co., San Francisco, Cal., a subsidiary of the Oliver Continuous Filter Co., has issued a new catalog on "Cutless Bearings." Illustrations are given as well as a description of the weak link in every pump, the secret of the cutless bearing, the elimination of expense of machining, the many uses of cutless bearings and a list of pump manufacturers using the bearings.

THE NORTON Co., Worcester, Mass., in a 40-page booklet, illustrates and describes "Alundum Safety Tile," which is for stair treads, floors, ramps, elevator landings, entrances to public buildings or wherever a slip-proof, non-wearing surface is desired. Illustrations and descriptions are given on materials and process of manufacture, its advantages, general characteristic of physical properties, types and sizes and specifications for the proper installation of alundum safety tile. Interesting illustrations are given of the actual use of this tile in buildings, subways, stairs, floors, etc.

THE FULTON FOUNDRY & MACHINE Co., Cleveland, O., describes the Airedale clutch in a bulletin just issued. This clutch is made for services from 6 to 560 hp. in standard sizes, and is applicable for a wide range of machines in many kinds of industries. The clutch will not "grab," but picks up gently and is simple and ruggedly made.

THE MERRILL Co., San Francisco, Cal., announces its new catalog, "Merco Processes and Products." Descriptions are given of the Merco precipitation processes and products and also some of the up-to-date results achieved by representative installations, as well as descriptions of the Crowe vacuum-zinc shavings process, Merrill sluicing clarifying filter, Merco-Nordstrom plug valve, Merrillite and Merco methods for clarifying and precipitating cyanide solutions.

THE PHILADELPHIA DRYING MACHINERY Co., Philadelphia, Pa., has recently issued a 4-page folder which describes the various type of "Hurricane" driers for chemicals, battery plates, pharmaceuticals, electrical porcelain, leather, tobacco, spark plugs, food products, etc. The truck tray drier is described as well as the storage battery plate drier, the tunnel truck driers, automatic conveyor type of drier, cabinet tray drier, continuous sectional conveyor drier and "Hurricane" automatic combination stick and apron tobacco drier.

THE WELLMAN-SEAVER-MORGAN Co., Cleveland, O., has issued Bulletin 71 descriptive of the application of labor-saving machinery, particularly car dumpers, excavators, filling bridges and excavating bridges. It also describes the practical method of working very low-grade ore, especially by the leaching process.

THE COLORADO IRON WORKS Co. has issued Pamphlet 33, on "The Akins Flotation and Aeration Machine."

THE AMERICAN STEAM GAUGE & VALVE MFG. Co., of Boston, Mass., is distributing a folder describing its recording thermometer which has recently made its appearance on the market. This new product is actuated by different methods, depending on the purpose, and either saturated vapor expansion, inert gas or liquid is employed. It is in a 10-in. moisture-proof case to record any temperature up to 1,000 deg. F. at any distance up to 200 ft.

THE UEHLING INSTRUMENT Co., Paterson, N. J., announces two new publications: Bulletin 220, on "Magnitude of the Power Plant's Chimney Loss" and Bulletin 221, on "Relation Between CO_2 and Money Wasted Up the Chimney."

THE NASH ENGINEERING Co., South Norwalk, Conn., calls attention to Bull. 18, on "The Jennings Hytor Vacuum Heating Pump, Steam Turbine Driven," for return line heating systems, drier exhaust in paper mills and other vacuum work where liquid is handled with a gas. The booklet is printed in colors.

THE DORR Co., engineer, of New York, has just published an unusually attractive booklet entitled "Testing That Pays Dividends." It describes the laboratories and testing plant housed in the Westport mill at Westport, Conn., and discloses the philosophy of investigation and research into industrial processes. Individuals or companies confronted with the problem of replacing old processes or developing new ones will find much of interest and profit in the bulletin, a copy of which will be sent on request.

THE WHITLOCK COIL PIPE Co., Hartford, Conn., in Bulletin 30, describes the Whitlock all steel superheater, which represents a comparatively recent addition to the line of heat exchange apparatus manufactured by this company.

THE THWING INSTRUMENT Co., Philadelphia, Pa., in a recent bulletin, No. 10, illustrates and describes Thwing thermo-electric pyrometers, indicating and multiple-recording types.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the third Monday of April, instead of the second Monday as usual.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY and the AMERICAN PULP AND PAPER ASSOCIATION will hold annual meetings at the Waldorf-Astoria, New York, the week of April 10.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
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Bad Paint and Good Medicine

THERE was a graduate of the University of Pennsylvania who was engaged in a zinc oxide works where, of a sudden, they had trouble. There was something wrong, something unusual in the product. So the Pennsy man dissolved the product, precipitated the zinc, filtered and then added hydrogen sulphide to the filtrate. This showed a white precipitate. In the back of his head was the recollection that germanium sulphide was white, and he announced his observation of the presence of this rare element. Older heads urged him to calm himself, and assured him that his remarkable find was nothing but sulphur. But he dissolved his so-called "sulphur" in aqua regia and H_2S brought it down again. Other tests confirmed his analysis.

Faithful to his *alma mater*, he sent a sample to the Philadelphia laboratory, whereupon Professor TAGGART called for more, and a barrel of the defective zinc oxide produced a couple of ounces of germanium sulphide. Here was a chance for some interesting work, and at the suggestion of Professor TAGGART an advanced student proceeded at once to a study of the periodic table. Germanium is in the carbon group, titanium and zirconium are respectively above and below it, and its near neighbor in the next, or nitrogen, group is arsenic, with atomic weight of 74.96, that of germanium being 72.5. What followed was suggested by the close relationship between arsenic and germanium in their respective positions in the periodic table, and in the behavior of the germanium dioxide in water, which resembles that of arsenic much more nearly than the oxides of the other elements of its own series. A stable saturated solution contains 0.004684 gram of germanium dioxide per 1 c.c. of water..

Then a test was made on guinea pigs by Dr. JOHN H. MUELLER and Miss MIRIAM S. IZARD to see if a solution of the GeO_2 would increase the red blood corpuscles as does As_2O_3. The results were amazing, and they are reported in the March, 1922, number of the *American Journal of the Medical Sciences*. In all the animals treated the blood count went up over a million per cubic millimeter. With rabbits the same effect was observed. A big old dog weighing 142 lb., with the infirmities of age upon him and a blood count of about 2,000,000 below normal, was tried next. Old Rover got a little above 100 mg. of the aqueous solution injected daily for 9 days, and 234 mg. injected the thirty-second day. He developed a normal blood count on the third day, and 2 months after beginning he was still normal. The excess was eliminated in the urine. The next subject was a man 39 years of age who drank the GeO_2 solution half an hour before meals, and here again was the same effect. Lethal doses of arsenic are about 8 mg. per kilo of body weight, whereas that of germanium are over half a gram. Arsenic is also a cumulative poison, while the cumulative feature of germanium is negligible. It therefore does the work of arsenic, is only slightly toxic, and it looks as though means of overcoming pernicious anemia had been discovered. What organic compounds may be built up on germanium remain to be seen. They are at work over it in the John Harrison laboratory in the University of Pennsylvania and in the Wistar Institute.

Unfortunately we can not give more particulars at present, but the little we have learned goes far to show what a curious series of crosscuts chemistry brings into life. There was a batch of zinc oxide that went wrong. There was a live chemist in the works who knew his own mind well enough to stick to his conclusions until he could prove them one way or another. There was his loyal association with his *alma mater*. And now what follows bids fair to be a great contribution to the healing art.

Doesn't it seem worth while to keep good chemists around?

Containers for Coconut Oil

IT'S CURIOUS how hard it is to be up and doing in the tropics. And yet some of the most energetic men we know live under summer skies all the year around. They are, however, few in number. With most of us perpetual sunshine makes us dozy.

There is the copra business, for instance. According to *Commerce Reports* (Nov. 7, 1921) it is said that despite immense sums invested in coconut plantations, most of the groves of the Pacific are stifled with undergrowth and receive little cultivation.

There are oil mills in the Philippines, Dutch East Indies, Australia, the Straits Settlements and French Oceanica, and these have brought about a better quality of oil by avoiding deterioration of the copra in long transit. But these mills incur serious difficulties in finding good containers. Steel drums are expensive, wooden casks are unsatisfactory, and discarded kerosene cans, which are cheap in some localities, cause trouble in opening them and getting out the oil. Tank steamers present obvious disadvantages in shifting from an outward-bound cargo of petroleum to an inward-bound cargo of edible oil. That is, the disadvantages accrue to the edible oil rather than to the tankers.

This shortage of containers has caused a number of tropical oil mills to give up buying copra save at a fraction of the normal price, and accordingly a great deal of it has been shipped to Europe with the consequent deterioration in transit. It is curious that nobody has invented a cheap container for this valuable oil. Over here nobody seems to think of it, and out there in the tropics thinking is hard work. Maybe the hookworm is the obstacle that lies across the road to invention.

Permanence of Light Aluminum Alloys

DOUBT has been frequently expressed by engineers that light aluminum alloys can come into general use on account of their instability. For instance a British official who is best qualified to state an opinion has been quoted as saying, "Speaking generally, the aircraft industry had experienced great trouble with the alloys." Several instances of rapid corrosion, volume change and season cracking have been quoted, while apparently perfect pieces of duralumin have developed mysterious defects. Nevertheless it is unfair to condemn a metal because certain samples go wrong. Brass jars have been known to crack badly, standing on a shelf. Tin in storage has converted itself into dust. Steel castings have exploded with much fuss. But we have not yet discarded brass hardware, tin plate or steel wheels—the effort is rather to study the causes of the troubles and prevent their reoccurrence. So it is reassuring to read in the Eleventh Alloys Research Report—reviewed at length elsewhere in this issue—that the evidence of 9 years' study "indicates very clearly that the alloys do not deteriorate to any appreciable extent within that period of time, while in regard to retention of shape and dimension they are adequately stable for all purposes except for accurate standards of length."

Experience of years has therefore substantiated the theoretical conclusion that well-made alloys such as duralumin, "A," "E" and "Y" alloy, while they do change at room temperature, and continue to change for years, change in a way which enhances their usefulness rather than the opposite. If this be "instability," give us more of it!

Such alloys rank with steel in their susceptibility to heat-treatment. That is to say, proper heating and cooling will change the strength, hardness and ductility to such an extent as to suggest that an entirely new metal has been generated. They are unlike steel, however, in that changes in physical properties occur at room temperature—some steels will change perceptibly after a short stay in boiling water, but seldom is any change noted at atmospheric temperature. In other words, steel is stable in service; we believe that the strength which it possesses now will be possessed by the same metal after 50 or 500 years, if it is guarded against corrosion, heat or overstrain. Duralumin, "A," "E" and "Y" are unstable when quenched—that is, the physical properties determined a week later will be different than if determined immediately. It is said that they "age."

"Aging" is a rather unfortunate term, for it suggests the general deterioration of faculties as a man grows old. "Maturing" would be more apt, for the changes occurring in light aluminum alloys are similar to those which occur when a boy grows into a man—the boy ages; he also matures.

It is of course important that metallurgists and engineers should know exactly what these changes at room temperature are, in order that they may be able to predict the state of a maturing metal at some time in the future. Recent work on these alloys and on the theory of hardening makes it almost certain that the same kind of reactions go forward in heat-treated steel and in light aluminum alloys.

At the risk of stating well-known things, the analogy will be drawn in detail.

At elevated temperatures the normal constituents of an alloy which hardens mutually dissolve in one another, and distribute their atoms uniformly throughout the mass. With lowered temperature some of the constituents (cementite Fe_3C in steel and Mg_2Si and $CuAl_2$ in the light alloys) become insoluble, precipitate and accumulate into tiny hard crystals. Such reactions take time. If the cooling is quick enough, even the precipitation may be prevented—we fix the solid solution permanently in the cold metal if but a very small atomic movement is possible at the subsequently encountered temperatures. Such drastic chilling gives relatively soft metal—like quenched manganese steel. But anything which allows a little more atomic movement will allow precipitation of the insoluble constituents and their aggregation into minute crystals. Thus, hammering manganese steel hardens it almost instantly; gentle tempering does the same thing to other analyses which are austenitic when quenched.

Atoms comprising quenched aluminum alloys, however, seem to possess enough movement so that the precipitation and accumulation occur in metal at rest and at room temperature—the alloy hardens and strengthens continuously—rapidly for a few days, but continuing at a decreasing rate almost indefinitely.

It seems that maximum strength and hardness in metallic alloys are associated with a uniform dispersion of insoluble hard constituents of a certain size—if too small the metal is soft; as the particles grow the metal hardens; as the particles grow still larger the metal becomes again softer. Maximum hardness (that is to say, "critical dispersion") may therefore be had in two ways—by drastic quenching from the temperature range where all constituents are soluble followed by mild reheating, or quenching at a slower rate. Softer metal in turn can be produced by more prolonged or higher reheating, or by still slower cooling, either of which allows the insoluble particles to coalesce further into a smaller number of larger crystals.

The above statement is a general one, and holds for duralumin as well as for steel. From this viewpoint the maturity of light aluminum alloys at room temperature is no different than tempering quenched steel—maturing is slow and proceeds at a constantly decreasing rate, whereas the effect of tempering is quickly felt. However, we need not feel alarmed to find that duralumin after 7 years has increased in hardness, strength and brittleness, and imagine that the ductility will continually decrease with passing time. At the worst the ductility can decrease only to that value associated with the maximum hardness—further progress of the reaction will soften and toughen the alloy. However, the rate of reaction at room temperature continually approaches the vanishing point, since it is increasingly difficult for growing crystals to attract additional molecules from deeper and deeper regions.

The maximum hardness and strength and the minimum ductility ever to be attained by a matured aluminum alloy should therefore be quickly determined by a series of quenching and tempering experiments—the maximum and minimum of these curves represent the "asymptotic values"; indeed, there seems no reason why the metal could not be put into such shape that further change with time from the hardening reactions would be negligible. In this way we would have light metal like most of our heat-treated steels—metal in metastable equilibrium, but metal which is permanently stable under the conditions of its intended use.

Automatic Processes In Industry

SCARCELY an industry in the country has made more than a start toward the utilization of the principles of mass production by automatic methods which were developed in the great metal-working plants and which have contributed so largely to putting them in their present high place in the world's industrial scale. We have been told that the methods applied to the working of metals cannot be applied so well to other materials and in most cases cannot be applied at all. The truth of the matter is that the particular machines used in metal working cannot often be used. The principle, which consists in the careful analysis of the operations of the non-automatic manufacture of the product and the translation of the results of this analysis into machinery which will duplicate the operations automatically, can be applied to almost any industry. There is a point, however, at which the size or complication of the machinery needed may increase its cost so much as to make its adoption uneconomical. But this is true in only a few cases, and we have no doubt that eventually almost the whole of industry will be on an automatic, mass production basis.

In this connection it was recently our privilege to visit a plant where the automatic side of the glass industry has had a notable extension. For some time the molding of bottles has been an automatic process. Now, in this plant, the drawing of tubing and the manufacture of various articles from tubing have been reduced to an automatic machine process.

This indication of the way the wind blows in ceramics is confirmed by similar beginnings in leather-working, wood-working and other industries. The eventual extension of this tendency will no doubt carry the introduction of automatic processes to the economic limit. But when the possibilities for lowered cost per unit of production and the increased efficiency in the use of men and equipment are considered, it would seem to be the wisest course for industry to automatize as quickly and as widely as possible.

The Waste in Coal Mining

SO FAR as known, no record has been kept of the number of addresses that have been delivered and papers and editorials that have been written on wastes in coal mining, all referring to waste of coal. The waste referred to is of coal that would be valuable only to our descendants many years hence.

No doubt we ought to regard the interest of posterity. Besides leaving coal in the ground, we should do well to employ our present capital and man power so as to leave the maximum of comfort and enjoyment in works of art, public and private buildings, transportation facilities, means of production and fertile soil.

In coal mining we have been wasting some coal, but there has been a vastly greater and more important waste of capital and of man power. The pity of the coal strike that began April 1 is that it will not dispel this economic evil. Everyone knows that there are large stocks of coal on hand and that the strike will not end until the stocks are depleted. Meanwhile man power is lost and capital lies idle.

Coal operators and coal miners use different language, but they say the same thing, that there are too many coal mines, and that means that there are also too many coal miners. The capital invested is not efficiently employed and man power is wasted. Repeatedly the coal miners have employed the strike as a means of passing on the expense of part-time employment to the public, the buyers of coal. In other words, they demand that the public support a partly leisure class, demanding a coal-mining rate that will pay an annual salary for a very limited amount of actual work.

Good use for capital can be found, and when capital is put into one thing that same capital cannot be put into another. If a coal miner works a few hours on each of 150 or 200 days in a year and is idle the remainder of the time, man power is being wasted. A detail in which we may be interested is who pays for the idleness, the public, the coal operator or the coal miner himself, but it is a detail in which posterity will not be interested. Posterity will reflect that we were wasteful of our capital and our man power, although we did a good bit of talking about how we should be careful to leave in the ground all the coal gleanings possible. If that principle were a good one, we might stop building roads and leave the stone for posterity, or stop building steel bridges to leave behind some additional iron ore.

More Pure Than Applied

THE program for the meeting of the International Union of Pure and Applied Chemistry which takes place in Lyons June 28 to July 1 indicates how difficult it is to bring pure and applied chemistry into association when once the habit of separation has been formed. For instance, as reported in the *Journal of Industrial and Engineering Chemistry*, the International Committee on the Elements has agreed to three sub-committees respectively on isotopes, radioactive elements and atomic mass. Three commissions on nomenclature are also to be appointed in reference to organic, inorganic and biological chemistry. An investigation is to be conducted to determine whether the principal chemical periodicals shall or shall not adopt the system of abbreviations used in *Chemical Abstracts*. The program ranges slightly over into the field of applied chemistry in taking up standards in certain phases of the three divisions of this subject—viz., the Bureau of Physicochemical Standards at Brussels, pure products for research in England and the service of Documentation on Industrial and Technological Products at Paris. And applied chemistry is brought into activity in the discussion of international laboratory analysis of food products.

But applied chemistry in its more general sense seems neglected. We had hoped that these more frequent meetings would replace the former international congresses of applied chemistry while maintaining vigorous activity in theoretical work. The two belong together, and each encourages work in the other. The developments coming along in the tanning industry, for instance, are distinctly short-cuts from research in pure chemistry over into its very practical application.

What we miss in this program is something in the way of engineering, technology and industrial chemistry. Of course the scope of these more frequent meetings cannot be as broad as that of the former triennial congresses, but we venture the belief that they would have a livelier interest if provision were made to couple up the subjects discussed with the ways and means that they may be of service to humanity.

Readers' Views and Comments

Atomic Disintegration of Tungsten

To the Editor of Chemical & Metallurgical Engineering

SIR:—The note in your issue of March 22 on "Atomic Disintegration of Tungsten" is of extraordinary interest, and a few comments may be justified.

It is said that the method employed was suggested by astronomical researches at the Mt. Wilson observatory, and I infer that the experimenters have ingeniously obtained, in the laboratory, conditions approximating those resulting from collisions of dark stars or similar bodies in the vacuum of intersteller space. When such collisions take place, there of course occurs a prodigious transformation of kinetic energy into heat of intensity that might easily reach or surpass the filament temperatures calculated by Drs. Wendt and Irion. The solid elementary masses of the colliding bodies thereupon explode like the tungsten filament of the experiment, with incredible violence, the main product always or usually appearing in the spectroscope as hydrogen. This gas, if I remember correctly, was driven off from the nucleus of Nova Perseus at a speed exceeding that of any observed solar protuberance and which remained as our record of the highest velocity obtained by matter until that of the helium alpha particle from radium so far surpassed it. Whatever the results of the work prove to be, all must honor the vision and ingenuity by which cosmic conditions have been so nearly reproduced on a laboratory scale.

The outstanding feature of the report is that tungsten of atomic weight 184 has been transmuted to mercury of atomic weight 200.6. Here is something entirely new; for all the long series of elementary transformations familiar to the student of radioactive phenomena involve a lowering of individual atomic weights. It is not of record that either by natural degradation or from alpha particle bombardment an element has been changed into another of higher atomic weight. A key to the answer may be found in that word "degradation." From the supposed beginning in U or Th, to the ending in Pb or an isotope, each step of radioactive elementary transformation apparently consists of a drop in individual atomic weights, with *liberation* of energy. Admitting this, it is conceivable that from an intensely applied source of supercalescence an atomic system might *absorb* energy, and that, doing so in the work under consideration, some multiple of W (184) may have been energized into some multiple of Hg (200.6); a sufficient amount of H (1) and He (4) being freed to complete the equation.

This would be an "ennobling," in sharp distinction from the "degradation," or loss of potential energy, involved in all previously observed elementary transformations. It would more closely meet the general conception of the term "transmutation" than anything heretofore accomplished.

I may be excused for suggesting that this unique reversal in the direction of atomic weight alteration, however capable of speculative explanation, perhaps casts a shade of doubt on the results that might not otherwise be felt and that all will eagerly wait to see removed. In this connection I venture to mention the possibility of H or He occlusion or inclusions in the metal of the W filament used for the experiment. It is of record that these cause trouble in the "hard" type of thermionic valve radio tubes; the gases being slowly liberated from the W of the filament even after its painstaking purification and under the comparatively mild conditions there existing. Spectroscopic evidence of Hg, also, needs a rigid "third degree" when observed in connection with any form of exhausted-tube apparatus. I apologize to Drs. Wendt and Irion for bringing up these points if, as is probable, they have already been considered.

DALTON M. GOETSCHIUS.

The Standard Chemical Co.,
Canonsburg, Pa.

When Does an Employment Contract Terminate?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I know of no remedy at law for unfortunate engineers or technical men who have, in good faith, signed a valid employment contract before entering such employment. If employment is entered into without such a contract and later the employee is asked to sign a contract which imposes unsatisfactory conditions and is given to understand that his services will be no longer required if he does not sign such a contract, there may or may not be an element of coercion.

In my opinion, the real remedy for such conditions as you have described in your editorial of Feb. 22 lies in the proper education and enlightenment of the engineer or technical man. For years American engineering and scientific schools have prepared their graduates to render not only valuable and efficient service in the everyday duties that they are employed to perform but they have also given them a training which has cultivated the inventive or initiative faculty and foresight to a greater degree than can perhaps be acquired in any other course of human training or experience. Unfortunately engineering and scientific schools have not in the past and still do not, so far as I can learn, attempt to impress upon their students the value of such inventive or creative talents.

On the other hand, these schools have inculcated in the minds of their students a spirit of loyalty to their employers and the strict observance of a code of moral and professional ethics. Without deprecating the inculcation of loyalty to one's employer or the observance of proper moral and professional ethics, it is my opinion that the engineer or technical man who is guided by these high principles in making an employment contract is at a tremendous disadvantage in dealing with the average employer, whether such employer be the sole proprietor of his business or merely an official of a corporation. Unfortunately for the engineer seeking employment, the business-man employer generally has only one motive, and that is to make the best bargain possible. That is the only code of ethics with which he is familiar. He is, however, well aware of the high principles and code of ethics which actuate the average engineering graduate and generally takes advantage of them.

From a legal viewpoint and from the generally

accepted brief code of business ethics which I have above mentioned, the employer is probably within his rights in driving a hard bargain. If the employee does not desire to accept employment under the conditions proposed by the employer, he does not have to, and if, after being employed, the employee is required to accept further unsatisfactory conditions or get out, he is still at liberty to make his choice. Engineers should understand this and also understand that alluring prospects for promotion and for sharing in the profits of his employer are will-o'-the-wisp-like unless written into a contract in plain, unmistakable language that such promotion and sharing of profits are considerations of the contract.

Unless, therefore, the technical man knows the value of his wares and has the courage to demand a fair price for them, he is likely to be the victim of the employer, who, though he may have no knowledge and have no ability to acquire knowledge of technical matters, possesses superior faculties and has had infinitely better training in the knowledge of values and the analysis of character.

If the technical man will stop to consider that many of the large employers of engineers who exact the signing of employment contracts calling for the assignment of all patents or inventions of their employees for no other consideration than that of their wages and employment carry their patents and inventions on their books at an enormous capitalization and use these patents as the means of maintaining a virtual monopoly of their business and, incidentally, of maintaining high prices, such a technical man, from the training he has received, ought to be able to judge the value of his inventions. If he is contributing to the aggregation of patents owned or controlled by such an employer, he should insist upon receiving reasonable compensation for such as he contributes. If he does not insist upon such compensation, he should not later complain that his contract of employment is unjust.

Engineering and scientific schools can do much to alleviate the situation by teaching their students the value of technical service particularly as relates to patents and inventions and teaching them also that the product of their brains is their natural heritage and that they should not sell it for a mere "pot of porridge."

I do not agree with the statement made by W. S. Landis in his discussion of this subject which appeared in your issue of March 15, that "raising of the ethics of the profession would go a long way" toward making unnecessary the form of contract under discussion. The ethics of the profession are already on such a high plane that he who is governed solely by them when negotiating for the sale of his services has an insurmountable handicap.

Nor can I conceive of a just "comprehensive and adequate patent law whereby the granting of a patent assumes novelty, without the burden of adjudicating the same through litigation." It is obvious that if one be deprived of the right to contest the validity of a patent, the Patent Office would have to be infallible, else injustice would be done in some if not many cases. It is humanly impossible to be infallible, and our wise and altogether admirable laws governing the issuance of patents therefore provide for relief where injustice has been or is thought to have been done.

Cleveland, Ohio. FRANK L. SESSIONS.

Philip Argall—A Case of Parallel Invention

To the Editor of Chemical & Metallurgical Engineering

SIR:—The late Philip Argall of Denver, Col., whose untimely passing was noted in your issue of March 29, was a remarkable man. I was well acquainted with him when I held the chair of chemistry at the State University of Colorado, at Boulder; and I am indebted to his fertile and original practical scholarship for many a help. Mr. Argall was far ahead of most of his profession, in mining, milling and metallurgy. It was his bold suggestion that first reduced the resistant Cripple Creek ores, the "tellurides," to subjection in cyaniding. That the tellurides are one of the few cases where gold occurs combined chemically has long been well known. That these tellurides can be easily roasted has also been well known. Thus in the old days of rich specimens, it was common to make show pieces by simply placing the raw ores in a fire, when the tellurium would volatilize off, and the gold would "fry out" in great drops all over the specimen. But it was Argall's brain that saw that the reason raw telluride ores would not cyanide was that the cyanide could attack only free gold; and a simple roasting of the telluride sets the gold free. Mr. Argall put this into practical working at the D. Moffat Works near Florence, Col., back in the '90s. In connection with the recovery of the gold from the cyanide solution, zinc shavings were used to precipitate the metal; but Mr. Argall tried scores of other possibilities.

While he was deep in the midst of that work, I recall that he made me a visit at Boulder, in the course of which we had many a confidential discussion of chemical ways and means. One day he told me, with emphasis of the need of secrecy, that he had succeeded in making common metallic aluminum active, about as active as sodium amalgam, when immersed in water, by the action of such salts as those of mercury or metallic mercury, or both. I listened with no small degree of interest, for that was a new reducer worth attention; but as I did not seem to be as much impressed as he had expected, he paused to hear my reply. I went across the room to the last file of *Berichte*, and showed him the identical discovery, just published in the last number, by Prof. Wislicenus of Leipsig, who had worked out the same invention from the standpoint of organic chemistry. Of course Mr. Argall was almost dumfounded, for he said that I was the first man to whom he had trusted any word of his discovery.

On questioning Mr. Argall and on looking up the date of the receipt of Prof. Wislicenus' manuscript, it appeared that those two men, one in Leipsig, Germany, and the other in Florence, Col., had evidently made the parallel invention within a few days of each other and from entirely different points of attack, one inorganic and the other organic; one from the heart of an old and well-furnished university laboratory and the other in the midst of all the trials and distractions of a workshop. This must have been in the late '90s.

The incident is only one of many showing that new inventions are always in the minds of several men; but it is not often that one has the opportunity to check up the facts in such an incontestable way. The episode shows not only the brilliant working of the inventive mind of Philip Argall but it also throws some interesting light on the close connection between fields of research apparently far apart.

Pittsburgh, Pa. CHARLES SKEELE PALMER.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, March 18, 1922.

CHEMICAL markets are still somewhat uninteresting and although the trend of prices is in a slightly upward direction, this is due more to depletion of stocks than to substantial business. Fertilizers, as mentioned in last month's notes, continue to be an exception, and sulphate of ammonia is almost impossible to obtain for early delivery. Glacial acetic acid is again in demand and a further rise in price is predicted, chiefly owing to failures to make delivery from the continent. The lockout in the engineering trade is not expected to last more than 2 or 3 weeks, but even if a prolonged stoppage is avoided, the effect on the chemical industry will be noticeable, a slight setback nowadays making a relatively deep impression.

SUCCESS OF CHEMICAL EXHIBITS AT BRITISH INDUSTRIES FAIR

It seems unnecessary to deal at length in these columns with the magnificent exhibition organized in London and Birmingham under the auspices of the Department of Overseas Trade. Full reports and comments have appeared in the *Chemical Age* (London) and the *Times Trade Supplement*, while some excellent impressions of the fair appeared in the *Journal of the Society of Chemical Industry* this week. The writer has paid several visits to the fair and the essential point about the chemical exhibits was that perhaps for the first time in this country there was a real attempt at organized as distinct from haphazard presentment. For this credit is undoubtedly due to the Association of British Chemical Manufacturers and instead of a duplication of exhibits, the keynote was specialization and concentration on specific lines not competing too actively with other manufacturers represented at the fair and very often covering some special brand or quality. It would be invidious to refer to any specific exhibits without dealing with all of them, but the fine chemical industry as a whole certainly rose to the occasion, and particularly as regards purity the exhibits reached a very high standard. A particularly British characteristic is the continued existence and progress of relatively small firms, which either alone or as constituent parts of an organization demonstrate that individual effort and initiative upon which the trade of this country was founded have not been entirely eliminated by the war-time tendency of amalgamation. Dyestuffs were well to the fore and a very complete and up-to-date collection of finished manufactures using dyestuffs aroused great interest and compared very favorably with similar exhibits seen by the writer last year at the Chemical Exposition in New York. In fact the method of presentment was perhaps better, even if the range of colors exhibited was not quite so extensive. The size and scope of the fair as a whole may be judged by the fact that in London alone there were somewhat less than 1,000 exhibitors, taking a total space of 200,000 sq.ft., the actual frontage of the stands being over three and a half miles. Even if these notes are concerned chiefly with the chemical exhibits, the remainder of the fair was most illuminating and gave a comprehensive picture of present trade tendencies and of real progress in almost all branches of British manufacturing activity. Exhibitors appear to be well satisfied with the results obtained and are likely to give increased support next year. In addition, there was ample opportunity, apart from the business of securing orders, for exhibitors to become better acquainted by interchange of views on the spot and some interesting developments are expected. Although only about one-twentieth of the whole, the chemical exhibit was generally regarded as the outstanding feature of the fair and its educational value to the public and to the legislature has been appreciable. It will not be out of place to mention that only one of the chemical trade papers really made a feature of giving its fullest support, while the older established journal seems to have failed in its duty as a handmaid to the industry.

FURTHER DECISIONS UNDER SAFEGUARDING ACT

It was decided today that tartaric acid, cream of tartar and citric acid are not fine chemicals and in consequence they will not be subject to duty. Apparently the evidence of foreign manufacturers was accepted in preference to that provided by members of the Association of British Chemical Manufacturers, and speaking broadly, it is thought that in view of the large quantities handled annually, it might even have been possible to classify some of these products as heavy chemicals, although it was not part of the referee's duty to apply any such definition. A further decision was that in the case of lactose, which under the act was subject to duty, whereas Allen & Hanbury, Ltd., claimed that it was really a food, that its manufacture did not call for more skilled chemical supervision than, say, cane sugar and that such supervision was not such as would enable the product to be called a fine chemical. As a result lactose has been struck out of the list of articles subject to duty and general opinion seems to indorse the referee's view.

GENERAL NOTES AND NEWS

The organizers of the proposed Institution of Chemical Engineers have made rapid progress and the drafts of the articles of association and of the bylaws have already been circulated to the advisory committee, which consists of more than one hundred prospective members. The Institution should come into being during the next few weeks. It has been well supported financially and otherwise by the leading members of the profession. It will be noticed that the word British does not enter into the title selected for the Institution and the standard which has been set by those responsible will render it worthy to rank in every way equally with the pioneer American Institute. Some confusion has arisen as to its relationship with the chemical engineering group of the Society of Chemical Industry, but clearly there is no connection, the former being a qualifying and examining institute, while the latter should work in close co-operation and function more particularly as an educational body.

The Plauson colloid mill referred to in my January notes is making further progress, the necessary financial and technical support having been forthcoming, and interesting developments are expected in the near future. It will be remembered that some months ago Plauson, in conjunction with Vielle, took out a very large number of provisional patents and the publication of complete specifications should soon begin.

The Alby United Carbide factories is now definitely being wound up, the negotiations with the Barton group having failed.

The Business Side of Chemical Manufacturing

The First of a Series of Articles Discussing the Non-Technical Departments, Their Shortcomings and the Usefulness of the Technical Man in These Fields—The Organization—The Purchasing Department

By CHARLES WADSWORTH, 3d

CONSIDERABLE attention has recently been focused on the fact that chemists and chemical engineers know so little about the business side of chemical manufacturing. Perhaps it would be more accurate to say the non-technical side of chemical manufacturing, for it includes practically all phases of the manufacturing business which are not strictly technical. For these things there is practically no preparation in technical schools. It is therefore excusable, perhaps, that the technical man should fail to realize the importance of the non-technical at the start of his career. That he should continue to ignore it is unfortunate for the industry and for himself. To drive home to the technical man the vital importance of the field he is neglecting is the main purpose of this discussion. As a corollary it is hoped that employers may be made to realize that technical men possess qualities which are distinct assets in the non-technical side of chemical manufacturing as well as in their special fields.

Relative Importance of Non-Technical Departments

How important is the non-technical side of chemical manufacturing? To arrive at this, let us first consider a theoretical organization. There are eight departments into which the work is usually divided. They may be regarded as the "elements" of organization. They are:

1. Research and development.
2. Operating.
3. Engineering (maintenance and construction).
4. Purchasing.
5. Sales and credit.
6. Advertising.
7. Accounting.
8. Finance.

You must understand that the problem of every organization is different and that the relative emphasis placed on any given department will vary tremendously. A dye plant, for example, will have to have seven research chemists, where a sulphuric acid plant of the same financial size will have none. Again, in a plant which produces large tonnage the chief engineer is likely to be a very much higher priced man than in a plant where the mechanical factors of production are small, and so on. In large organizations subsidiary departments, such as traffic or credit, often become important enough to enjoy separate existence. But every healthy chemical manufacturing plant will have all of those eight departments represented. The aims of each department are under constant scrutiny by the best executives. In fact it may be said that the principal executive effort should be the discovery of fresh ideals and stricter standards for the elements of his organization, in accordance with the principle of balance of which we shall have more to say in a little while.

In the list given above there are three technical departments and five non-technical departments. Is that not food for thought? Five to three! Please let me forestall any argument about the technical department being more important. "What would become of the business if it was not for the discovery of the process and the production of the goods? Where would the business be?" That has a good sound, but the answer to it is, "Just exactly where it would be if you couldn't sell the product, if you did not know accurately whether you had made money or not and if you did not know how to handle money! Nowhere!" Talk to executives about the situation. Consider why it is that in the long run the purchasing agent, the sales manager and the auditor get as much salary as the head of research, the operating superintendent and the chief engineer—sometimes more. What is the answer? That only three-eighths of the business of manufacturing chemicals is technical. Indeed in arriving at this figure we have assumed that all the work of the technical departments is technical, which is far from the case. But we are interested only in bringing forward the fact, novel and a little bitter for the technical man, that non-technical work is more important to the organization than technical work.

Strength and Weakness in an Organization

Before we undertake a detailed study of any of the individual departments, it will be worth while for us to consider the organization as a whole and to bring to light any generalizations as to causes of strength and weakness. It will give us a better perspective through which to gage each element of the organization. Organization is a human machine and its problems are the problems of the human equation. Retaining our analogy to a machine, we can say that an organization to run smoothly must be well balanced and that its parts must be in good condition. Lack of balance indicates weakness, just as balance indicates health. In studying a particular organization to determine its specific weaknesses (for every organization will have weaknesses—it is inevitable, since its elements are human beings) the best way to proceed is to study routine. With a knowledge of normal routine it is comparatively easy to locate departures from it. Sometimes these departures indicate executive wisdom but more often a lack of understanding of the functions of a given department.

The best way to understand this is to study specific cases. If we follow a purchase requisition through from its origin until the purchase order is ready to mail, we shall discover who the big men are and what departments are not functioning properly. We may

find that some one who is not the purchasing officer carries out the negotiations. A requisition for a specific piece of apparatus is turned in to the purchasing agent, who then transcribes it on the purchase order form. This means that the purchasing agent is nothing more than a clerk and that his department contains only a small part of the invaluable data which it should contain.

Again, how are the data of the accounting department obtained? Are the forms designed for its convenience or does it have to glean information from operating department forms? Are its reports turned in on time or is there delay in making them out? In obtaining answers to these questions we shall be able to determine whether the accounting department is being treated with proper respect or whether the factory men regard it as a nuisance and adopt a condescending attitude toward it. Still again, a decision to shut down a unit in the plant is made. Who makes it? Who is consulted? Does the superintendent say "please" and "sir" to the chief engineer or does he forget to warn him that less power and steam will be needed? All of these things are indicators. They show us very conclusively whether there is a lack of balance in the organization and where a corrective is needed.

Weaknesses of the Executive

There is another type of weakness in organizations not due to the departments but to the executive. This weakness—the weak executive—may take a number of forms, but there are three which are especially common and therefore deserve mention. The first has already been mentioned. It has to do with lack of familiarity with non-technical departments on the part of technical men. Unfortunately, the technical man who becomes an executive is not an exception to the rule. He is made an executive largely because he is familiar with company procedure or because he is the logical man to promote. After his elevation he becomes absorbed in the routine of his position and does not feel called upon to round out his experience in other fields. The technical man who is head of his own business is, on the other hand, even more apt to become wedded to bad practice in his non-technical departments.

The second type of weakness in executives consists in a belief in the dignity of executive office. This manifests itself in a reserve toward subordinates which kills any possibility of intimacy and therefore closes the most perfect contact which the executive has with his organization. Without it he has no way of discovering what is happening, what dissensions are brewing, what ill feeling exists. Weaknesses that appear in his organization are often a matter of distinct surprise to him.

Lack of Consistent Policy

Finally, the third weakness consists in a lack of consistent policy. Vacillation is perhaps the most disrupting thing that any organization can have. It may be the fault of the board of directors or it may be the fault of the executive. Perhaps it may be that a department is created and then given up. Perhaps men are taken on for a special purpose and in a few months are discharged arbitrarily. Perhaps the change may be only the rerouting of an office form and then a switch back to its former route. Whatever it is, little or important, it affects the morale of an organization. Only those who have experienced such things can realize how serious it is. Vacillation must in no way be confused with the progressive changes which a good executive introduces. An organization is very quick to recognize the difference between progress and vacillation. Too often expediency is the evil genius of the executive.

All of these things tend to create a lack of balance in the organization and balance is the name we have given to the principle which keeps the organization in smooth equilibrium. Your organization may consist of one man who is simultaneously the head of every department or it may be so large that hundreds of men are necessary to accomplish the routine. This principle of balance is just as inescapable for the one as for the other.

The title of this article is the Business Side of Chemical Manufacturing, so let us get back to the subject. Perhaps we are in a better position to discuss the details of the various departments by reason of our digression. We shall try to develop the aims of a normal department and discuss the methods by which the work is accomplished. We shall try to show that technical training is of great assistance when it is given the opportunity. Perhaps we shall be able to indicate definite ways in which technical men may become familiar with the work of non-technical departments. (By this I do not refer to business courses, but I want to take this occasion to indorse such courses when given by reputable organizations. A technical man can go very far without finding a better paying proposition than a reading course in Modern Business Methods or a night school course of the same kind. That is personal experience.) Finally, there may be an occasional idea advanced in the line of enlarging the scope of existing departments to include functions which have been discarded.

Perhaps it has already occurred to some of you that the word technical training was a happily vague phrase which covered a multitude of sins. It is. There are many sins, too. I have encountered technical training which was not worth as much as a good grammar school education; but, vague though it is, the phrase has certain connotations and means, if nothing else, familiarity with scientific vocabulary and method of work.

The Purchasing Department

The purchasing department buys raw materials and equipment for the business. In order to do this, it is necessary for the department to know:

(1) Specifications—what to buy!
(2) Consumption—how much to buy!
(3) Markets—when to buy!
(4) Transportation—where to buy!

This seems rather elementary, and yet it is in those four words that we can condemn the average purchasing department today. A purchasing agent is very likely to know the market for raw materials which are used in his plant and he is apt to know something about transportation. But if he knows anything about specifications or consumption, it is so much parrot talk and he doesn't *know* it. He is usually woefully weak on new equipment, for he does not understand it, and is unintelligent on the general stock of material which is kept on hand. Let us consider some of the things which lie behind the four words given above.

It will be easier to study by the case method and so

we will watch a well-organized purchasing department act in the purchase of a piece of equipment and then in obtaining a supply of raw material.

Equipment

A manufacturing department sends in a requisition to the superintendent's office for a kettle. It is sent on with his O.K. to the purchasing department. It is perfectly safe to assume that the details given about the kettle are insufficient to complete the purchase, so the first thing that must be undertaken is the completion of the requisition by conference with all of the interested parties. This may include the engineering department, and a blueprint of the kettle may be forthcoming. It is even possible that this was turned in with the requisition. In any case the purchasing agent first puts himself in possession of all the data that are available and he then knows the material preferred, the probable corrosion, the pressure under which it will be operated, whether there is to be a jacket or a coil, and the dimensions and details thereof. In addition he knows the kind of stirrer desired, number of revolutions per minute, kind of driving mechanism, outlets and inlets to the jacket and kettle and so on. It can honestly be said that the efficiency of the purchasing department in making this purchase will depend upon the thoroughness with which the details of this equipment are mastered. I do not mean memorized, but understood; so that the purchasing agent can of himself make or authorize changes in the specifications.

Consulting the Card Index

And in the meantime the purchasing agent has been consulting a file of cards, labeled "Equipment." On the card labeled "Kettles" there is listed all those firms which are in a position to supply equipment of this type. An appropriate mark identifies each firm as having estimated previously on similar work or as having supplied equipment before. The most promising firms are looked up in an additional catalog of firms alphabetically indexed. These cards contain a history of the purchases made from a given firm with comments as to whether the transaction was satisfactory and whether the equipment was reliable. If the kettle is a replacement, another index is consulted called the plant ledger which gives a history of that particular piece of equipment on one of its cards. A similar history of every important piece of apparatus in the plant is contained in this index. Finally, a file of manufacturers' catalogs is searched for additional information. This completes the investigation in the organization.

Sending Out Inquiries for Bids

The purchasing agent is then ready to send out inquiries. The method of canvassing the market for material is thoroughly well known and yet withal very poorly done. Ask anyone who has to quote on material or equipment how easy it is to understand the average letter of inquiry except where no confusion is possible. As the bids come in, it is sometimes a really difficult thing to determine whether everyone is bidding on the same equipment. A separate file is often kept on which the data obtained from answers to the bids are summarized. Finally, after the purchase order is made out and sent, a copy is retained in the purchasing office on which to keep a record of the follow-up work which is done. This follow-up consists in ascertaining whether the time of delivery on the original contract is to be adhered to and perhaps in following the freight shipment after it has left the supplier.

A word at this point on purchase order forms is not out of place. Too often these forms are miserably designed. Study those that come in from the outside some time and construct a form which will be satisfactory, complete and clear. The best forms often belong to dealers or traders who are not producers. Purchasing is even more vital to them than to manufacturers, for it takes the place of their production department as well as occupying its own important functions. Some large corporations are cursed with the most inefficient, vague forms that exist. It is a minor point, but one which reflects the finesse and technique which has been put on the purchasing effort.

Can you see in the purchase of that kettle where a technically trained man would have an advantage? How much easier it would be for him to understand specifications and to make sure they were complete? How much easier it would be for him to decide whether the differences between two pieces of apparatus estimated by competing firms were serious or minute?

Raw Materials

Now let us follow the same department in the purchase of a quantity of raw material for the plant. As in the case of the kettle, the requisition may originate in one of the departments, but more likely it originates in the purchasing office itself. A file of stock cards, one card for each material, shows purchases, receipts and consumption daily. It may also contain such other information as the origin of the material, chemical analysis, usefulness, etc. When the stock of material as shown by the cards reaches a certain definite minimum, which may be a month's supply or only a week's supply, the purchasing agent puts through an order for more material. He may get it from a single source or he may shop for it (that is the name given to the method of purchase followed in buying the kettle). Quite frequently raw materials are contracted for on a yearly basis, though seldom in the last 2 years for many obvious and grim reasons. On the other hand, even in normal times with steady consumption, the purchasing agent often prefers to take a chance on the spot market, which means immediate purchase. Otherwise, the system is the same as already outlined in the case of the kettle.

Pitfalls for the Purchasing Agent

Oftentimes this kind of purchasing is very intricate. The specifications for chemicals may be negligible. They may be standard throughout the trade. They may, on the other hand, be very special, based perhaps on a definite percentage composition. Indeed the method of analysis is often of necessity the crux of the whole purchase. Again, do you see that technical training would have value? Consider this. Can your purchasing agent decide of himself that the analysis giving 93 per cent material had been properly carried out? Can he talk to the referee about the technique of the method? If he can't, consider my friend, Smith we'll call him, who lost $10,000 on one purchase through just such an error. He did not know exactly what the per cent analysis meant, although he thought he did.

Another memory! Purchasing Agent Jones made a very advantageous buy of a heavy chemical on the

spot market. The material began to come into the plant and the available storage space at the point of consumption was soon used up. Other storage space about a half mile from the consumption point had to be utilized. When the raw material stored at a distance was being consumed, the increased cost of handling boosted the cost of raw material well above the price of that material then on the spot market. The advantageous buy turned out to be a very poor buy.

Still again, on a contract for a large number of cars of raw material each month shipment was usually made all at once. These cars arrived about the same time and in order to avoid demurrage to the railroad they had to be unloaded immediately. If they had arrived even approximately at a given rate they could have been unloaded so that the material would be consumed straight from the cars. This would have avoided a rehandling charge and saved several cents per hundred pounds.

The Tragedy of Inefficient Purchasing

Such errors are unfortunately very common. They are typical of a large number of mistakes in purchasing which have come to my personal attention. You will realize that very many of these would pass unnoticed in an organization. That is the tragic part of inefficient purchasing, that no one realizes that it is inefficient. Neither of these two problems has ever been completely solved, but that only adds zest to the game.

The purchasing agent must also know a good deal about transportation. This includes not only a knowledge of routes so as to obtain best deliveries for materials in transit, but ability to follow up shipments on the way to the plant, to trace lost cars and understand the recovery of damages from the railroad for losses in transit. Sometimes when the company is large enough there will be a separate traffic department, but that will not relieve the purchasing agent of knowing some transportation.

Interviewing Salesmen

Not infrequently purchasing agents will regard salesmen as a cross between a nuisance and a performing dog. He will instruct them to call between 1 and 1:30 on Mondays, Wednesdays and Fridays or some such arbitrary time. When he does see them he makes the salesmen perform under difficulties. A brusque, testy air which keeps salesmen hurried and ill at ease! It was very aptly described by a good friend of mine as the "horse-trading attitude." The result is that oftentimes the purchasing agent loses an important message. Salesmen are his antennæ, his contact with industry and progress. It has always seemed to me that here was the purchasing agent's main job: to know salesmen, to make friends with them, to know their products. The stories are too numerous to count of the salesman who has delighted in slipping one over on the rough horse-trading purchasing agent. Courtesy pays in more ways than one. When a purchasing agent knows more about the product than the salesman does, then he may be justified in being brusque. How many purchasing agents are there who can do this? Practically zero. And yet I have seen salesmen dismissed curtly by a purchasing agent who could not have mentioned a single use for the product, without even attempting to discuss the comparative merits of its competitors.

In addition to salesmen, purchasing agents have a few other antennæ out in the world. One of the most useful is the advertisements in the technical magazines. These and the excellent Chemical Exposition at New York will keep him remarkably well informed. If a technical man wanted to be better informed than almost any purchasing agent, at least in the matter of equipment, he would need to do little more than keep up on advertising in the technical papers. It sounds simple, doesn't it? You would almost imagine that a great many technical men would take advantage of this very simple procedure, but they do not. Ninety per cent of the technical men whom I know cannot take a single piece of equipment and give a decent résumé of the different types on the market, mentioning the relative advantages and disadvantages of each. Ninety per cent is not estimate, it is count. How about you? How many pieces of equipment do you know? As a technical man you cannot be sure that your process is running at its maximum efficiency if you do not know equipment. The same thing is also true if you do not know the raw material market.

And yet, with all their ignorance, technical men have understanding which would be of great service, if properly developed, in a purchasing department. Of course, if your company has only a clerk who is called purchasing agent, while the actual work of negotiation is carried out by the superintendent or the chief engineer; a purchasing agent who merely transcribes requisitions onto purchase orders, then they will not need, nor will they understand the need of a technical man in the purchasing department. But they are losing the invaluable asset of centralized control of purchasing with all the vast store of knowledge which would accrue from it.

Technical Brains Needed in the Purchasing Department

Any well-organized purchasing department needs technical brains. I do not mean that a technical man is fitted, *a rerum natura*, to take charge of a purchasing office. Not without an adequate preparation in the technique of purchasing which is intricate, difficult and vital. But I suggest this prescription to any technical man who is doing a technical job and who is perhaps a little discouraged at the prospects. Ask the boss if you can't do some purchasing. Take a job as clerk in the purchasing office. Never mind the salary! Ask if you can't meet the salesmen. Start some of the card indexes mentioned in these paragraphs. Collect all of the catalogs you can and know the products. Read the advertisements in the technical magazines. If the purchasing agent is a good one, you will be his right-hand man inside of 2 years. If not, you will either have his job or be qualified for a job with a corporation where a good purchasing agent is appreciated. It will be interesting. Try it.

Perhaps you are an employer and have a purchasing department. Has it all the functions it should have? It hasn't? But you can't put any more responsibility on the present incumbent? Well, try a young technically trained man! Lord knows they are cheap enough. Give him a conception of the way to handle a purchasing department and then turn him loose. I will gamble the result will not be disappointing.

Finally, as a technical man, you should realize that purchasing is a vital function of your business and that you must understand it.

Chicago, Ill.

Contributions to the Study of Ammonia Catalysts—V

The Concluding Article of This Series, Which Takes Up in Detail the Effect of Pressure on Catalytic Activity as Determined by the Fixed Nitrogen Research Laboratory*

By ALFRED T. LARSON

IN MAKING a preliminary study of an ammonia catalyst, one is first concerned with the activity of that material at different temperatures and pressures. If the activity is reasonably high, it then becomes important to consider such factors as longevity and recovery from contact with poisons. But activity tests must come first. In order to examine a large number of catalyst materials, activity tests ought to be easily and inexpensively made. Now, testing at low pressures, particularly 1 atmosphere, is relatively simple and rapid. This method would therefore provide the most convenient way in which to study the activity of ammonia catalysts, provided, of course, that the behavior of such catalysts at high pressures could be predicted from results at low pressures. If this were feasible, it would then be possible to avoid the more laborious and expensive high-pressure testing.

In the preceding paper of this series, it was intimated that the decrease in efficiency of ammonia catalysts as the pressure is increased is much greater for some catalysts than for others. That is, if the tests at low pressure, say 1 atmosphere, show the catalyst to be very active, it may not be safe to assume that this catalyst will be equally efficient at higher pressures. It will be the purpose of this paper to present the experimental results which have been obtained in testing a variety of catalysts, and to show to what extent results of tests at low pressures are useful in predicting their behavior at higher pressures.

Apparatus and Procedure

In earlier papers we have called attention to some of the difficulties which must be faced if exact information concerning the behavior of ammonia catalysts is to be obtained. The need for known regulation of temperature, pressure and purity of gas cannot be too strongly emphasized. Unless all the factors which influence the behavior of a catalyst are under proper control, one cannot hope to obtain comparable results. Therefore, in studying the effect of pressure on a variety of ammonia catalysts, we have attempted, in so far as our present technique would allow, to establish complete identity of conditions. By carrying out all the tests on the various catalysts within bombs of the same type, all of which have been found to be strictly comparable; by employing the same instruments and regulating devices in all tests; by operating on the same purified gas and by reducing all catalysts under the same conditions of temperature and pressure, it is believed that identity of conditions has been obtained.

The apparatus employed in this investigation was described in article II of this series.[1] The arrangement of the apparatus was given in Fig. 1, while the details of the catalyst bomb were given in Fig. 4. This equipment was specially designed to give complete identity of conditions and to be capable of operation at any pressure up to 100 atmospheres. The four bombs employed in these tests were found to give the same results when operating on the same catalyst under the same conditions of temperature and pressure.

The catalysts, all of which were iron oxides with different kinds of promoters, were reduced in a 3:1 mixture of hydrogen and nitrogen at 1 atmosphere pressure and the following temperatures: 24 hours at 300 deg. C., 24 hours at 350 deg. C. and 24 hours at 400 deg. C. At the end of the third day the temperature was raised to 450 deg. C. and the ammonia samples taken at regular intervals until the conversion became constant. All catalysts were tested at a temperature of 450 deg. C. and at pressures varying from 1 atmosphere up to 100 atmospheres. Each catalyst was tested on pure, dry gas, and on pure gas humidified at 25 deg. C. and 100 atmospheres pressure. This gave a gas containing 0.031 per cent of water. The purification of the gas and the method of its humidification were described in article II of this series.

Summary of Results

In Table I we have summarized the results of tests on eleven catalysts, the pressures being 1, 10, 31.6 (450 lb. gage pressure) and 100 atmospheres.[2] The table includes the performance of each catalyst on both dry and wet gas. In each case we have given the actual

[2]The experimental work for this paper was done by A. P. Brooks, F. E. Smith and L. A. Stengel.

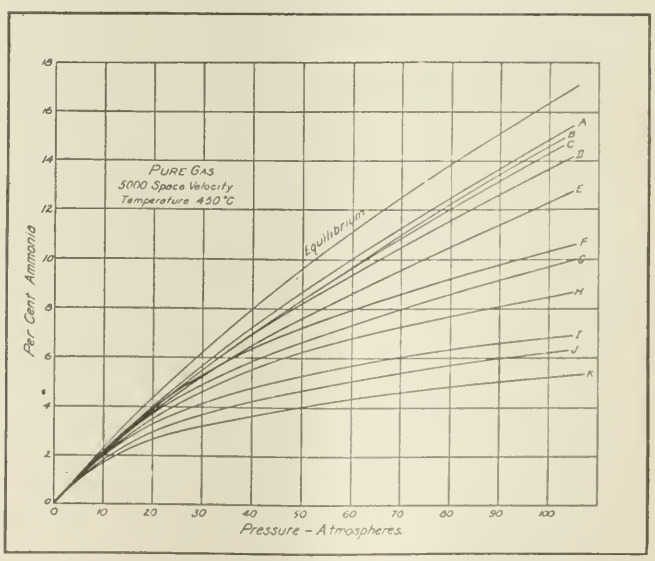

FIG. 1—EFFECT OF PRESSURE ON PER CENT OF AMMONIA USING PURE GAS

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*For Parts I, II, III and IV see CHEM. & MET. ENG., vol. 26, Nos. 11, 12, 13 and 14, pp. 493, 555, 588 and 647, March 15, 22, 29 and April 5, 1922.

[1]CHEM. & MET. ENG., vol. 26, No. 12, pp. 555-560, March 22, 1922.

TABLE I—TABULATION OF RESULTS OF TESTS ON ELEVEN CATALYSTS SHOWING EFFECT OF PRESSURE ON PER CENT AMMONIA AND CONVERSION EFFICIENCY

Pressure Atms.	A Per Cent NH_3	A Eff.	B Per Cent NH_3	B Eff.	C Per Cent NH_3	C Eff.	D Per Cent NH_3	D Eff.	E Per Cent NH_3	E Eff.	F Per Cent NH_3	F Eff.	G Per Cent NH_3	G Eff.	H Per Cent NH_3	H Eff.	I Per Cent NH_3	I Eff.	J Per Cent NH_3	J Eff.	K Per Cent NH_3	K Eff.
Pure Gas																						
1	0.223	96.5	0.206	89.5	0 202	87.3	0.204	88.7	0.216	93.0	0.225	97.0	0.227	98.0	0.232	100	0.220	95.0	0.212	91.4	0.213	92.0
10	2.14	94.3	2.02	89.0	1.95	86.0	1.98	87.2	2.02	89.0	2.11	93.0	2.12	93.4	2.03	89.4	1.95	87.2	1.82	80.2	1.76	77.5
31.6	5.97	91.8	5.78	89.0	5.70	88.0	5.72	88.0	5.42	83.4	5.43	82.8	5.02	77.2	4.75	73.1	4.22	64.8	3.79	58.3	3.30	50.8
100	14.85	90.6	14.60	89.0	14 33	87.4	13.75	83.9	12.35	75.3	10.38	63.3	9.72	59.4	8.47	51.6	6.80	41.5	6.22	37.9	5.24	31.9
Wet Gas																						
1	0.156	67.3	0.166	72.0	0.099	42.7	0.137	59.0	0.123	53.0	0.203	87.5	0.207	89.2	0.192	82.8	0.189	81.3	0.145	62.5	0.133	57.8
10	1.30	57.3	1.48	65.0	0.68	30 0	1.07	47.2	0.95	41.8	1.83	80.6	1.79	78.8	1.6	70.4	1.55	68.3	1.14	50.2	0.81	35.9
31.6	2.65	40.8	4.07	62.5	1.77	27.3	2.90	44.6	2.01	30.9	4.42	68.0	4.05	62.3	3.37	51.8	3.20	49.2	2.20	34.5	1.80	27.7
100	5.98	36.4	9.35	57.0	4.9	29.8	6.93	42.3	2.39	14.6	7.80	47.5	6.78	41.3	6.82	41.6	5.73	34.9	4.25	25.9	3.3	20.0

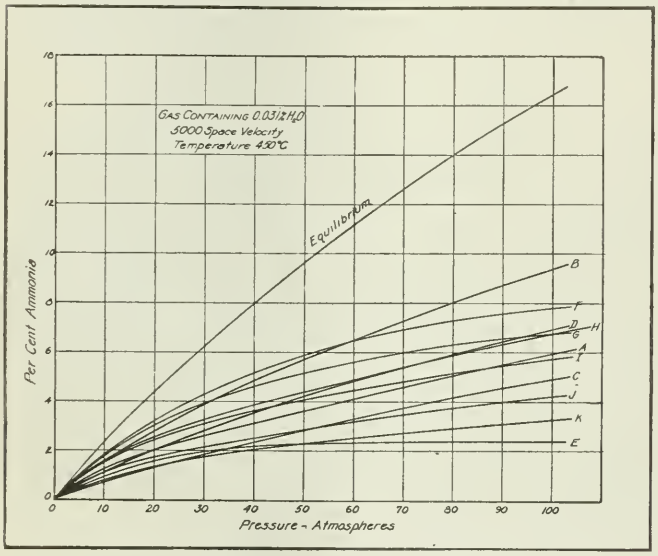

FIG. 2—EFFECT OF PRESSURE ON PER CENT OF AMMONIA USING POISONED GAS

percentage of ammonia produced (per cent NH_3) and also the efficiency (per cent Eff.) that is, the ratio of the actual percentage of ammonia in the gas to that theoretically possible under the conditions in question. Since all these catalysts would be very nearly 100 per cent efficient at 500 deg. C., a lower temperature—namely, 450 deg. C.—was selected, where the real differences in activity are more apparent. The space velocity was 5,000—that is, 5,000 liters of gas were passing over the catalyst per liter of catalyst per hour.

In representing graphically the results of Table I, we have plotted the change in the percentage of ammonia as the pressure is changed and also the variation in efficiency as the pressure is changed. The latter method of expression is the more convenient basis on which to consider the behavior of a catalyst at different pressures, so we shall limit our discussion to Figs. 3 and 4.

In Fig. 3 it will be noted that all the catalysts at 1 atmosphere pressure have an efficiency in excess of 80 per cent. At 100 atmospheres only four are able to maintain that high value. It will also be noted that at 1 atmosphere the catalysts *B*, *C* and *D* show the lowest efficiencies of the group, yet at 100 atmospheres they, together with catalyst *A*, are the only ones which maintain an efficiency of 80 per cent or better. It is evident therefore that one cannot predict from the results on dry gas at 1 atmosphere what the efficiency will be at higher pressures.

Relation of Efficiencies at Different Pressures

All the results which we have accumulated indicate that a catalyst does not increase in activity as the pres-

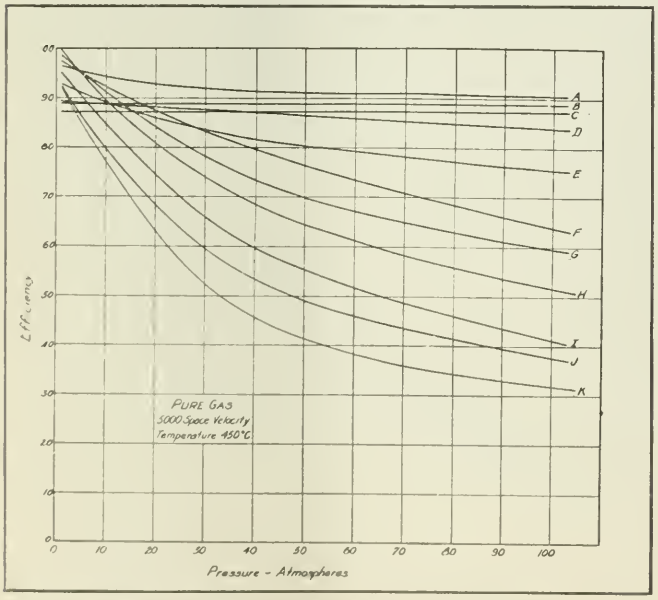

FIG. 3—EFFECT OF PRESSURE ON EFFICIENCY OF CONVERSION USING PURE GAS

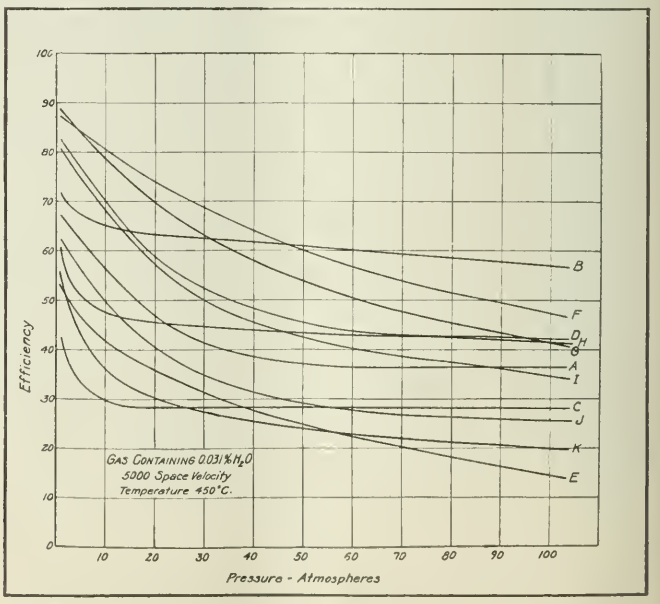

FIG. 4—EFFECT OF PRESSURE ON EFFICIENCY OF CONVERSION USING POISONED GAS

sure is increased. This was probably to be expected and needed only experimental confirmation. It is not, however, so easy to understand why a catalyst like *C*, for example, which is only about 87 per cent efficient at 1-atmosphere, should retain practically that same efficiency at pressures up to 100 atmospheres. We might expect that at 1 atmosphere it would be more efficient than those catalysts which show such a rapid loss in efficiency with increase in pressure. In presenting experiments dealing with the mechanism of the synthetic ammonia reaction, we hope at a later date to discuss more fully these peculiarities. For our present purpose it is sufficient to recognize that efficiency tests at a low pressure are not a safe basis for predicting the behavior of catalysts at a higher pressure.

If, however, the efficiencies at two pressures are known, say at 10 and 30 atmospheres, or better still at 30 and 50 atmospheres, from the general trend of these efficiency curves a very close estimate can be made of the efficiency at some higher pressure, as for example 100 atmospheres. A very large number of our catalysts have been examined in this way and the results have in general been found to be trustworthy.

Effects of Catalyst Poisons

When a catalyst is tested with a gas containing a contact poison, as for example water vapor, we find the same characteristic behavior as has been noted above. Fig. 4 shows the change in efficiency with change in pressure when operating on a gas containing 0.031 per cent water. As would be expected, all the efficiencies have dropped, although in changing from dry to wet gas the order has been somewhat altered. Thus, catalysts which show the highest efficiency on dry gas no longer rank first when tested against wet gas. These results indicate very clearly the importance of making tests with a gaseous mixture of known composition. If the character of the gas is not kept the same in all the tests, the results obtained will not be comparable.

The results in Fig. 4 also emphasize the importance of knowing the behavior of catalysts on impure gas. In technical operation it might not be feasible to produce a gas of such purity as that employed in these "pure gas" tests. Certainly, to make a selection of a catalyst for technical operation from such pure gas tests would not be safe. On wet gas, catalyst *B*, for example, is very much better than catalyst *A* which gave the highest results on pure gas. Of course, it is true that the discrepancy between *B* and *A* would become less as the temperature is raised, but still the optimum temperature when operating on wet gas would certainly be lower in the case of catalyst *B*.

Perpetual Inventory of Stores Discussed in Chamber of Commerce Pamphlet

The Fabricated Production Department of the Chamber of Commerce of the United States has just issued an important pamphlet on perpetual inventory of stores control system as an aid to manufacturing plants. The pamphlet discusses the advantages which accrue from the use of the perpetual inventory. They include a control of the investment in stores to an efficient minimum, the elimination of duplication in types of supplies and the automatic ordering of supplies which need replenishing. This question is timely and will receive much fuller treatment in these pages shortly.

Resale Price-Fixing Scheme Declared Unfair by Supreme Court

By Wellington Gustin
Of the Chicago Bar

UNFAIR competition in trade and commerce is the special concern of the Federal Trade Commission. Its acts and rulings are reviewable by the United States Supreme Court. Unfair dealing in industry is not defined in the act, and decisions of the commission and federal courts are left to determine what constitutes this offense. So a decision of the Supreme Court upholding or reversing a decree of the Trade Commission is of momentous importance to commerce and industry.

The Colgate & Co. case and the Schrader's Son, Inc., case have become historic in industry, and now comes a decision of the U. S. Supreme Court in the case of the Federal Trade Commission vs. Beech-Nut Packing Co. The decision is arrived at through a divided court, five judges to four.

How the resale price of a product may be controlled and forced to be kept up to a specified or determined figure has been the concern of many manufacturers and distributors of various kinds in practically every field of industry. Few have been able to devise a scheme or plan that will stand a test in courts. And one that has been tested out and found to be not in conflict with the Sherman anti-trust law, the Clayton act and the scrutinizing eye of the Federal Trade Commission must be accorded as being ingenious indeed.

Therefore the Supreme Court's recent decision in the Beech-Nut case is of special moment. The Federal Trade Commission had condemned the plan of resale of the Beech-Nut Co. on its products being sold throughout the United States and ordered the company to desist from the alleged illegal practices.

Charges Against the Company

It was charged that the company had adopted and enforced a system of fixing and maintaining certain specified standard prices at which its products shall be resold by purchasers thereof, including jobbers, wholesalers and retailers, with the purpose and effect of securing the trade of such distributors and of enlisting their active support and co-operation in enlarging the sale of its goods, to the prejudice of its competitors who do not require and enforce the maintenance of resale prices for their products; and with the purpose and effect of eliminating competition in prices among all jobbers, wholesalers and retailers, respectively, engaged in handling the company's products, thereby depriving such distributors of their right to sell, and preventing them from selling its products at such prices as they may deem to be, and as are, adequate and warranted by their respective selling cost and efficiency, and with various other effects; and that the company as a means of making effective its system of resale prices and of inducing and compelling its customers and the dealer customers of its customers to maintain such resale prices has:

Made it known generally to jobbers, wholesalers and retailers, respectively, that it required and insisted that they should sell its products at the resale prices so fixed by it, and refused to sell to jobbers, wholesalers or retailers not maintaining such prices; that the company threatened and refused to sell to all jobbers, wholesalers and retailers who failed to maintain the

resale prices so fixed by it, or who sold to other distributors who so failed; that the company caused the diversion of retailers' orders away from jobbers and wholesalers who did not maintain the resale prices so fixed by it, and refused to supply other jobbers, wholesalers and retailers failing to maintain such prices; that the company solicited and secured the co-operation of wholesalers, jobbers and retailers in reporting price cutters, all in pursuance of its efforts to ascertain the names of all distributors of its products who had failed to maintain the resale prices or who had sold to other jobbers and others failing to maintain the fixed prices; that it entered in card records kept by it the names of all dealers reported to it, either in this or other ways, as not maintaining its resale prices or as selling to those who in turn did not maintain such prices, and had taken various measures to prevent all such dealers from obtaining further shipments of its products from any source until it had received from them declarations, promises, assurances, statements or other similar expressions to the effect that in the future such dealers intend to and will sell such products at the resale prices fixed by the company and will refrain from selling to others who fail to maintain such prices; that the company employed various other means and methods for the enforcement of its system of maintaining resale prices.

Charges Found True by Commission

The commission found that the charges were substantially true; that the company selected its wholesale and retail dealers as desirable customers because they are believed to be of good credit standing, willing to resell at the fixed prices and maintain same. Such are designated by the company as "selected" or "desirable" dealers, and include the greater number of such dealers throughout the United States.

The Beech-Nut Policy

The company has adopted and maintained what is known as the "Beech-Nut policy" and requests the co-operation of all dealers selling its products, but dealing with each customer separately. In order to secure such co-operation and to further the policy the company acts as follows:

1. Issues circulars, price lists and letters to the trade generally showing suggested uniform resale prices, both wholesale and retail, to be charged for its products.
2. Requests and insists that the selected jobbers, wholesalers and retailers sell only to such other jobbers, wholesalers and retailers as have been and are willing to resell at the prices so suggested by the company, and requests that they desist from selling to others who fail to resell at the fixed resale prices.
3. Makes it known broadcast to such selected jobbers, etc., whether sold by them direct or not, that if they, or any of them, fail to sell at the resale prices suggested by the company, it will absolutely refuse to sell further products to them.

How It Carries Out the Policy

In carrying out this policy the company refuses to sell to any of the classes who fail to maintain the fixed resale prices in every particular. And it refuses to sell the so-called mail order houses engaged in interstate commerce on the ground that these firms frequently sell to others who resell to such mail order houses. It refuses to sell all so-called price-cutters. It maintains a large sales force of specialty men who call upon the retail trade and solicit orders therefrom to be filled through jobbers and wholesalers; but its salesmen are instructed to and do refuse to accept any such "turnover" orders to be filled through jobbers or others who themselves sell or have sold at less than the suggested resale prices, and in such cases the salesmen request the retailer to name other jobbers.

How Violators of the Policy Are Detected

The company has utilized a system of key numbers or symbols stamped or marked upon the cases containing its products, thus enabling it, for any purpose whatsoever, to ascertain the identity of the distributors from whom such products were purchased. And when instances of price-cutting have been reported the company investigates through its salesmen and representatives, who are able to trace the price-cutters from whom the goods were obtained as well as the distributors from whom price-cutters have purchased the products; and thereafter the company has refused to supply all such dealers with its products.

Blacklisting Violators or Undesirable Customers

Further, the company maintains card records containing the names of thousands of jobbing, wholesale and retail distributors, and in furtherance of its refusal to sell to price-cutters has listed upon these cards, bearing the names of such distributors who do not maintain the fixed prices, the words "Undesirable—Price-Cutters," "Do not sell" or D.N.S., or expressions of like character to indicate that such distributors were not to be sold its goods in the future for failure to maintain the fixed prices, or selling to others who so failed. And when a jobber or other has been entered in the card records as one to whom shipments should not go forward, the company notifies those jobbers, wholesalers, etc., who supply the distributor, of this fact, and also notifies its specialty salesmen, and gives similar notices to such jobbers, wholesalers and retailers and to its specialty salesmen when reinstatements are made in its list of "selected" jobbers, wholesalers and retailers.

What the Circuit Court of Appeals Found

In passing on this case the federal Circuit Court of Appeals was of the opinion that the only difference between the price-fixing policy condemned as unlawful by the Supreme Court in Miles Medical Co. vs. Park & Sons Co. (31 Sup. Ct., 376), and the price-fixing plan embodied in the Beech-Nut policy was that in the former case there was an agreement in writing, while in this case the success or failure of the plan depended upon a tacit understanding with purchasers and prospective purchasers. It believed there was no difference between a written agreement and a tacit understanding in their effect upon the restraint of trade, yet it regarded the case as governed by the decision in United States against Colgate & Co. (39 Sup. Ct., 465), and accordingly held that the commission had exceeded its powers in making the order appealed from by the Beech-Nut Co.

Acts Analyzed and Distinguished in Cases

In the Colgate & Co. case the indictment charged a violation of the Sherman act prohibiting monopolies, contracts, combinations and conspiracies in restraint

of interstate commerce. But on the facts showing what the company had done in maintaining the resale prices of its products the Supreme Court held that such had amounted only to the exercise of the right of the trader or manufacturer, engaged in private business, to exercise his own discretion as to those with whom he would deal and to announce the circumstances under which he would refuse to sell; and that this was one's undoubted right and no crime had been committed.

In a subsequent case to Colgate, in United States vs. Schrader's Son, Inc. (252 U. S., 85), the manufacturer was charged with having sold to manufacturers in several states under an agreement to observe certain resale prices fixed by the vendor. The Colgate case was cited as upholding this company's right so to agree but in distinguishing the two cases and holding the manufacturer in the latter case guilty, the court pointed out that the indictment in the Colgate case failed to charge that the company made agreements, either express or implied, which undertook to obligate the buyers to observe specified or fixed resale prices. The doctrine established in the Miles Medical case, that it was unlawful under the Sherman act to attempt to destroy the dealers' independent discretion through restrictive agreements, is not in conflict with the undoubted right of a manufacturer to specify resale prices and refuse to deal with anyone who failed to maintain the same, as recognized in the Colgate case.

The Supreme Court Announces the Law as Established

These decisions have settled the law in this country that in prosecutions under the Sherman act a trader is not guilty of its violation who simply refuses to sell to others, and he may withhold his goods from those who will not sell them at the prices which he fixes for their resale. He may not, consistently with the act, go beyond the exercise of this right, and by contracts or combinations, express or implied, unduly hinder or obstruct the free and natural flow of commerce in the channels of interstate trade.

The Unfair Methods of Competition

The above-stated doctrine is applied in the Beech-Nut case only in so far as it shows a public policy to be considered in determining what are unfair methods of competition, which the Federal Trade Commission is empowered to condemn and suppress. The Federal Trade Commission act was intended to supplement the Sherman and Clayton anti-trust legislation, and the Beech-Nut suit was begun under it. The commission is given authority after a hearing to make orders to compel the discontinuance by an individual, firm or company of any "unfair methods of competition."

What are "unfair methods of competition" Congress has thought best to leave without precise definition, and to have each case determined upon its own facts, owing to the multifarious means by which it is sought to effectuate such schemes. Subject to judicial review of its decrees and orders the commission has the determination of all such schemes and practices. But it is for the courts, not the commission, ultimately to determine as matter of law what the phrase includes. In another case (253 U. S., 421) it is said by the Supreme Court that the words "unfair methods of competition" are clearly inapplicable to practices never heretofore regarded as opposed to good morals because characterized by deception, bad faith, fraud or oppression, or as against public policy because of their dangerous tendency unduly to hinder competition or create monopoly. The act was certainly not intended to fetter free and fair competition as commonly understood and practiced by honorable opponents in trade, the court says.

The declaration of public policy under the Sherman act permits a trader to refuse to sell goods to persons who will not sell at stated prices. But in the recent Beech-Nut case the system of merchandising was found to go far beyond this, being against public policy because of "its dangerous tendency unduly to hinder competition or to create monopoly." This "dangerous tendency" is another indefinite phrase, if not a "dangerous" one. The decision is by a majority of the court, five to four.

The opinion states that the Beech-Nut system of merchandising constitutes a scheme which restrains the natural flow of interstate trade which it has been the purpose of all the anti-trust acts to maintain. It says that in its practical operation it necessarily constrains the trader, if he would have the products of the Beech-Nut Co., to maintain the prices "suggested" by it. If he fails to do so, he is subject to be reported to the company either by special agents, numerous and active in that behalf, or by dealers whose aid is enlisted in maintaining the system and the prices fixed by it. Furthermore he is listed as "Undesirable—Price Cutters," to whom goods are not to be sold, etc. From this course of conduct the court concludes that competition among retail distributors is practically suppressed, for all who would deal in the company's products are constrained to sell at the suggested prices. Nor is this conclusion overcome by the fact that the merchandising conduct of the company does not constitute a contract whereby resale prices are fixed, maintained or enforced. The specific facts found show suppression of the freedom of competition by methods in which the company secures the co-operation of its distributors and customers, which are quite as effectual as agreements express or implied intended to accomplish the same purpose. By these methods the company, although selling its products at prices satisfactory to it, is enabled to prevent competition in their subsequent disposition by preventing all who do not sell at resale prices fixed by it from obtaining its goods. The authority and power of the Trade Commission to order a discontinuance of such trade practices is undoubted.

Forest Products Laboratory Publishes Decennial Record

A complete report of the proceedings of the decennial celebration held at the Forest Products Laboratory in July, 1920 (see Chem. & Met. Eng., vol. 23, p. 270, Aug. 18, 1920), forms part of an attractively printed and handsomely bound volume which has just been published by the Decennial Committee under the chairmanship of Howard F. Weiss.

The first part of the book traces the origin of the Forest Products Laboratory and then treats of its growth, organization, equipment, personnel, its pre-war research, war work and plans for future research. There are also chapters on the financial value of research results and on how to use the laboratory.

Copies of this valuable record of the work of the Forest Products Laboratory may be obtained from the Director for $1.75.

Executives of the Future

By J. J. Lawton

ONE of the most serious problems with which the factory executive always has to deal, in bad times as well as in good, is that of finding capable assistants. How little does the typical executive realize this fact! If times are good he wants men on whom he can depend to get a maximum yield from the plant. In bad times he needs men who will keep the cost of production down to a minimum.

The policy of the average manufacturing plant of today is to drop competent men when production lags for want of a market, and then to import executives when the need arises. That is, they obtain men from outside the organization to fill positions that rightly belong to those who have helped build it up. Such importations are likely to play havoc with the morale of the staff, which usually includes a few who have forged their way along by sheer persistence and force of character. However, it may be said that in general these men lack the breadth of view and general grasp of the scope of the business as a whole that would render them efficient executives. Of course there are exceptions: men who in sticking to their jobs have had the intelligence to learn the scientific principles underlying the development of the industry, but these are rare. Many reach their saturation point of efficiency long before they gain the top. After that their competency dwindles steadily as they ascend.

Executives Need a Course to Fit Them to Train Others

Modern business lays great stress on the training and education a young man should have before he is graduated into the school of commerce. When these young men do not come up to the mark in industry it is customary to blame the colleges and universities for their defective curriculum, or for turning out a poor class of graduates. Instead of this, however, the fault should be laid at the door of our modern executives, so called. It is they who are in need of a thorough course of training in industrial pedagogy which would fit them to train others in turn—to develop young material into competent assistants who ultimately will become successors to themselves. In this case the benefits of experience would manifest themselves and many plants would not be standing still, as they are today.

A young man, after leaving college, enters some corporation or plant. In most cases he is started at the foot of the ladder, in the "submarginal" class. And there, as a rule, he stays. True, there are companies with the vision and practical good sense to train their young men to become "supermarginal" in their respective lines, but these are the exception. In general the young chemist or engineer receives from his superiors no help which would enable him to climb, the usual policy being to keep him on any routine work in which he has shown himself to be proficient.

It is our engineers and chemists who should control production and manage our industries, and not our corporation lawyers and bankers with lucrative salaries who, with a stroke of the pen, can stop all research work, thus thwarting progress and throwing thousands of chemists and engineers out of employment. It is only a matter of time when these conditions must be changed. In order to compete with European industries, research work must go on, unhampered. Otherwise our chemical industries will disappear, and only a few monopolies will remain.

Ours is still to some extent a new country. Its opportunities have been so varied and numerous that ability in the rough has been sufficient to make good. But the day of untutored success in business is passing. The untrained man has less and less chance daily in obtaining the best places. The rough diamond who molded raw new-country conditions with inborn shrewdness is giving way to the smooth, well-read man, who trains his future executives so that they, in turn, will carry on the policy of wisdom with the men under them. Organized training on the part of our executives will develop the breadth of vision, the fertility of resource, demanded by latter-day business. In a word, a general realization of the need of wider perception and finer initiative on the part of our executives is bound to produce admirable results in industry. And it is a matter of vital importance to the stockholders—in the long run.

The Early Bird Certainly Gets the Worm in the Oil Fields

A very interesting report which will shortly be published by the U. S. Bureau of Mines states that delay in drilling property in a field that is being worked often results in a loss of 50 per cent of the possible production of a well. The report is based on studies by one of the engineers of the bureau in the Oklahoma, Louisiana and California fields. Many examples are given where a delay in the time of drilling was responsible for a loss of several thousand barrels per acre. Two wells exactly similar in every respect except that one was drilled nearly a year later than the other showed a difference of 53 per cent production per acre. This was in the Adair pool in Oklahoma. It has now become an axiom of the oil fields that a man must drill or be prepared to accept his loss with good grace.

An interesting analogy exists between the game laws of England and the oil fields. A deer may run across many pieces of property, but it finally belongs to the man on whose property it is killed. So it is in the oil fields. There is no way of storing oil under ground and you may have oil under your property, but it will come up through your neighbor's well unless you have one too.

Methods of Extinguishing Zinc Dust Fires Studied by the Bureau of Mines

Serial Report 2,335, issued last month by the Bureau of Mines, deals with the subject of zinc dust fires. Piles of zinc dust which are burning offer many difficulties. Water or other liquids when thrown on such a pile explode and scatter the burning powder. In addition, water will decompose, giving its oxygen to the zinc and setting free hydrogen, which of course aids the combustion.

In all, five extinguishers were used—water, sodium carbonate solution, carbon tetrachloride, silicon tetrachloride and a frothy mixture. The frothy mixture extinguished the fire most quietly and effectively. A large fire was then tested with the foam extinguisher. The fire was smothered effectively, but the pile retained its heat for several hours, so that the foam had to be left in place for some time to avoid rekindling. This objection would be more and more serious as the size of the pile increased, but the frothy mixture proved easily the best of the extinguishers tested.

New Aluminum Alloys of High Strength

Digest of Eleventh Alloys Research Report to the Institution of Mechanical Engineers—Important Properties of "A" Alloy (77:20:3 Al:Zn:Cu)—Another Alloy Has an Ultimate Strength of 91,000 Lb. Per Sq.In. With 9 Per Cent Elongation

THE tenth of a notable series of reports to the Alloys Research Committee, British Institution of Mechanical Engineers, was published about 8 years ago. Since that time the investigation of the light alloys of aluminum has been greatly expanded and increased in scope. The original plans contemplated a systematic investigation of the whole field of aluminum alloys, and the eighth, ninth and tenth reports dealt with the aluminum-copper, aluminum-copper-manganese alloys, and the aluminum-zinc alloys respectively. The war emergency, however, made the development of light alloys a national necessity. Previous experience of the members and investigators of the committee, in part unpublished, furnished an excellent foundation for the extensive investigation of the most promising aluminum alloys, an inquiry which was undertaken at once. Publication has now been made of the eleventh report, prepared by Messrs. Rosenhain, Archbutt and Hanson in collaboration with other members of the staff of the National Physical Laboratory at Teddington, England, and with the co-operation of a number of English industrial concerns and other laboratories engaged in the study of aluminum alloys for war purposes.

The eleventh report, from which these notes on new alloys have been taken, contains 256 pages of text and includes 171 figures. The authors confess at the outset that the wealth of data at their disposal and the demands of conciseness permit only a very sketchy treatment of the subject. It includes, therefore, only the more important phases of the investigation, and with only sufficient detail to give a clear understanding of the results and conclusions reached.

Cast Alloys

Twenty of the ternary alloys containing up to 4 per cent copper and 30 per cent zinc similar to those described in the tenth report were studied in the form of both sand and chill castings. The tensile strength was found to increase with increasing content of zinc, but variation of the copper content from 1 to 3 per cent made no substantial difference. With 15 per cent zinc the strength in sand castings was of the order of 30,000 lb. per sq.in.; tensile strengths as high as 44,000 lb. per sq.in. were obtained by increasing the zinc content to about 30 per cent. There are, however, certain inherent defects in these alloys from the commercial standpoint. High strength produced by a high zinc content (25 per cent) is accompanied by a relatively high density (3.2 as compared with 2.7 for pure aluminum), the alloys are hot-short, and the elongation is low. Fifteen per cent of zinc seemed to be about the practical limit, and a commonly used specification known as "L5" called for 12.5 to 14.5 per cent of zinc and from 2.5 to 3 per cent of copper.

These zinc alloys showed the phenomenon of aging to a marked degree. On standing at room temperature there is a substantial increase in the strength, amounting to about 30 per cent in the course of 7 to 9 months; this gain in strength is accompanied by a decrease in elongation. However, the marked loss in strength of these alloys at elevated temperatures, together with other properties, indicates a limited field of usefulness.

Alloys for Use at High Temperatures

As just indicated, the zinc alloys show a serious loss in strength as their temperature is raised. The importance of the use of aluminum alloys as pistons of airplane engines and automobiles and in other places where they are subjected to elevated temperatures made it essential to find alloys suitable for such duty. Considerable effort was spent on this problem. As a step in this investigation the strength of cast aluminum-copper alloys containing 6, 8, 12 and 14 per cent copper was investigated at temperatures up to 350 deg. C. At a temperature of about 200 deg. C. there was no significant difference in the strength of all four alloys as chill-cast. At the higher temperatures, of 300 and 350 deg. C., there is a marked advantage in favor of the alloys containing 12 and 14 per cent copper. The 92:8 Al:Cu alloy, chill-cast, changed in strength from about 18,400 lb. per sq.in. at 20 deg. C. to 7,500 lb. per sq.in. at 350 deg. C. Similarly the 86:14 aluminum-copper alloy had a strength of about 22,000 lb. per sq.in. at 20 deg. C., and 10,700 lb. per sq.in. at 350 deg. C.

It was found that manganese was a valuable addition in increasing the strength of aluminum alloys at high temperatures. The maximum improvement was secured with 1 per cent manganese. Aluminum-copper-manganese alloys containing 1 per cent manganese were actually stronger at 250 deg. C. than at room temperature; the increase amounted to about 2,000 to 2,500 lb. per sq.in. Above 250 deg. C. the strength fell off at the same rate as with the Al:Cu alloys without manganese. There was some practical difficulty in the use of the 85:14:1 Al:Cu:Mn alloy in the foundry, so other alloys containing iron, molybdenum, tungsten chromium or vanadium were investigated. None of these alloys proved entirely satisfactory.

The effect of nickel was then investigated and it led to results of first importance. One to 3 per cent Ni was tried in combination with from 8 to 12 per cent Cu. It exerted a beneficial effect, but there was still a marked decrease in strength at moderate temperatures. Magnesium was then added in addition to copper and nickel, whereupon a marked improvement was obtained. Investigation of the limits of the three components showed the 4 copper, 2 nickel, 1.5 magnesium alloy (remainder aluminum) to be the best combination, and this alloy, known as "Y" alloy, was

[1]By the Institution of Mechanical Engineers, Storey's Gate, St. James' Park, London, S. W. Price, £2 2s.

made the subject of an extensive investigation. It was also found suitable for forging and rolling. The preparation, treatment and properties of "Y" alloy will form the subject of another article in this journal, as its importance seems to warrant separate treatment.

Casting Contraction

The total linear contraction on casting was determined for a number of alloys. As shown in Fig. 1, the method consisted of casting a ½ x 1-in. bar 10 in. long in a steel yoke, and after cooling measuring the contraction. The highest contraction was noted in the

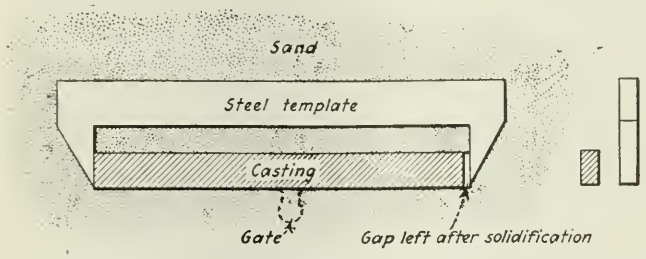

FIG. 1—METHOD FOR DETERMINING LINEAR CONTRACTION

binary alloy with 15 per cent zinc and amounted to 1.42 per cent. The 85:14:1 Al:Cu:Mn alloy was among the lowest, with a contraction of 1.21 per cent. No differences in the solid shrinkage were observed which could account for the marked differences observed in casting the different alloys.

Thermal Conductivity

One marked advantage which the aluminum piston offers lies in the high thermal conductivity of the metal. It is important, therefore, that the alloy selected be favorable from this standpoint also.

A series of determinations of the thermal conductivity of certain of the aluminum alloys was carried out by Dr. E. H. Griffiths of the heat department of the National Physical Laboratory. As far as is known to the abstractor, these are the only thermal conductivity data available on aluminum alloys, and a few are reprinted in Table I. The full report contains information

TABLE I—THERMAL CONDUCTIVITY OF SOME ALUMINUM ALLOYS

		Chill Cast Specimens Thermal Conductivity, C.G.S. Units			
		As Cast		Annealed at 450 Deg. C.	
Name	Analysis	100°	300°	100°	300°
	Pure aluminum	0.52	0.52		
"L5"	Al + 2.75 Cu + 13.5 Zn	0.31	0.37	0.34	0.35
	Al + 7.91 Cu + 0.82 Fe	0.35	0.38	0.40	0.42
	Al + 8.18 Cu + 2.09 Fe	0.34	0.36	0.38	0.39
	Al + 13.9 Cu + 0.98 Mn	0.27	0.30	0.37	0.38
	Al + 8.0 Cu + 0.98 Mn	0.25	0.30	0.36	0.39
"Y"	Al + 4 Cu + 2 Ni + 1.5 Mg	0.37	0.40	0.40	0.41
Gray Cast Iron	3.5 C + 1.8 Si + 0.08 S + 1.1 P + 0.8 Mn	0.102	0.099	0.121	0.113

on both sand and chill castings, but the data are complete only for chill castings and since there was no significant difference the values for the latter are taken for comparison.

Heat-Treatment of Castings

Although the opinion was commonly held that castings of the composition of duralumin (4 Cu, 0.5 Mn, 0.8 Mg, 0.5 Si, remainder Al) could not be materially improved by heat-treatment, nevertheless the authors satisfied themselves that by the selection of the proper conditions a very desirable improvement could be obtained. Their tests showed that in chill-cast test-bars containing up to 4 per cent of copper all of the CuAl, could be brought into solid solution by 3 days' heating at a temperature between 450 and 520 deg. C. Only a trace of undissolved CuAl, remained in a sample containing 4.5 per cent copper. Such annealing increased the strength of the 4.5 per cent copper alloy from 21,100 to 33,600 lb. per sq.in. It is not stated whether the sample was quenched or not after heating. It was also found that temperatures as high as 530 deg. C. could be successfully used for heat-treating copper-aluminum castings. Alloy "Y" proved exceptionally amenable to heat-treatment.

Wrought Alloys

In investigating the working of aluminum alloys by forging, rolling, extrusion and drawing, the first series investigated was the ternary system Al:Zn:Cu. Alloys containing up to 25 per cent zinc and 4 per cent copper were cast in cylindrical billets, 3 in. in diameter and 19 in. long. It was first attempted to roll these experimental billets at a plant of the British Aluminium Co., but difficulty was experienced because the regular practice was not suitable for rolling such hard alloys. Steps were taken, therefore, to install an experimental mill at the National Physical Laboratory.[2] The chief difficulty encountered was the cracking of the ingots during the hot-rolling, and surface defects and edge cracking in the finished sheet. Information gained in preliminary rollings, however, indicated that the 3 copper-20 zinc alloy was about the most promising of the lot and its properties were sufficiently good to warrant further investigation.

Development of Alloy "A" or "3/20"

First it was attempted to roll the alloy containing 3 per cent copper and 25 per cent zinc into bars and rods. About fifty of the 3-in. billets were tried with preliminary forging of various degrees, with working temperatures from 400 deg. C. down to 300 deg. C., and with variations in the rolling speed and reduction per pass without eliminating the serious cracking. Although the authors believe that the "3/25" alloy could have been rolled satisfactorily after a sufficient study of the problem, the urgent need for light alloys caused them to center their efforts on the somewhat softer "3/20" alloy, which has been christened "A." Between June, 1915, and March, 1916, they demonstrated to their satisfaction that this alloy could be satisfactorily produced. As a result of their extended experiments they concluded that most of the cracks and defects developed on rolling could be traced back to the original ingot and only when proper attention was given to the casting of the ingot could a satisfactory product be assured. Slow pouring of billets was adopted, with the mold tilted at an angle of about 45 deg. The object in pouring slowly was to permit solidification of the metal in the mold to proceed at about the same rate as the liquid metal was added. Thus shrinkage cavities were largely avoided and little or no "heading up" of the ingot was required. Molds were also used at a relatively low temperature (100 deg. C.).

In addition to the necessity of careful control of the casting of the ingots, the authors found it necessary to give "A" ingots a forging treatment. Hot-forging at 400 deg. C. was followed by an intermediate annealing

[2]To be described in some detail in the subsequent article on "Y" alloy.

and another forging operation together with a final annealing for 1 hour at 450 deg. C. before rolling. The object of the annealing was to obtain complete absorption of the free $CuAl_2$ and a more homogeneous structure. It is also necessary to lubricate the rolls properly. When it was attempted to cast and roll slabs 7 x 14 x 1½ in., more difficulties were encountered. Cracking and surface defects were quite common. The fact that they could be largely eliminated by machining the surface of the ingot to a depth of about ⅛ in. before rolling demonstrated again that the cast surface of the ingot was the source of part of their difficulties, and this trouble was largely overcome by careful attention to detail.

Extrusion

In view of the early troubles in breaking down chill-cast ingots, extrusion was resorted to in order to get the metal in shape for subsequent rolling. Many of the hard alloys were successfully extruded at temperatures much lower, but requiring higher pressures than for aluminum. Longitudinal central defects leading to lamination in the extruded bars have injured the reputation of extruded bars. These defects are due to original contraction cavities in the ingot, or by drawing down portions of the skin into the bar. Such troubles were therefore eliminated by correct pouring practice—as noted above. Drawing of the rear surface of the ingot into the center of the bar can be avoided by placing a corrugated friction plate of steel between ram and billet. Alloy "A," for instance, when successfully extruded in bars 1½ in. in diameter and greater, gives tensile properties closely analogous to those of the same alloy after forging and rolling.

Overannealing

In cold-working, such as spinning of this alloy sheet, it was found that 250 deg. C. was the most satisfactory annealing temperature, as it gave the highest ductility to the annealed product. Thirty minutes' annealing at 100 deg. C. produced a noticeable softening of alloy "A" sheet, while annealing at 180 deg. C. produced the maximum softening and gave material having a tensile strength of 42,000 lb. per sq.in. and an elongation of 29 per cent in 2 in.

Experiments on the behavior of the alloys under prolonged stress led to the discovery that many of them can be seriously damaged by annealing at moderate temperatures. This type of fracture occurs between the crystals, and is very similar to "season cracking." It may be investigated by bending a strip of comparatively thin sheet into a U with about 1½ in. radius, when it acquires a permanent set. If a piece will withstand this position for several days it never undergoes failure in use—at least for 2 or 3 years.

Hot-rolled "A" alloy is entirely free of intercrystalline fracture induced by bending, if the reduction after any possible heating is 50 per cent. Such safe materials having a structure shown in Fig. 2, however, if annealed 1 hour at more than 250 deg. C., will fail in short time—the quicker the higher the anneal. High annealing produces an equiaxed structure shown in Fig. 3. Heat-treatment has so far been found inadequate to correct this liability for fracture. A low amount of "overannealing" can be cured by a moderate amount of cold-work; an excessively overannealed piece can be rendered immune from failure under the bend test only by a reduction while hot of at least 50 per cent, applied in moderate drafts.

This alloy in the form of thin sheet was suggested as a covering for airplane wings, and with this object in view the British Aluminium Co. eventually produced sheets 12 in. wide by 6 ft. long and 0.0035 in. thick. This sheet had a tensile strength of 51,000 lb. per sq.in. and an elongation of 3 per cent in 2 in., after annealing at 250 deg. C. Its low resistance to ripping seemed to be a decided disadvantage as a covering for airplane wings.

TABLE II—PHYSICAL PROPERTIES OF ALLOY "A" (77 Al, 3 Cu, 20 Zn)

Density = 3.1

Material	Condition	Yield Point, Lb./Sq. In.	Tensile Strength, Lb./Sq. In.	Elongation, Per Cent in 2 In.
Rod; 1½ in. dia.	Hot-rolled	39,400	59,100	17
Rod; ⅞ in. dia.	Hot-rolled	41,000	60,500	21
Sheet; 0.104 to 0.048 in. thick	Hot-rolled	37,900	61,000	19
Sheet; 0.05 in. thick	Hot-rolled and aged 4 years	60,500	74,000	16
Sheet; 0.104 in. thick	Hot-rolled and annealed at 200 deg. C.	27,600	49,800	24–28
Sheet; 0.119 to 0.048 in. thick	Cold-rolled	58,300	66,500	11

Tests of a wide variety were made on the alloy and included compression, fatigue (alternating stress), notched bar impact, at ordinary and at high temperatures. Exposure to temperatures as low as —185 deg. C. had no deleterious effect on the alloy. The properties of this alloy in various forms and after different treatments are summarized by characteristic tests in Table II.

Development of Alloy "E"

Concurrently with the development of alloy "A" the possibility of still further improving it by the addition of magnesium and by heat-treating was investigated. It was found impossible to roll or forge these alloys containing 0.25 to 0.5 per cent magnesium. If the alloy were first extruded, however, it could be readily hot-rolled. Some experimentation led to an alloy having the following nominal composition and known as alloy "E."

	Per Cent		Per Cent
Copper	2.5	Manganese	0.5
Zinc	20.0	Iron (not over)	0.20
Magnesium	0.5	Silicon (not over)	0.20

Tensile tests of this material in the form of a ½-in. rod showed strengths of over 80,000 lb. per sq.in., with an elongation of 12 per cent in 2 in. These properties merited further development, and the rolling of sheet was investigated.

Again, the cast slabs gave trouble. One improvement

FIG. 2 (AT LEFT)—HOT-ROLLED ALLOY "A" Annealed at 250 deg. C. Immune from intercrystalline cracking. × 125.

FIG. 3 (AT RIGHT)—ALLOY "A" Intercrystalline crack in overannealed structure. × 125.

was made by discarding the use of the rich 20 per cent magnesium-aluminum alloy for the addition of magnesium and adding the pure magnesium metal in the form of a couple of sticks just before pouring. Furthermore, it was found necessary to carry out the preliminary forging at a low temperature (300 deg. C.) and to break down the slabs in the rolls at about the same temperature. After a 50 per cent reduction in thickness was effected, a higher rolling temperature (400 deg. C.) was employed. Edge-cracking was always serious with these alloys and the scrap loss high; machining the surface of the ingots had to be done. Typical tests of sheet rolled from this alloy are given in Table III.

TABLE III—PHYSICAL PROPERTIES OF ALLOY "E"—18-GAGE SHEET

Condition	Yield Point, Lb./Sq. In.	Tensile Strength, Lb./Sq. In.	Elongation, Per Cent in 2 In.
As hot-rolled	59,000	70,400	15
As hot-rolled	55,600	73,000	16
Annealed at 250° C	32,500	56,700	20
Quenched from 250° C. and aged	30,700	52,200	22
Quenched from 350° C. and aged	61,200	81,800	10
Quenched from 400° C. and aged	62,300	86,700	9
Quenched from 400° C. and aged	68,400	87,600	11

Although remarkably high tensile strengths were obtained after quenching and aging, the ductility was rather low. By reducing the magnesium content to 0.25 per cent, or by reducing the magnesium to 0.25 per cent and increasing the silicon to 0.5 or 1.0 per cent, the ductility was materially improved with only a small reduction in tensile strength.

The highest strength for any aluminum alloy given in this report was obtained with alloy "E" after extrusion, hot-rolling, quenching from 400 deg. C. and aging. It then had a strength of 91,100 lb. per sq.in. and an elongation of 9 per cent in 2 in. Alloy "E" is a typical duralumin composition except for rather low copper and the addition of 20 per cent zinc.

Both alloys "A" and "E" showed a serious loss in strength at slightly elevated temperatures (150 deg. C., for example), so that alloy "Y," which in castings had proved so satisfactory, was developed as a rolling alloy. Its properties proved to be quite similar to those of alloys of the duralumin type except that alloy "Y" maintained these properties somewhat better at elevated temperatures.

In summarizing and comparing the properties of these alloys the authors put alloys "A" and "Y" in a class by themselves as regards ease of production. They feel, however, that alloy "E" and its modifications possess certain properties which might for certain purposes discount the manufacturing difficulties. The possibility of season cracking with alloy "A" is one which should be considered. All of these alloys except "Y" are quite susceptible to corrosion and would need proper protection. They are also somewhat denser, which is a disadvantage for some purposes.

Permanance of the Alloys

The literature has contained references from time to time concerning the deterioration of certain aluminum alloys on long standing. The fact that the zinc alloys and alloys of the duralumin type undergo an internal change at ordinary temperatures raises the question as to what the ultimate course of these changes might be and what reliance might be placed on the stability of this material. The authors had this point in mind and were able to bring data collected over a period of 10 years as evidence to the reliability of these alloys, and the conclusions are quite reassuring. While the alloys studied (and more particularly duralumin, as it was the oldest of these alloys on which they had made tests) showed certain changes in the direction of increased hardness and strength, the ductility was only slightly diminished and they were sufficiently stable in dimension and length for all practical purposes.

Cast specimens of "L5" (2 to 3 per cent copper and 12 to 15 per cent zinc) showed an increase in tensile strength of about 30 per cent and a decrease in elongation from about 2 to 3 per cent to 1 per cent after a period of 10 months.

Rolled alloys increased in hardness on aging with increase of the zinc content. A 1¼-in. diameter hot-rolled rod (2 per cent copper and 15 per cent zinc), had a Brinell hardness number of about 94 at 7 months after production; 10 years later the hardness had increased to 150. A sample of sheet from alloy "A" (3/20) 0.103 in. in thickness had a strength of 57,500 lb. per sq.in. and an elongation of 14 per cent, as rolled; after 4½ years its strength was 64,300 lb. per sq.in. and its elongation 10 per cent. The aging was more marked in thin sheet than in thick sheet.

Other alloys were of relatively recent development and results extending back much over a year were not available. Some samples of duralumin manufactured by the regular makers of that alloy and tested in 1911 and again in 1921 showed an increase from 60,500 to 63,200 lb. per sq.in. in strength and a reduction in elongation from around 18 per cent to about 15 per cent. The yield point increased from 38,500 to 46,100 lb. per sq.in. This material is, of course, not typical of present-day production, but the results are nevertheless of value; they indicate no serious deterioration in the properties of the alloy.

Duralumin, as first suggested by Wilm, contained 3 to 4 per cent of copper, about 0.5 per cent of magnesium, and iron and silicon in the proportions contained in the original ingot. The composition is fairly well standardized now on 3.75 per cent copper, 0.5 per cent magnesium, and 0.6 to 0.7 per cent manganese.

Alloys of the duralumin type and "Y" alloy, when heat-treated were the best of the alloys described as regards resistance to corrosion. Alloys "A" and "E" were very seriously corroded by prolonged contact with even weak saline solutions like tap water, and would require adequate protection where exposed to the weather or similar corrosive environments.

Constitution of the Alloys

Development of the alloys described was accompanied by a study of their constitution and microstructure, and this theoretical attack of the problem was indispensable. Equilibrium relations in the ternary system copper-zinc-aluminum were determined in continuation of the plan adopted in the tenth report. Copper-aluminum binary diagram was completed by determining the solubility of copper in solid aluminum; at 540 deg. C. 5 per cent of copper was found to be soluble in aluminum and at 20 deg. C. this had decreased to about 3 per cent. In the ternary system with zinc, no new compounds were found to exist and the principal phase in the alloys with low copper and moderately high zinc is a solid solution of copper, zinc and aluminum.

Although the iron-aluminum system had been investigated by Gwyer, the diagram was not complete at the aluminum end. It had been found that the compound

$FeAl_2$ forms a eutectic with aluminum which contains 2 per cent iron and melts at 648 deg. C. $FeAl_3$ was found to be practically insoluble in solid aluminum, and the purest aluminum they examined still showed the presence of free $FeAl_2$.

Aluminum and silicon form a eutectiferous series with a eutectic at about 10.5 per cent silicon. The authors state that silicon is sparingly soluble in solid aluminum; they were able to bring 1.5 per cent into solid solution, and the solubility did not appear to decrease appreciably as the temperature was lowered. They note that when the silicon alloys are attacked with strong oxidizing agents, as in the chemical analysis of such alloys, part of the silicon resists attack and may be determined as free silicon, while part is oxidized and determined as silica. The part which is oxidized to SiO_2 is supposed to be the silicon which was in solid solution or in combination in the aluminum, while the portion determined as silicon existed as free crystals of silicon in the alloy.

The iron-silicon-aluminum system is important, as iron and silicon occur as impurities in all aluminum made by present-day processes. Alloys containing silicon up to 8 per cent and iron up to 8 per cent have been investigated. Fig. 4 shows a new constituent, identified as constituent "X," but its composition was not determined. The constitution of the ternary alloys containing up to 4 per cent silicon has been established, and is illustrated by a number of diagrams.

An investigation of the aluminum-magnesium diagram by Hanson and Gayler has already been published in the *Journal* of the Institute of Metals. The ternary system silicon-magnesium-aluminum has been investigated up to 11 per cent silicon and 35 per cent magnesium; equilibrium relations are quite complex and the full report must be studied for a complete understanding of the alloys. A compound Mg_2Si was identified as blue crystals of striking appearance. This compound, Mg_2Si, and aluminum form a eutectic freezing slightly below 600 deg. C., as in typical binary systems, and this eutectic contains about 13 per cent Mg_2Si (8.2 per cent magnesium and 4.8 per cent silicon). (See Fig. 5.) At the eutectic temperature about 1.6 per cent Mg_2Si (1.0 per cent magnesium and 0.6 per cent silicon) is soluble. The solubility decreases very appreciably at lower temperatures and at 30 deg. C. not more than 0.54 per cent Mg_2Si is soluble; even this latter figure is probably somewhat high.

Age-Hardening of Alloys of Aluminum With Magnesium and Silicon

The authors establish the fact that when magnesium and silicon are both present in aluminum, the alloy has the property of hardening after quenching. In order to identify the hardening effect with the compound Mg_2Si, a series of specimens was prepared in which the amount of Mg_2Si increased progressively to well beyond the solubility limits of that compound at the eutectic temperature. These samples were first forged and rolled to strips $\frac{1}{10}$ in. thick. After heating 1 hour at 500 deg. C., samples of each were quenched and other samples were slowly cooled in the furnace. After aging for 7 days the samples were tested. The results showed a progressive increase in hardness as the amount of Mg_2Si was increased up to the limit of solubility; thereafter the hardness remained practically constant. Other tests with alloys containing either silicon or magnesium in excess of the ratio to form Mg_2Si were made and confirmed this conclusion. All of the alloys examined reached a maximum hardness in the neighborhood of the solubility line.

These results convinced the authors that the aging of these alloys is due to the fact that the Mg_2Si, by quenching, is retained in an unstable form, such as a solid solution, and that this reverts to a more stable form on standing. Gradual hardening is believed to be the result of the tendency to form particles of Mg_2Si of sub-microscopic size. No visible change is revealed by the microscope. The evidence indicates that the alloys in the quenched and age-hardened condition are permanent—that is, in stable equilibrium—at ordinary temperatures. Their theory of the mechanism of the hardening of duralumin is quite similar to that developed independently by Merica, Waltenberg and Scott at the Bureau of Standards. The American investigators attributed the hardening largely to the compound $CuAl_2$, whereas the authors state that $CuAl_2$ is not able to produce hardening of the order found in the heat-treatment of such alloys, and that the part corresponding somewhat to that played by cementite (Fe_3C) in steel is played by Mg_2Si in these compounds.

Duralumin is completely hardened after about 4 days at room temperature; the greater part of the hardening occurs in the first 24 hours, however. Magnesium-silicon alloys just discussed attain complete hardness in about the same time, except one sample which contained magnesium in excess of that required to form Mg_2Si and which was not completely hardened after 12 days; the final hardness was then lower. This anomaly the authors attribute to the lowering of the solubility of Mg_2Si by the excess magnesium.

FIG. 4—ALLOY 91 : 8 : 1 Al : Fe : Si

Annealed 170 hours at 565 deg. C. Matrix of aluminum-rich solid solution; long crystal of $FeAl_3$ surrounded by an envelope of constituent "X". Etched with 10 per cent NaOH in water. × 1,000.

High aging temperatures were investigated on these same alloys, which contained silicon from 0.6 to 1.0 per cent and magnesium from 0.6 to 2.0 per cent. Improvement in strength increased with the temperature, and a maximum hardness was reached by heating at 200 deg. C. Higher aging temperatures resulted in rapid decrease in hardness and tensile strength.

The effect of copper, zinc and nickel on the age-hardening of aluminum as effected by the compound Mg_2Si was studied. A series of alloys, each containing 3 per cent of copper and magnesium silicide varying from the minimum corresponding to the silicon content of the alloy up to 3 per cent, was prepared. They were all heated at 500 deg. C.; one sample of each was quenched and a second cooled slowly in the furnace.

They were then tested after aging 3 weeks at room temperature. Age-hardening was quite appreciable with 0.55 per cent Mg_2Si, corresponding to 0.20 silicon. The maximum effect was reached with 0.9 per cent Mg_2Si (0.35 per cent silicon); this amount corresponds to the solubility of Mg_2Si at 500 deg. in aluminum containing 3 per cent copper. They conclude that the addition of copper reduces the amount of Mg_2Si which can be dissolved and hence reduces the maximum hardening effect which it is possible to obtain. No advantage was found in increasing the Mg_2Si beyond 0.9 per cent in the presence of 3 per cent copper. Reheating the quenched alloys for 1 hour at 50 or 100 deg. C. showed an inappreciable increase in hardness, while a slight softening was observed in the alloy containing very low Mg_2Si after heating at 150 deg. C. All except this latter sample showed a marked increase in hardness at 200 deg. C. but at 250 deg. C. the hardness decreased.

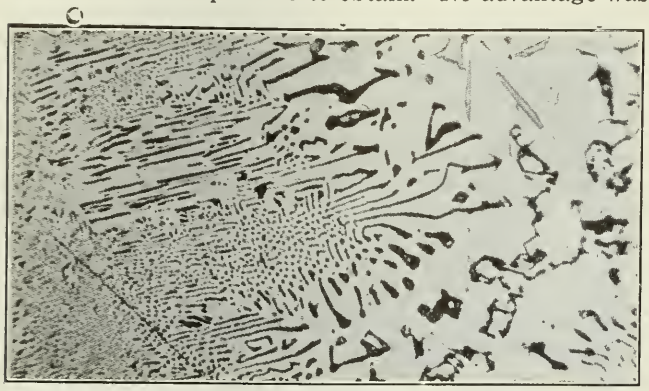

FIG. 5—CAST ALLOY 86:10:4 Al:Mg:Si
A little primary aluminum, but the alloy is largely a binary eutectic complex of Mg_2Si and aluminum. Unetched. × 125.

Alloys containing 15 per cent zinc instead of 3 per cent copper showed little increase in strength on aging; the maximum effect was obtained at 150 deg. C.

Alloys containing 3 per cent of nickel indicated that this element had less effect on the solubility of Mg_2Si than either copper or zinc. The maximum hardening was obtained with about 1.3 per cent Mg_2Si, and after heating at 200 deg. C.

In order to study the hardening of copper-aluminum alloys after quenching from a high temperature, a series of ten alloys containing from 0.5 to 5 per cent copper were cast, forged and quenched from 500 deg. C. After 5 days' aging, a small increase in hardness was observed, but in no case did Brinell hardness increase more than 10. The samples were then reheated for 1 hour at various temperatures. In the alloys containing 3 to 5 per cent copper, a somewhat greater hardness was obtained at 205 deg. C., and a still greater improvement after heating 2.5 hours. The maximum hardness would be obtained with an alloy containing 4.5 per cent copper, heated at 500 deg. C., quenched and subsequently reheated for about 3 hours at 205 deg. C. The amount of this hardening is considerably less than in similar alloys containing Mg_2Si.

To alloys containing 4 per cent copper and 4 per cent copper with 0.5 per cent manganese, varying amounts of magnesium silicide were added. With the 4 per cent copper alone, 0.55 per cent Mg_2Si gave a tensile strength of about 52,000 lb. per sq.in. after heating, quenching and aging for 4 days; reheating at temperatures above 100 deg. C. resulted in a loss in strength, although the elongation was improved up to 150 deg. C. With 4 per cent of copper and 1.35 per cent Mg_2Si (0.85 per cent magnesium and 0.5 per cent silicon), the strength, after quenching and aging, was 55,000 lb. per sq.in. The strength was increased to about 57,000 lb. per sq.in. by reheating at 200 deg. C.

In the alloys containing 0.5 per cent manganese and 4 per cent copper, a decided increase in strength was obtained by increasing the magnesium silicide from 0.55 to 1.35 per cent. The maximum strength was 56,000 lb. per sq.in. with the smaller amount of Mg_2Si and about 64,000 lb. with 1.35 per cent Mg_2Si (after reheating to 175 deg. C.).

The elongation of any one of the alloys of this series is not reduced by the aging process nor by reheating at higher temperatures up to about 150 deg. C. Above 200 deg. C. the ductility decreases rapidly.

The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations

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THE practice of modern combustion calorimetry properly begins with the work of Berthelot,[1] who was the first to design an instrument in which the material under examination was burned in an excess of oxygen under high pressure. His bomb, because of its heavy platinum lining, was extremely expensive; in 1892, Mahler,[2] besides improving its mechanical design, substituted a lining of enamel for the more costly material.

A calorimeter bomb embodying many of the best features of those used today was described in 1894 by Atwater.[3] Corrosion was prevented by the use of a platinum lining or in lieu of that, of a copper lining heavily plated with gold. One of these in particular withstood 300 combustions before blisters appeared in the plating and 400 before the presence of copper could be detected in the washings.

Some years ago Prof. A. H. White furnished for the use of his classes at the University of Michigan a bomb made of steel only, which gave good service by virtue of the formation of an inner coating of dense adherent scale. Later, however, Monel metal was selected to replace the steel, with more satisfactory results.

In 1915 Prof. S. W. Parr[4] perfected a new acid-resisting alloy known as Illium to replace platinum in calorimeter bomb construction. This complex combination of nine different metals has the necessary tensile strength and is extremely resistant to both nitric and sulphuric acids. The first bomb constructed of this material was in constant use in his laboratory for months without showing deterioration, and the test of time has since proved it to be the equivalent of platinum for the purpose in question.

It is evident from this brief review of the work of the authorities on the subject that the necessity for providing a non-oxidizable inner surface for the bomb has been, almost without exception, tacitly assumed. It is clear that corrosion or oxidation of the metal, which invariably involves an exothermic reaction, increases the total heat to be measured by an amount

[1] *Compt. rend.*, vol. 104, p. 375 (1887).
[2] *Compt. rend.*, vol. 113, p. 774 (1891).
[3] *J. Am. Chem. Soc.*, vol. 25, p. 659 (1903).
[4] *J. Am. Chem. Soc.*, vol. 37, p. 2515 (1915).

equivalent to the quantity of metal dissolved, and that even should the injury to the instrument be overlooked, the expenditure of time and labor for determining the metal content of the bomb washings for the purpose of applying a correction could not be tolerated.

The Nickel-Lined Bomb

Of particular interest from the standpoint of this paper was the announcement in 1909 of the design of a new calorimeter by Emerson.[5] This instrument embodies many excellent mechanical features with respect both to ease of assembly and to the admission of oxygen. As advertised in current catalogs of dealers in scientific apparatus, bomb linings of three different metals are offered—viz, platinum, gold and nickel. The latter because of its low cost has apparently proved to be the most popular, especially as it carries the unqualified recommendation of the manufacturer for general work. Concerning this point, Charles J. Emerson in a private communication writes: "The nickel linings are perfectly satisfactory for the general run of calorimeter work, as the errors involved in the use of this type of instrument are well within the limits of accuracy of the other elements entering into the determination, as, for instance, the thermometric errors and those in sampling as encountered particularly in fuel work."

In view of this radical departure from established standards, since pure nickel cannot be considered especially resistant to oxidation, the work of determining the corrosion effect on nickel was undertaken, primarily to guide the technical worker in interpreting results obtained with this type of instrument and secondarily to throw light on the general question of standards for bomb construction. Manifestly if a relatively inexpensive metal will serve for instruments used in industrial laboratories, no logical reason can be advanced for providing gold or platinum.

Experimental Procedure

The work done was divided into Series I and II. In the first, a substance or mixture of known calorific value was burned in the bomb to be tested and the discrepancies between the values calculated and those found were measured. Thus the sources of error were determined. In the second series parallel samples of coal were burned in a standard bomb in which no corrosion could take place, and also in the nickel bomb. As before, the magnitude and sources of error were studied. Calorimetric measurements were made in each case with all the care prescribed for accurate work on fuels, following in general the methods of Stanton and Fieldner[6] as given in Technical Paper No. 8 of the Bureau of Mines. The thermometer used was certified by the U. S. Bureau of Standards.

Series I.—Combustion samples for Series I were made up of standard sucrose (Bureau of Standards No. 17), with a heat value of 3,949 calories per gram, mixed with relatively small quantities of pure rhombic sulphur. According to Thomsen[7] the molecular heat of combustion of the latter plus heat of solution is 142,400 calories, and calculations were made on that basis.

After each run the bomb washings were titrated with standard alkali, then analyzed for nickel by the well-known dimethyl-glyoxime method. Runs 1-5, as shown in Table I, were made with sugar alone, and since nitrogen was the only acid element present, the formation of $Ni(NO_3)_2$ is assumed. Referring again to Thomsen's figures, we find the value 83,420 calories for $Ni\text{-}O\text{-}N_2O_5Aq$, from which the errors due to corrosion were calculated. Where sulphur was added, as in runs 6 to 18, the predominating salt is $NiSO_4$ and the computation of error was based on Thomsen's figures of 86,950 calories for $Ni\text{-}O\text{-}SO_3Aq$. It is evident, of course, that some nickel nitrate is present in the washings from these later runs as well, but inasmuch as the heats of formation of the two salts are so nearly equal the actual difference in this case amounts to only a few calories. Nickel determinations were made in each case only after filtration of the washings with a view to the elimination of any nickel oxide that might be present, thereby insuring the presence of nickel salts only.

TABLE I—COMBUSTION OF SUCROSE AND SULPHUR IN NICKEL-LINED BOMB

1	2	3	4	5	6	7	8	9		10		11		12	13
No.	Wt. of Sucrose, in Grams	Wt. of Sulphur, in Grams	Wt. of Nickel Dissolved, in Grams	Free Acid (0.0898 N Alk.), in Grams	Acid Equiv. to Sulphur Added (H_2SO_4), in Grams	Heat of Combustion of Sucrose, in Cal.	Heat of Combustion of Sulphur, in Cal.	Heat of Formation of $Ni\text{-}O\text{-}N_2O_5$ In Cal.	In B.t.u.	Heat of Formation of $Ni\text{-}O\text{-}SO_3Aq$ In Cal.	In B.t.u.	Total Heat Calculated, In Cal.	In B.t.u.	Total Heat Observed, in Cal	Percentage of Error (Ratio of cols. 9 and 10 to col. 11)
1	1.7430	.....	0.0239	.....	.....	6,883	.....	32.5	59	.....	...	6,918.4	12,093	6,945.9	0.47
2	1.9057	.....	0.0256	.....	.....	7,530	.....	36.0	65	.....	...	7,567.9	13,622	7,545.2	0.47
3	1.7939	.....	0.0237	.....	.....	7,087	.....	32.2	58	.....	...	7,122.1	12,820	7,122 6	0.45
4	1.9850	.....	0.0220	.....	.....	7,840	.....	31.2	57	.....	...	7,872.6	14,171	7,917.4	0.39
5	2.2390	.....	0.0236	.....	.....	8,840	.....	33.1	60	.....	...	8,874.9	15,975	8,855.8	0.37
6	0.9500	0.0500	0.0636	0.0418	0.1500	3,751.7	222.5	....	..	94.2	170	4,068.4	7,322	4,079.7	2.32
7	0.9500	0.0733	0.0678	0.0998	0.2199	3,751.7	326.2	....	..	100.5	181	4,178.4	7,520	4,161.3	2.41
8	0.9500	0.0473	0.0583	0.0405	0.1419	3,751.7	210.5	....	..	86.4	156	4,048.6	7,288	4,072.0	2.13
9	0.9500	0.0588	0.0798	0.0220	0.1764	3,751.7	261.6	....	..	118.2	213	4,131.5	7,438	4,179.2	2.85
10	0.9500	0.0704	0.0785	0.0683	0.2112	3,751.7	313.2	....	..	116.3	209	4,181.2	7,528	4,128.2	2.77
11	0.9500	0.0511	0.0711	0.0286	0.1533	3,751.7	227.4	....	..	105.3	190	4,084.4	7,351	4,077.2	2.57
12	0.9500	0.0536	0.0755	0.0466	0.1608	3,751.7	283.0	....	.	111.7	202	4,146.4	7,463	4,166.4	2.70
13	0.9500	0.0647	0.0791	0.0493	0.1941	3,751.7	288.0	..	.	117.2	211	4,156.9	7,483	4,169.0	2.81
14	1.4250	0.0762	0.0872	0.0656	0.2286	5,627.3	339.2	....	.	129.2	232	6,095.7	10,973	6,101.9	2.12
15	1.4250	0.0864	0.1020	0.0616	0.2592	5,627.3	384.5	....	.	151.1	272	6,162.9	11,093	6,142.7	2.45
16	1.4250	0.1023	0.0976	0.0880	0.3069	5,627.3	455.2	....	..	144.5	261	6,227.0	11,209	6,216.6	2.33
17	1.4250	0.0656	0.0781	0.0484	0.1968	5,627.3	292.0	....	..	115.8	209	6,035.1	10,863	6,066.1	1.92
18	1.4250	0.0965	0.0891	0.0836	0.2895	5,627.3	429.4	....	..	132.0	238	6,188.7	11,140	6,155.4	2.13

TABLE II—PERCENTAGE COMPOSITION OF COALS USED IN SERIES II

Sample No.	Moisture	Ash (Dry Basis)	Sulphur (Dry Basis)	Nitrogen
1	5.88	15.42	4.25	1.17
2	5.72	17.67	4.15	1.19
3	2.69	10.71	3.70	1.46

Series II.—The coals used in the second series of tests, collected from Illinois fields, were chosen partic-

[5] *J. Ind. Eng. Chem.*, vol. 1, p. 17 (1909).

[6] Tech. Paper 8, Bur. Mines (1913).

[7] Landolt-Börnstein, Tabellen, 1912, p. 868.

ularly for their rather high sulphur values. Table II shows their content of non-coal substances.

The bomb used as a standard for comparison was one of the Mahler-Atwater type lined with platinum. As before, free acids were determined by titration and, since no corrosion was possible, the titer was a measure of the acids generated in the reaction. Similarly the coals were burned in the nickel-lined bomb and free acid and nickel contents of the washings were determined. Results are given in Table III.

Corrections and Sources of Error

Attention is directed to the fact that for the purpose of comparison the heat values of the coal given in columns 2 and 4 of Table III as determined by the two instruments are not corrected for sulphur. It should be noted, however, that in the regular practice of coal calorimetry a correction is invariably made for the difference between the heats of formation of the dioxide and the trioxide as they are generated in the furnace and the bomb, respectively, and for nitric acid produced. Formulated, this correction is

$$C = vk + 13w$$

where C is the number of calories, v the volume in cubic centimeters of standard alkali used in titrating the bomb washings, k a constant quantity of heat, which is a function of the strength of the standard solution, and w the weight in centigrams of the sulphur as determined separately.

TABLE III—PARALLEL COMBUSTIONS OF COAL WITH PLATINUM AND WITH NICKEL-LINED BOMBS

1	2	3	4	5	6	7		8		9		10
Sample No.	Heat of Combustion Per Gram, Platinum Bomb, in Cal.	Amt. of Free Acid Per Gram, by Titration Calculated as H_2SO_4 (0.0898 N Alk.), in Grams	Heat of Combustion Per Gram, Nickel Bomb, in Cal.	Amt. of Free Acid Per Gram by Titration, Calc'd as H_2SO_4, in Grams	Amount of Nickel Dissolved, in Grams	Heat of Formation of Ni-O-SO_3Aq, in Cal.	in B.t.u.	Error* in Titration Correction, in Cal.	in B.t.u.	Total Error, in Cal.	in B.t.u.	Percentage Error
1	6,514	0.1720	6,696	0.0167	0.0694	103	185	47	85	150	270	2.35
	6,517	0.1716	6,703	0.0154	0.0768	114	205	47	85	161	290	2.47
2	6,379	0.1619	6,516	0.0070	0.0703	104	187	47	85	151	272	2.36
	6,412	0.1681	6,500	0.0192	0.0706	105	189	44	79	149	268	2.32
3	7,072	0.1336	7,702	0.0079	0.0670	99	178	38	68	137	247	1.93
	7,064	0.1320	7,181	0.0048	0.0673	100	180	39	70	139	251	1.96

* See "Methods of Analyzing Coal and Coke," Stanton and Fieldner, Tech. Paper 8, Bureau of Mines, pp. 33-34.

Inasmuch as only a small quantity of free acid remains in the washings from the nickel bomb in consequence of its reaction on the lining, as shown by comparison of columns 3 and 5, the value of v as found is too low, and the correction is consequently in error by an amount varying with the quantity of acid-forming constituents of the coal. For total error this value, which is tabulated in column 8 of Table III, must be added to that calculated for the heat of formation of nickel salts.

Any attempt to apply a correction for the heat of corrosion of the lining calculated as a function of the sulphur content of the fuel would not be feasible for the reason that with continued use the bomb becomes more and more roughened and pitted, thereby offering increasingly favorable contact to the acids present. Moreover the period between the time of ignition and that of washing the bomb must always be a variable affecting the accuracy of the correction.

It should be noted particularly that the values of absolute errors as given do not depend directly upon our calorimetric measurements, which include the reading of the thermometer, the calculation of corrections for radiation and the like, as well as the weighings and adjustments incident to a run, all of which offer opportunities for error, but upon two simple and highly accurate methods of chemical analysis—viz., the determination of nickel by the glyoxime method and the titration of an acid with a standard alkali solution. Of course, indirectly they depend upon Thomsen's work, which, however, is generally accepted.

Conclusions

In attempting to pass judgment on the merits of an instrument on the basis of results obtained in its use the matter of a standard of comparison is naturally of prime importance. A conservative estimate of the accuracy obtainable with a good oxygen bomb calorimeter is a figure well within 0.5 per cent. Naturally, this limit of accuracy assumes that operators of the calorimeter should be experienced, versed in quantitative procedure and reasonably careful.

In the opinion of the committee on coal analysis of the American Chemical Society, results obtained by a single analyst should not differ more than 0.3 per cent, while those obtained by different analysts should agree within 0.4 per cent. Reference to the accompanying tables will show errors as high as 2.5 per cent or more in the use of the nickel bomb, equivalent in the heat determination of a coal, for instance, to a mercury rise of about 0.15 deg. F. Inasmuch as no difficulty is experienced in reading accurately to 0.002 deg. F. with a Beckmann thermometer or with the Richards modification of the Beckmann instrument, it is readily seen that the inherent error of the instrument far exceeds that of the observer's eye or of the personal equation in general. It seems fair to say that greater accuracy than that obtained can be had with instruments of other types and of much lower cost or indeed by calculation from analytical data according to formulas that have been prepared for that purpose. Furthermore, the purchaser of an oxygen bomb outfit, who must make in any case a relatively large capital investment and whose use of the instrument must necessarily involve considerable care and expense, expects a fairly high accuracy. In buying a cheaper lining, therefore, he defeats his own ends.

With respect to the subject of standards in fuel technology, the growing tendency for large consumers of coal to purchase their supplies on rigid specification is increasing the demand for accurate calorimetry, inasmuch as the results must govern the question of bonus or penalty on settlement. An attitude of tolerance toward questionable technical methods naturally cannot be long maintained by either party to the transaction.

The authors wish to emphasize, in conclusion, the fact that this article is not, in general, a criticism of any particular instrument but of the use for bomb linings of nickel or any other metal so slightly resistant to corrosion as nickel proves to be.

Minerals, Earths and Clays of Latin America—II

The Natural Resources of the Central and South American Countries, Many of Which Are Now Undeveloped, May Yet Contribute Largely to the World's Supply of Manganese, Chromium, Tungsten, Vanadium, Molybdenum, Cobalt, Titanium and Zirconium

By Otto Wilson
Former Chief, Latin-American Division, Department of Commerce

THE European war and the shutting off of supplies of manganese from Russia and India resulted in an important development for the production of that mineral in Latin-American countries, especially in Brazil. The Brazilian deposits are numerous and rich and the possibilities for future production are most promising. Some of these deposits had already been exploited, since for 25 years Brazil had been exporting manganese and up to the time of the war had had a total output amounting to about 500,000 tons. Exports rapidly mounted, however, when the American steel plants called on Brazil to replace Russian and Indian ores, and in 1917 they reached their highest point, 532,856 tons, valued at $14,321,003. This amount is about all the present railway facilities can handle. In 1918 exports dropped in quantity to 393,388 tons and in value to $11,460,760. In 1919 they amounted to 205,725 tons, valued at $4,397,468, and in 1920 to 453,737 tons, valued at $8,762,479. Lack of transportation facilities is said to be the only factor that retards development.

Manganese Deposits in Brazil

The greater share of past production has come from three states—Minas Geraes, Bahia and Matto Grosso—but other deposits are known in Maranhao, Parana, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Santa Catharina and São Paulo. The most important producing region is in Minas Geraes, near the iron deposits, and much of the ore is found in the same Itabira formation referred to in the preceding article of this series.[1] The chief deposits are near the stations of Lafayette and Miguel Burnier, on the Central Railway of Brazil. The leading mine of the Lafayette district, the Morro da Mina, has produced 2,000,000 tons of ore, and there is a proved reserve of 10,000,000 tons. The ore is of high grade, three analyses of the ore from the Lafayette district showing 49 to 51 per cent, 50 to 52 per cent and 50.47 per cent manganese, from 1 to 7 per cent silica, and 0.08 to 0.10 per cent, 0.12 to 0.15 per cent and 0.069 per cent phosphorus, respectively.[2] Some samples contain as high as 57.48 per cent manganese.[3] In the State of Bahia mining has been carried on in one district about 30 miles southwest of the port of Bahia, where there are estimated to be 700,000 tons of psilomelanic ore. The ore which has been mined averaged 43 to 49 per cent manganese, 3 to 6 per cent iron and 0.016 per cent phosphorus.[4] It ranges in size from small lumps to masses weighing as much as 1½ tons. In the State of Matto Grosso the two deposits that have been worked are a few miles south of the river port of Corumbá, to which river vessels ply from Buenos Aires. Some of the ore has as much as 60 per cent manganese, but the average is about 46 or 47 per cent, with 9 to 10 per cent iron. The deposits are in the hands of an English-American company which has a 70-year concession covering about 25,000 acres. There are reported to be many other deposits in these three states, as well as the others mentioned above, some of which are most promising.

Before the war the price per unit of manganese was about 14 cents, or $6.70 per ton, less moisture. There is an export tax of 10 per cent in Minas Geraes, based on the official valuation, which varies so much that in one year the amount of the tax per metric ton ranged from $1.80 to $3. The reserve of Brazil's manganese deposits is said to be sufficient to supply the United States with all its requirements almost indefinitely.

Other War-Time Sources of Supply

Ecuador has been working some manganese deposits near Quito for export, but the only other country of South America besides Brazil that has shipped manganese in any large quantities is Chile. Prior to 1905 that country had sent over half a million tons to the United States. About that time competition from Russia and India developed and stopped production in Chile and there has been little since. In the 3 years preceding 1921 shipments amounting to about 15,000 tons were made, but these were discontinued in 1921 because of the high ocean freight rates. With lower rates it is thought that manganese ore can be sent to the United States with good profit and that this can be further increased by improving methods of handling. The chief production has come from the Carrizal district in the Province of Atacama and the Corral Quemada district in Coquimbo, but there are many others that have been or might be worked. The ore formerly mined carried up to 52 per cent manganese.

Cuba, Costa Rica, Panama and Mexico also answered the war-time call for manganese. The largest Cuban deposits are in the eastern end of the island, in the Province of Oriente. There are smaller deposits in the provinces of Pinar del Rio and Santa Clara. In Costa Rica manganese mining and exporting were started in 1916, when 1,305 tons was shipped. In the next year exports rose to 8,191 tons, and in 1918 to 9,893 tons. In 1919 they fell to 7,852 tons. In Panama seven manganese deposits were profitably working during the war, the bed lying near the historic port of Nombre de Dio, on the Atlantic side of the country. These were old workings that had been closed down since the beginning of the century and were reopened only in 1916. Other deposits, near Porto Bello, are said to be ex-

[1] For Part I see Chem. & Met. Eng., vol. 26, No. 14, p. 631, April 5, 1922.

[2] Harder, E. C., "Manganese Ores of Russia, India, Brazil and Chile," *Trans.*, A.I.M.E., vol. 56, p. 60. Also Miller and Singewald, "Mineral Deposits of South America," p. 185.

[3] Derby, O. A., as quoted by Miller and Singewald.

[4] Hewett, "Mineral Resources of the U. S., 1914," p. 181, U. S. Geol. Sur., Washington, 1916.

tensive. The Mexican mines are found in Chihuahua, Puebla, Chiapas and Lower California, the manganese being often associated with gold, silver or iron. Production in 1917 amounted to 73 metric tons, in 1918 to 2,878 tons, in 1919 to 2,294 tons, and in 1920, according to preliminary figures, to 838 tons. The ore shipped to the United States has averaged 40 to 48 per cent manganese. Besides these countries, Uruguay has pockets and traces in all parts of the country, two or three of which are worked for local purposes, and one company in Argentina has offered to supply 200 tons of ore a month for export from that country, provided a market can be found.

Chromium Found in Brazil, Cuba, Guatemala and Mexico

In chromium production four countries are listed, although production in none of them has reached large proportions. These countries are Brazil, Cuba, Guatemala and Mexico, in each of which the deposits were opened up by the war demand. Brazil took the lead in exports, and in 1918 shipped 17,854 tons. This fell off in 1919 to 4,800 tons and in 1920 to 3,451 tons; the average value in the last year was $21.36 per ton. The Brazilian ore came from a single district, near Queimadas and Bom Fin, in the State of Bahia, but there are other deposits reported farther inland, near the São Francisco River. The ore shipped has run about 44 to 46 per cent chromic oxide. The producing deposit is owned and operated by Americans. In no other South American country have deposits of any importance been uncovered, although in Venezuela, on the Coro Peninsula, and in Colombia, near Antioquia, occurrences of the ore have been reported, and a blast furnace near Medellin, in the latter country, is said to have produced chromiferous pig iron.

The Cuban deposits have been surveyed, and since 1916 several thousand tons has been exported to the

FIG. 14—SOUTHEAST END OF THE MAIN WORKINGS AT THE TOP OF THE MORRO DA MINA MANGANESE MINE, THE LARGEST IN BRAZIL

United States. The figures are as follows: 1916, 35 tons; 1917, 17 tons; 1918, 8,963 tons; 1919, 14,693 tons; 1920, 710 tons; 1921, 600 tons.[5] The deposits are found in twelve groups, all within 25 miles and most of them within 10 miles of the north coast, beginning with the Province of Havana and extending to the eastern end of the island. The eastern part of Havana has one deposit and the Province of Matanzas has two. The most important sources are found in the Province of Oriente, south of Nipe Bay, near the Mayari iron mines of the Bethlehem Steel Co., which has been taking out the chromite. About 40,000 tons of ore is now in sight. Next in importance are the Cayoguan and Potosi deposits, where it is estimated that there is an apparent reserve of about 35,000 tons. These lie near the eastern end of the island northeast of Baracoa, and are owned by two groups of American interests. Deposits near the town of Camaguey are said to have reserves of 20,000 tons. Of prime importance also are the chromiferous iron ores of Cuba found along the northeastern coast. Although present

FIG. 15—SHARP CONTACT BETWEEN MANGANESE ORE AND ROCK IN MORRO DA MINA

Black line at left shows contact, the lightest material is rock, the remainder is ore.

in vast amounts, these ores have so far been mined only at Mayari.

The changed conditions brought about by the war caused the development of chromite deposits in Guatemala in 1917, in which year 182 tons was sent to the United States. This increased in the three following years to 1,212 tons, 1,686 tons and 1,122 tons, respectively. The ore is described as very pure, averaging about 58 per cent chromic oxide, and is especially valuable for chemical purposes. It is in serpentine and is found about 100 miles inland from Puerto Barrios. Nicaragua is also said to have deposits of unknown extent, from which small shipments have been made. A part of Mexico's production of chromite is of high grade, containing as much as 54 per cent chromic oxide. This occurs in the Department of Progreso, from which shipments have been made to the United States. Other deposits, also worked during the war, are found in the Department of Jalapa.

Tungsten Resources of South and Central America

Bolivia, Peru and Argentina are the South American producers of tungsten, the first named being the most important. The production of Bolivia in recent years, in concentrates of 60 per cent tungsten, has been as follows: 1913, 278 long tons; 1914, 272 tons; 1915, 780 tons; 1916, 2,987 tons; 1917, 3,827 tons; 1918, 3,363 tons; 1919, 1,963 tons. Four districts lead in tungsten production—viz., those around La Paz, Oruro, Potosi and Cochabamba—although the deposits are not confined to these regions. The mines are in or on the sides of the eastern Cordilleras, extending over about

[5] U. S. Import figures.

400 miles of territory, from Puerta Acosta to Chorolque. The principal mines of the La Paz district are the fields of Palca or Yungas, and Quime or Inquisivi, with others of importance at Araca and Colquiri. In the Oruro district there are some important scheelite deposits at Conde Auque and elsewhere, and the Uyuni district has produced, according to report, some hübnerite of remarkable purity at Salasala and in other localities. Wolframite is obtained from a great number of mines. The deposits are generally in veins and are closely associated with tin, although many tungsten deposits contain little or no tin. The average cost of mining seems to be about $12 a ton at the mine.

Production in Peru, amounting to 200 to 500 tons annually, is practically confined to the districts of Conchucos and Corogno, both near the ports of Salaverry and Chimbote. Deposits are reported to be large but of low grade, and their working fluctuates sensitively with prices for the ore in Liverpool and New York. Production is almost entirely in the hands of Indians, and is carried on in a very primitive manner. Before the war German interests were a controlling element in tungsten mining.

The Argentine ores occur in the pampa range of mountains, an isolated range lying about 20 miles east of the Andes. The deposits are more abundant in San Luis and Cordoba, but also occur in La Rioja. The ores are found at an elevation of 2,000 to 5,000 ft. They consist of wolframite, hübnerite and scheelite, and are associated with ores of bismuth, tin, mica, copper and molybdenum. The veins contain ½ to 1½ per cent tungsten in unevenly distributed crystals, lumps and slabs, weighing up to 110 lb. Mining is of the crudest sort, and the deposits are seldom worked to any exact depth. Exports in recent years have ranged from 175 to 1,000 tons. A sample of the ore from Catamarca, sent to the United States, was found by the Bureau of Mines to contain about 80 per cent scheelite and 11 per cent silica. Mexico has deposits of tungsten ore,

FIG. 16—NATIVE CHOLO INDIAN CARRYING ORE FROM AN OLD SPANISH MINE

The method of handling is so crude that only about 60 per cent of the ore is saved.

FIG. 17—OPEN CUT WORKING IN MANGANESE MINE

The dark portion at left is ore, the lighter material is rock.

which are apparently a continuation of those of southern Arizona. The known deposits apparently all carry scheelite, which is associated with copper minerals. The Mexican output is given as 187 metric tons of tungsten (doubtless concentrated ore) in 1917, 149 tons in 1918, 22 tons in 1919 and 33 tons in 1920.

Two-Thirds of the World's Supply of Vanadium

Of two other important steel alloys, vanadium and molybdenum, one department of one country supplies a very large part of Latin America's whole contribution. This is the Department of Junin, in Peru, in which the well-known Cerro de Pasco copper mines are located. This department contains numerous deposits of asphaltite, running as much as 500 ft. in length and containing an average of 1 per cent vanadic oxide.

The one deposit, however, which has attracted commercial attention is very much richer in vanadium. It is known as the Minasragua deposit and consists of a lens-shaped bed of mixed hydrocarbon and vanadic sulphide 300 ft. long and with a maximum width yet to be determined but probably between 30 and 40 ft. During the last 15 years this single deposit has furnished from 60 to 85 per cent of the world's supply of vanadium. The bed was originally of interest to miners because of the coal, but the sulphur content was too high to permit profitable exploitation and it had been abandoned when the manager of a nearby smelter discovered, in 1905, that the deposit was rich in vanadium. It was at once denounced and was later sold to an American company, which in turn has recently disposed of it to a company allied with the Bethlehem Steel Co. Since 1907 the total ore produced has carried a content of more than 5,000 tons of pure vanadium. The ore is called "patronite," and analyses give about 20 per cent vanadium and 59 per cent sulphur. The exploiting interests have established a large reduction plant near the deposit in which the ore is calcined to a sulphur content of only about ½ per cent, the vanadic oxide content being raised to 40 or 50 per cent. The Bethlehem Steel Co. plans to increase this, by further treatment, to 85 or 90 per cent before shipping.

The Arqueros silver mines in the Department of

La Serena, Coquimbo Province, Chile, are said to contain lead and copper vanadates, and in the State of Chihuahua, Mexico, the lead ores have been found to contain vanadium. The mineral is also reported from Zacatecas, Guanajuato, San Luis Potosi and Hidalgo, in Mexico. The asphalt of Mendoza and Neuquen, in Argentina, has a high vanadium content. When analyzed the ash has been found to consist almost entirely of vanadium salts, constituting 0.3 to 0.6 per cent of the whole. The Peruvian deposits, however, are the only ones in the world, aside from those in the United States, that are worked commercially.

Molybdenum and Cobalt

Peruvian production of molybdenum is not large, the total to date amounting to only a few tons. The producing deposits are in Juaja Province of the Department of Junín, but others are found in the Departments of Cuzco, Ancachs and Huanuco. The ore averages 5 per cent molybdenite, this being concentrated to 80 per cent for shipment. Molybdenum ores are known in the Mexican states of Sonora, Sinaloa, Oaxaca, Hidalgo and Jalisco, but only in the first named have they been developed to any extent. In the Sahuaripa district pockets of the pure mineral are found, and molybdenite, molybdite and wulfenite are found in lead and copper ores of other districts. In 1918 27 metric tons of ore was produced, in 1919 about 1.7 tons, and in 1920 about 0.6 ton. Bolivia has produced a few tons of

FIG. 18—OLD METHOD OF ORE CRUSHING IS STILL USED FOR TEST SAMPLES. POTOSI, BOLIVIA

molybdenum ore, the mineral being obtained from the Illampu range.

Cobalt is found in two South American countries, but production is spasmodic and of no great importance. In the Chilean Province of Atacama veins of cobalt oxide, arsenate and sulpho-arsenide, in which the ore averages 4 per cent cobalt, have been worked, the chief mines being about 30 miles from the port of Huasco. Rich veins of cobalt ore are found in the silver mines of this province, as well as in Coquimbo and Santiago. In Argentina cobalt ores have been reported from La Rioja and Catamarca.

Titanium and zirconium are found in limited quantities, the former in various parts of Latin America, usually associated with iron ores, and the latter in Brazil. The iron ores of São Paulo, Brazil, are said to be high in titanium and the diamond-bearing sands of Bahia and the monazite sands of the seacoast contain considerable amounts of both rutile and ilmenite. The zirconium of Brazil occurs in two forms, as a free zirconium oxide associated with silica, called baddeleyite or brazilite, and as an oxide combined with silica, known as zircon. The former carries 80 to 85 per cent ZrO_2 and the latter about 65 per cent. The chief deposits are in a mountainous region about 130 miles north of the city of São Paulo. They have not yet been fully explored, but appear to be very extensive. The average zirconium content of the ore which comes from Brazil is about 78 per cent.

Part III, which will discuss the Latin-American resources of the platinum metals, lead, zinc, antimony, bismuth, mercury, mica, monazite, asphalt, graphite, borax, potash and other minor minerals, will appear in a subsequent issue.

Byproduct Coke Operations for 1920

Figures have just been announced by the U. S. Geological Survey showing by states and by classes of coke the production, sales and use at producers' plants of byproduct coke made during 1920.

Of the total coke production, which was about 33 million tons, 26 per cent was sold by the producer and the remainder was used in the producers' plants. This indicates how largely the byproduct coke business is connected directly with the metallurgical industries. Of the sales about half, or 12 per cent of the total coke, was marketed as furnace size; 5 per cent of the total coke was marketed for foundry use, and 7 per cent was marketed for domestic and other similar fuel uses. Of the 7 per cent of the total coke which appeared as breeze or screenings, 2 per cent was sold and 5 per cent was used by the producer.

Reports to the Geological Survey indicate that the value per ton of the coke sold was approximately as follows: Furnace size, $10.57; foundry size, $13.86; domestic, $8.92; breeze, $2.22.

The steady increase in the ratio of byproduct coke plants to beehive ovens is reflected in the figures compiled on the byproducts obtained from coke-oven operations in the same year, shown in the following table:

BYPRODUCTS OBTAINED FROM COKE-OVEN OPERATIONS IN 1920 AND 1921

		1920		1921
Product	Unit	Production	Quantity	Estimated Production (*a*)
Tar	Gallons	360,664,124	174,363,696	233,000,000
Ammonia:				
Sulphate	Pounds	675,816,486	626,013,975	.....
Anhydrous or free ammonia (*b*)	Pounds	65,777,259	62,076,772	.....
Sulphate equivalent	Pounds	(938,925,522)	(874,321,063)	607,000,000
Gas:				
Distributed through city mains	1000 cu.ft.		53,220,824	
Used in steel or affiliated plant	1000 cu.ft.	476,485,744	151,764,807	308,000,000
Used under boilers etc.	1000 cu.ft.		25,430,288	
Light oil and derivatives:				
Crude light oil (*c*)	Gallons	109,709,915	1,067,045	71,000,000
Benzene: Crude	Gallons	8,747,572	1,510,420	.....
Refined	Gallons	16,977,556	15,720,356	.....
Motor fuel (*d*)	Gallons	57,645,462	55,764,265	.....
Toluene: Crude	Gallons	287,142	.....	.....
Refined	Gallons	2,710,649	2,470,364	.....
Solvent naphtha	Gallons	5,678,525	4,695,464	.....
Naphthalene: Crude	Pounds	11,246,807	11,507,703	.....
Refined	Pounds	2,921,282	2,941,059	.....

(*a*) Estimated by assuming that the quantity of the several byproducts obtained bore the same relation to the known production of coke in 1921 as in 1920. The recoveries per ton of coal charged in 1920 were as follows: Ammonia (sulphate or equivalent), 21.4 lb.; tar, 8.2 gal.; crude light oil, 2.7 gal.; gas, 10.8 M cu.ft. (*b*) Mostly ammoniacal liquor, reported in content of NH_3. (*c*) The quantity of crude light oil refined by the producer amounted to 106,564,417 gal. (*d*) The benzene content of motor fuel ranged from 50 to 100 per cent.

Recovering Coal and Coke From Ashes

By William D. Green

MACROSCOPIC examination of the ashes discharged from certain industrial plants reveals the fact that these ashes or cinders contain a large amount of unburned coal as such together with a large percentage of coke.

A representative sample from a cinder pit containing several hundred tons showed by analysis that the ashes contained 57.8 per cent combustible matter and 42.2 per cent ash. The average analysis of the coal from which these cinders resulted is:

	Per Cent		Per Cent
Moisture	2.03	Ash	10.03
Volatile matter	44.00		
Fixed carbon	43.94	Total	100.00
		Sulphur	0.56

The purpose of the work described in this paper is to show that the recovery of the unburned portion of these cinders is possible, and that the product recovered constitutes a valuable fuel.

First Test

A sample of cinders from one of the factories of the Utah-Idaho Sugar Co. was ground to pass a 10-mesh Tyler standard screen having an opening of 1.651 mm. The sample was then treated by flotation in a Janney test machine using a mixture of raw pine oil and Barrett No. 4 flotation oil.

The results of Test 1 given in the accompanying table indicate a fair recovery of the combustible matter—viz., 70.6 per cent—and a satisfactory removal of the refuse—viz., 83.7 per cent. Out of every 100 tons of cinders there would be obtained 47 tons of recovered coal having an ash content of 15.2 per cent and a combustible content of 84.8 per cent.

Second Test

Another portion of the same cinder sample ground as above was treated by flotation in a Janney test machine using a mixture of Barrett No. 4 flotation oil and crude turpentine. Toward the last of the test a small quantity of sulphuric acid was added in order to make a cleaner froth.

The results of Test 2 show a better recovery of the combustible matter—viz., 88.7 per cent. The removal of the refuse is very satisfactory, since the recovery of the combustible matter shows an increase over that of Test 1 amounting to 18.1 per cent.

The tests show that the carbonaceous matter can be removed from cinders with a satisfactory recovery.

RESULTS OF TESTS

	Per Cent By Weight	Analysis—Ash, Per Cent	Analysis—Combustible, Per Cent	Distribution of Original—Ash, Per Cent	Distribution of Original—Combustible, Per Cent
Test 1:					
Original cinders	100	42.2	57.8	100	100
Recovered coal	47	15.2	84.8	16.3	70.6
Refuse removed	53	68.7	31.3	83.7	29.4
Test 2:					
Original cinders	100	42.2	57.8	100	100
Recovered coal	61	16.0	84.0	22.8	88.7
Refuse removed	39	83.2	16.8	77.2	11.3
Test 3:					
Original cinders	100	42.2	57.8	100	100
Recovered coal	61.4	12.9	87.1	18.8	94.5
Refuse removed	37.3	91.6	8.4	81.2	5.5

The small quantity of acid used helped materially both the floating qualities of the coal as well as assisting in the dropping of the refuse. Knowing that the use of acid would be prohibitive in commercial work, it was decided to grind finer before going to flotation.

Third Test

A third portion of the same cinder sample was ground in a ball mill to pass a 20-mesh Tyler standard screen having an opening of 0.833 mm. The sample was then treated by flotation in a Janney test machine using Barrett Salt Lake City heavy oil and after agitating for a few minutes adding a little crude turpentine. The Barrett oil did not produce much froth, but immediately upon adding the crude turpentine a voluminous clean froth formed.

A marked improvement over the other tests is shown in the results of Test 3. Undoubtedly in the coarser material much refuse was held mechanically in the pores of the coke, causing a high ash content. Out of every 100 tons of cinders there would be obtained 61.4 tons of recovered coal having an ash content of 12.9 per cent and a combustible content of 87.1 per cent, the latter being 94.5 per cent of the combustible matter contained in the original cinders.

The recovered coal can be burned as a powdered fuel, mixed with slack or mine run, or briquets.

Midvale, Utah.

Manufacture of Steel Gages

A SECOND meeting[1] of manufacturers and users interested in permanent gages developed the fact that satisfactory results could most probably be had with the proper one of the following steels:

1. Carbon steels; (*a*) 0.85 C, (*b*) 1.10 to 1.20 C, with or without 0.5 Cr.
2. Ball-bearing steel; 1.10 C, 1.40 Cr.
3. Non-deforming steel; 0.90 C, 1.25 Mn, 0.5 Cr, 0.5 W.
4. Case-hardening steel (chromium-nickel).

One manufacturer uses ball-bearing steel for plug gages. In his experience they are free from soft spots, wear very well, and will stand more abuse than carbonized surfaces. Thread gages were made of low-carbon steel, carbonized and heat-treated. Thread gages are more carefully used, because it is evident that they will not stand abuse. After the usual quenching and drawing operations, the gages are rough ground to aid in relief of internal strains. Then the gage is reheated to 20 deg. under the original draw, and slowly cooled. High-class work is drawn a third time, in an effort to completely "season" the piece against subsequent dimension changes.

Another manufacturer uses ordinary machinery steel for thread gages and miscellaneous gages and parts: C 0.20 to 0.30, Mn 0.90 to 1.10, Si below 0.20, P 0.06 to 0.08, S 0.06 to 0.08. Plain plugs and ring gages are made of 1.00 to 1.10 carbon steel. Blanks are normalized after rough forming by heating to 1,475 deg. F. and cooling in oil. Plugs up to $\frac{5}{8}$ in. are carburized in cyanide at 1,425 deg. F., for 10 to 20 minutes, depending upon the size, cooled in air, reheated in cyanide to 1,420 deg. C. and quenched in soluble oil. Larger plugs and rings are carburized in 1 part new charred bone and 2 parts used bone at 1,425 deg. F. for 2 to 5 hours, depend-

[1] See "Permanence of Steel Gages," Chem. & Met. Eng., vol. 26, p. 248 (Feb. 8, 1922).

ing on size, and quenched in oil. Seasoning consists of ten alternate dips in boiling and cold water, each immersion bringing the entire mass to temperature. The chief difficulties experienced in this program is that ring thread gages will change in size excessively, some expanding and others contracting, a difficulty probably due to non-uniform steel rather than heat-treatment.

Thread gages for artillery ammunition ordinarily give a life of about 6,000 tests. Recently some gages which are still good after 50,000 tests were made by the Cleveland Twist Drill Co. of stock steel of the following composition:

Carbon	0.99	Silicon	0.24
Manganese	0.35	Sulphur	0.026
Phosphorus	0.012	Chromium	1.47

These gages were rough machined and annealed at 1,425 deg. F., taking 3 hours to bring the steel up to the heat and holding it there for 7 hours. They were then cooled slowly, after which the gages were finished, then hardened at 1,500 deg. F., quenched in oil and drawn to 350 deg. F.

They were heat-treated to produce a fine structure in the annealed condition. They machined easily, hardened uniformly without appreciable distortion and when finished had a smooth surface capable of resisting wear due to friction.

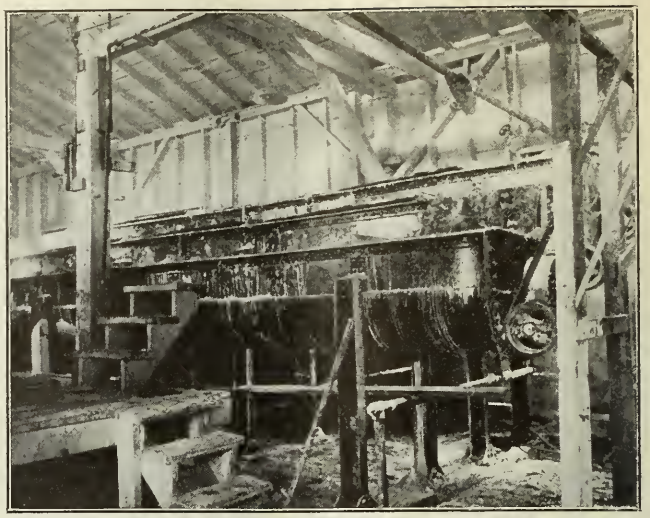
The analysis is close to that of the steel used in the races of the best ball bearings. It is not a high-priced steel, has a wide heat range, low risk in heat-treatment, changes but little in hardening or afterward, and the tools that are made from it are extremely tough. A thread gage made from this steel should cost less than one of machinery steel, pack-hardened, because the cost of pack-hardening would be more than the difference in the cost of the steel. Pack-hardening, if at all satisfactory, requires not less than 8 hours, while a gage made of the steel mentioned can be satisfactorily hardened in 10 minutes.

By accident, when these gages were made, the manufacturer left only 0.005 on pitch diameter for finish after hardening, but the gages cleaned up and took a very good finish. This shows conclusively that the steel used showed no appreciable change in hardening.

Improved Type of Continuous Crystallizer

Among the newer forms of chemical plant equipment designed for economy in operation is the Swenson-Walker continuous crystallizer shown in the illustration herewith. The internal moving parts of this device scrape across the internal semi-cylindrical surface of the troughs with such a small margin of clearance that caking on the surface is made impossible. The movement is sufficiently slow that the material which is crystallizing in suspension is not moved fast enough to produce much more than a minimum of fine material, while the shape of the flights is such as to produce a very slow, easy, forward movement of the entire mass of material at a rate just commensurate with the production wanted.

Tests carried out on the apparatus operating on the production of trisodium phosphate showed a weighed production of exactly 10,000 lb. in 12 hours, with an excess production in the form of crystals in process which were not present at the beginning of the 12-hour run. The effort was then made to test out the apparatus for continuity of operation and without any difficulty a run of approximately one week was carried through at or above the rated capacity of 10 tons per hour.



THE SWENSON-WALKER CONTINUOUS CRYSTALLIZER

The power consumed for the above-mentioned tonnage was only within the normal load of a 2-hp. motor. The water consumption for cooling was less than 5 gal. per minute, due to the fact that the entire apparatus is set up to run on the principles of a counter-current heat exchanger, and where it is possible to arrange the heat balance of a chemical plant properly, there is actually a very small amount of heat lost when using this system. This is particularly true due to the fact that the flow of cooling water, as well as the production of crystals, is continuous.

The question is often asked with reference to crystallizing problems whether a larger crystal can be obtained. The answer to this depends on the comparison which is made, but in the present instance it was found that instead of the previous figure of 65 per cent of the crystals being held over a screen of a certain size, the uniformity with which the crystals were produced raised this figure to 85 per cent. In other words, the dry fines produced in the plant were not over 45 per cent of the previous production, the fine material in this case, as in a great many others, being of far less market value.

The entire crystallization process need occupy only a part of the time of one man.

Recent Work on Reclamation of Molding Sand

The American Steel Foundries Co. has permitted a representative of the Molding Sand Research Committee to make a digest of the sand reclamation work carried on by its engineering staff.

After experimenting on different lines and thoroughly going over methods employed in other plants, a process of reclaiming old sand called "centrifugal scrubbing" was developed.

After establishing the principle of this method, equipment was designed which permits a recovery of about 70 per cent of refuse sand. Cost figures for 1921 show that a ton of reclaimed sand costs about $1 against the cost of new sand at the plant of $2.65 to $3.85 a ton. The process involves cleaning the sand grains of adhering fused material, then separating by air currents the good sand from the bad material.

The report covers the theory of sand reclaiming, centrifugal air-scrubbing process, cost of reclaiming sand by the latter process, and a description of the proposed sand-reclaiming unit.

Static Electrical Charges Detected by Neon Tester

By B. E. Shackelford, Ph.D.
Physicist, Westinghouse Lamp Co.

NEON, one of the rare gases of the atmosphere, has recently been made to serve as the basis of a convenient indicating device for the testing of high-tension electrical circuits. It now appears that this device, which was originally developed as an ignition gage for gas engines, may have a wide variety of uses in fields far removed from that of the automobile. The neon tube is especially sensitive to static electricty, and it may prove of great utility in detecting such charges in chemical plants and other factories where static electricity is regarded as a dangerous source of trouble.

During the last few years there have been many instances[1] of fires and explosions in mills, elevators and chemical factories caused by the discharge of static electricity which had gradually accumulated in the presence of flammable dust or vapors. Recently there was described in the columns of this magazine an explosion[2] of an agitator which was being filled with naphtha. Apparently this explosion was caused by the fact that the naphtha had become charged with static electricity while being pumped through pipe lines. The recent investigations of the Bureau of Chemistry and of the U. S. Grain Corporation have shown that one of the major fire and explosion hazards around grain elevators, flour mills, aluminum-powder factories, rubber plants, etc., is the accumulation of static electricity. It is, of course, always intended that such static charges be drained off by ground wires, but it is a fact that this desired end is not always attained. Pulleys, belts, grinding equipment, revolving reels and similar types of equipment are the most likely sources, and attention is usually given to their proper grounding. Sometimes, however, static accumulates in places where it is unsuspected and at other times it is found in places which are difficult to ground.

Description of the Neon Detector

The type of detector developed by the Westinghouse Lamp Co. and marketed under the trade name "Spark C," is an adaptation of the familiar Geissler tube. It is well known that the discharge of electricity through any such tube yields a glow, the color of which depends primarily on the gas contained in the tube. Pure neon is used in this instance both because of the ease with which it passes an electrical discharge and also because of the resultant color, a bright orange red. Even in daylight and with only a very small current passing, the resulting neon glow is quite marked.

The neon-filled Geissler tube is suitably mounted in an insulating casing of convenient size and provided at one end with a small metal contact tip and at the other end with a small condenser plate. The capacity of this plate to ground is sufficient for the current necessary for operation so that when the tester is brought near a live high-tension line or is touched to a body statically charged, the characteristic neon glow becomes visible.

The neon tube of the standard device operates at any voltage above 350 volts, but in the mounting one lead is connected only to the condenser and this increases the voltage requirement somewhat so that the complete device begins to glow at about 700 volts of any ordinary frequency. Certain factors of design also affect the operating voltage to a certain extent.

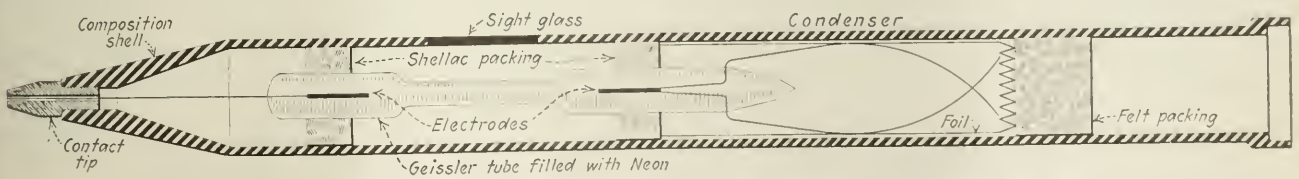
Static charges, although they may contain comparatively little energy, have usually a very high voltage to ground and consequently give a brilliant glow in the tube. It should be noted that the glow is exhibited each time a current passes; with rapidly alternating current there is an apparently continuous flash. In the case of static there is a glow when the discharge passes through the tube to the condenser and another glow when the condenser is discharged by touching the point to the hand or to any other ground.

An indication of the sensitiveness of this device may be obtained by walking across a rug and touching the tip to a radiator, metal desk or other grounding device. The tester may also be made to glow by rubbing it with a piece of wool or, on particularly dry days, even by bringing it near the body. At other times a greater frequency of glow may be obtained by simply moving it near to and away from some portion of one's own clothing; a discharge will be noticed as the tester passes over particularly localized charges on the material. This great sensitivity is very useful in detecting static, and accordingly the field of application is quite extended.

Its Uses in Chemical Plants

It is possible for a most inexperienced workman to use this neon device to test out each portion of the equipment in a chemical-manufacturing plant as well as all parts of the conveyor systems, grinding and milling machinery, etc. It is usually found that although a system may apparently be well grounded, there are a number of places where there is a sufficient static charge to give an indication with the tester. The inspector, having it with him on his inspection trips, can immediately locate the sources of possible trouble and see that they are eliminated.

In certain cases it is advantageous to drain off the static through the tester itself, connected directly to the ground wire. As soon as sufficient charge has accumulated to raise the voltage to approximately 350 volts, the tube flashes and calls attention to the presence of trouble. In this way there is available at all times an indicator of the rapid development of charges which otherwise might not be detected as soon as desirable.



A SECTIONAL VIEW SHOWING CONSTRUCTION DETAILS OF NEON TESTER

[1] See articles by David J. Price, Chem. & Met. Eng., vol. 24, pp. 29, 473 and 737 (1921).

[2] "Explosion of Agitator Charged With Naphtha," Chem. & Met. Eng., vol. 25, No. 21, p. 949, No. 23, 1921, and vol. 26, No. 1, p. 4, Jan. 4, 1922.

Physical Laboratory,
Bloomfield, N. J.

Synopsis of Recent Chemical & Metallurgical Literature

The Oxidation of Ammonia.—The *Journal of the Society of Chemical Industry* (vol. 41, No. 4, p. 37T, of Feb. 28, 1922) contained a report of recent work conducted by the United Alkali Co. on the catalytic oxidation of ammonia for supplying oxides of nitrogen to its chamber sulphuric acid plants and in the production of nitric acid. The former application has been so successful that it is now installed at all the chamber plants of the company. The latter is not being used at present because of the prohibitive cost of concentration of the weak nitric acid produced.

The converter used in connection with the acid plant at Widnes, which has a capacity of 250 tons of O.V. per week, was made of aluminum and consisted of a square base with two inlets and a tapering hood connected with an aluminum bend. An electrically heated gauze was used at first, but was soon replaced by an unheated fourfold gauze. It was also found that aluminum was not suitable for the construction of the converters, as its melting point is dangerously near the proper conversion temperature. Cast iron seemed satisfactory for the hood except for the risk of rust particles dropping on the gauze. Enameled iron was found to be entirely satisfactory and later it was found that iron could be satisfactorily and cheaply protected by painting while hot with Seller's cement, a mixture of sodium silicate solution and barium sulphate. The gauze was 6 x 4 in. cross-section, each gauze being woven of platinum wire 0.065 mm. thick, 80 mesh to the inch, the four pieces being stitched together with platinum wire. The gauze is carefully cleaned before fixing in the converter by boiling in hydrochloric acid and washing with distilled water.

With a plant of this type, with no preheating of the gas, conversions by analysis of 86 to 89 per cent were obtained. The capacity of this unit was limited to about 25 lb. of sodium nitrate per sq.in. of platinum per day. Any attempt to increase the speed of the gas beyond this limit led to a falling off in efficiency and the appearance of ammonium nitrate and nitrite in the condensite. In an attempt to improve this yield a preheater was designed to utilize the heat in the exit gases for preheating the gas. It has an internal diameter of 12 in. across the tube plates, with 7 tubes each 2¾ in. mean diameter and 2 ft. long. The tubes are either enameled or painted with Seller's cement. The inlet gas temperature is raised to about 300 deg. C. in the heat interchanger and the yield of the unit is increased to about 93 per cent as shown by the gas test.

It is reported that one platinum gauze was used continuously for 18 months before failure occurred at the point where it is held in the frames; another was used for 16 months before it was accidentally broken by a fitter, and others have worked for over a year and are apparently in good condition. The loss of platinum varies from 0.002 to 0.04 oz. troy per ton of 100 per cent nitric acid produced. In addition to this, allowance must be made for the depreciation of platinum, owing to the difference in the price between new platinum and scrap. With new platinum at £22 10s. per oz. troy and scrap at £19 10s., a fair allowance per ton of equivalent sodium nitrate for chamber working is 9d. for depreciation and 9d. for platinum loss, or a total of 1s. 6d. per ton.

The quality of ammonia used throughout has been commercially pure 25 per cent liquor from coke ovens or gas works, free from sulphides. It is stated that more risk of danger to the platinum exists from traces of iron rust than from any impurities normally to be expected in the ammonia.

The plant for the manufacture of nitric acid consisted of a converter with 6 x 4 in. gauzes, identical with those described above, coupled up with a set of towers belonging to an ordinary nitric acid unit. The absorption system consisted of three earthenware towers 3 ft. in diameter and 16 ft. 3 in. high, packed with rings and balls, followed by two smaller towers 2 ft. by 11 ft. high, packed in the same manner. Water or weak acid was circulated over the first three towers by means of air lifts, while a solution of soda ash or caustic liquor was circulated over the last pair of towers. Additional secondary air beyond that introduced by the air lifts could be introduced into the first tower if desired. The gases were cooled before entering the first tower by passing through a gallery of silica pipes. The total condensing space in the unit was 417 cu.ft., but an additional tower was later added at the front of the system to give increased oxidizing space, and this increased the total tower space to 533 cu.ft. Without a heat interchanger this plant produced the equivalent of about 1 ton of 100 per cent nitric acid per week, the acid being actually obtained at about 50 per cent HNO_3 with an overall yield of 78 to 79 per cent, of which 5 to 6 per cent was in the form of sodium nitrate from the final scrubbing towers. After the introduction of the heat interchanger, the output of the plant increased to the equivalent of about 1¾ tons of 100 per cent nitric acid per week with a yield of over 84 per cent. The acid was concentrated in the usual concentrating tower, using sulphuric acid as a dehydrating agent.

Sulphur and Oxides in Ordnance Steel.—W. J. Priestley, steel superintendent of the U. S. Naval Ordnance Plant, read a paper on this subject before the February meeting of the American Institute of Mining and Metallurgical Engineers. He noted that steels having high transverse ductility have not been made successfully in the basic open hearth, despite that furnace's ability to reduce phosphorus; consequently it has been usual to specify the acid process, although it requires low sulphur and phosphorus melting stock. The U. S. Naval Ordnance plant has been very successful in making steels by duplexing, as follows:

Pig and scrap (60:40 ratio) with 8 per cent limestone and

TABLE I—EFFECT OF SULPHUR AND OXIDES IN ORDNANCE STEEL

	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Phosphorus, Per Cent	Sulphur, Per Cent	Nickel, Per Cent	Tensile Strength, Lb. Sq. In.	Elastic Limit, Lb. Sq. In.	Elongation, Per Cent	Reduction in Area, Per Cent
Forging, 16 in diam., by 9 ft. long, 8½ in. bore; weight 5,000 lb. Average results from 10 forgings (or 20 bars) of each class										
Open-hearth steel*	0.36	0.66	0.23	0.04	0.039	2.98	98,013	57,720	20.4	36.9
Electric steel	0.34	0.64	0.22	0.012	0.008	1.16	95,435	64,010	24.5	58.3
Physical requirements	....	....	....	....	....	....	80,000	50,000	21.0	30.0
Forging, 11 in. diam. by 28 ft. long, 7½ in. bore; weight 6,000 lb. Average results from 10 forgings (or 40 bars)										
Open-hearth steel	0.37	0.65	0.21	0.040	0.044	3.02	104,785	73,162	19.6	39.4
Electric steel	0.30	0.67	0.179	0.012	0.009	2.81	96,995	67,785	24.2	55.9
Physical requirements	....	....	....	....	....	....	90,000	55,000	18.0	30.0
Forging, 9 in. diam. by 28 ft. long, 5½ in. bore; weight 4,000 lb. Average results from 10 forgings (or 40 bars)										
Open-hearth steel	0.38	0.64	0.206	0.039	0.040	3.09	103,185	73,231	19.2	39.9
Electric steel	0.34	0.65	0.212	0.014	0.012	2.87	100,340	72,610	23.2	52.5
Physical requirements	....	....	....	....	....	....	90,000	55,000	18.0	30.0
Forging, 26 in. diam. by 2 ft. long, 5 in. bore; weight 4,000 lb. Average results from 5 forgings (or 15 bars)										
Electric steel*	0.37	0.54	0.182	0.020	0.026	2.66	110,182	67,067	17.8	37.1
Electric steel	0.35	0.72	0.169	0.006	0.008	2.91	108,681	77,038	20.2	49.3
Physical requirements	....	....	....	....	....	....	95,000	65,000	18.0	30.0
Forging, 9 in. diam. by 28 ft. long, 5½ in. bore; weight 4,000 lb. Average results from 10 forgings (or 40 bars)										
Electric steel*	0.39	0.53	0.16	0.020	0.025	2.65	95,245	64,979	19.3	37.0
Electric steel	0.34	0.64	0.21	0.014	0.012	2.87	100,340	72,610	23.2	52.5

*These ingots were made by a private industrial plant during the war.

enough ore to lower the carbon to 0.25 is charged in a 75-ton basic open-hearth furnace. On tapping it contains C 0.23, P 0.007 and S 0.016; 2 lb. of 50 per cent ferrosilicon and 3 oz. aluminum per ton are added to prevent any oxides reacting with the carbon before the molten steel can be teemed into the two 40-ton electric furnaces. Here a new slag is made up of burned lime, fluorspar and coke, and adjusted from time to time; its total weight amounting to about 2,500 lb. The bath is held in a reducing atmosphere for 3 to 5 hours, and the finished steel contains C 0.32 to 0.40, P about 0.01 and S less than 0.01 per cent.

In the electric furnace, any oxides in the steel are rabbled to the top, and are reduced to metal by the carbon in the slag. When these reactions are complete, calcium carbide may form, which reacts with FeS or MnS, forming CaS, which is absorbed by the slag. It is important to remember, that deoxidation is preliminary to desulphurization, and it may be inferred that an electric heat which has markedly reduced sulphur has also produced a deoxidized metal.

Such steels appear to have a minimum number of slag inclusions, of one size and appearance—namely, minute round specks. High-grade acid open-hearth steel has, in addition, larger sheets or fibers of slag drawn out in forging. Basic steel includes both types of inclusions, but the elongated masses appear more brittle and badly shattered. Table I shows the excellent ductility in transverse specimens taken from large gun forgings made by the Naval Ordnance plant of duplex electric steel, as compared with acid open-hearth or basic electric furnaces from other sources, but possessing identical analysis except sulphur (and, inferentially, oxide).

The paper includes a very interesting discussion of the relative merits of electric and open-hearth steel, and detailed information on slag and metal analyses at various stages of the process.

Recent Chemical & Metallurgical Patents

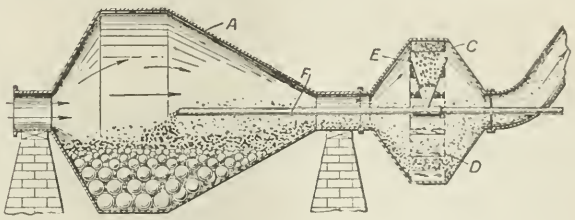
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Tanning.—A process of tanning consists in treating the hide with an arsenic compound which, if insoluble in water, has been rendered soluble or colloidal. In one example, a tanning agent is prepared by adding to a suspension of an insoluble compound of arsenious, arsenic, sulpharsenious, sulpharsenic, phenylarsinic or diphenylarsinic acid or arsenophenol a sufficiently large proportion of an alkali salt to produce a colloidal solution. In another example, the hide is treated with a free organic sulphonic acid of a hydrocarbon or with a synthetic tanning agent obtained by condensation and suphonation of a phenol and hydrocarbon used as a solvent for an arsenic compound, particularly a heavy metal salt of arsenious or arsenic acid. (Br. Pat. 171,693; not yet accepted. Gerb- und Farbstoff-werke H. Renner & Co., Hamburg. Jan. 11, 1922.)

Synthetic Tanning Agents.—Tanning agents are obtained by sulphonating the resinous condensation products prepared from phenols and formaldehyde with the aid of basic condensing agents. Starch, sugar, glucose or materials containing them may be mixed with the parent materials or the resins before the sulphonation. The sulphonation may be carried out so as to yield either readily soluble products or products which are sparingly soluble or insoluble. The readily soluble products have the property of solubilizing the sparingly soluble products or the unsulphonated resins or the insoluble phlobaphenes contained in vegetable tanning agents, and the resulting colloidal solutions may be employed as tanning agents. The process may be carried out by sulphonating one portion of resin to give an easily soluble product, sulphonating another portion to give a sparingly soluble or insoluble product, and mixing the two; or the process may be conducted so as to give first an insoluble product and solubilize this by further sulphonation; or an easily soluble sulphonation product may be mixed with the resin and the mixture sulphonated; or the resin may be sulphonated under such mild conditions that only a portion is sulphonated. The alkali salts of the sparingly soluble sulphonic acids dissolve the insoluble sulphonation products, and the resulting colloidal solutions may be used for tanning. In making the parent resins, the crude reaction product resulting from the alkali fusion of a sulphonated hydrocarbon may be used; ammonia of an ammonium salt, such as the sulphate, may be added to the alkali fusion to give ammonia for the condensation. Any of the tanning agents described above may be improved by oxidation—e.g., by means of atmospheric oxygen, ozone, hydrogen peroxide, potassium bichromate, permanganate, perchlorate, perborate or persulphate, chlorine or nitric acid, or by electrolytic oxidation. According to examples, phenol is heated with formaldehyde solution and aqueous ammonia, aniline, caustic soda or sodium carbonate, the resulting resin is sulphonated by concentrated or fuming sulphuric acid, the product diluted with water and free sulphuric acid neutralized by alkali; crude cresol or α- or β-naphthol may be substituted for the phenol; starch, molasses or concentrated or dry sulphite cellulose lye may be added to the above initial materials before condensation and sulphonation; mixtures are prepared from an easily soluble and an insoluble sulphonic acid, an easily soluble sulphonic acid and a non-sulphonated resin, an alkali salt of an insoluble sulphonic acid and the free sulphonic acid, an easily soluble sulphonic acid and quebracho extract; examples are also given of the use of alkali melts of resorcin and naphthols. (Br. Pat. 171,729. Gerb- und Farbstoff-werke H. Renner & Co., Hamburg. Jan. 11, 1922.)

Classifying Ground Material.—The patent describes an apparatus for treating ground materials, pulps or slimes for the separation of the fine material from the oversize and comprises a rotary vessel *C* fitted internally with scoops *D* which pick up the larger particles from the bottom of the vessel and pass them into a hopper *E* leading into a pipe *F* from which they are discharged by means of



a current of liquid or gas or both. The apparatus is preferably combined with a grinding-mill *A* to which the oversize is returned by the pipe *F*, while the fine material is discharged from the vessel *C* with or without the aid of a current of air; or, in the case of a mill for wet grinding, the fine material is allowed to overflow with water from the outlet of the vessel *C*. (Br. Pat. 172,525. H. W. Hardinge, London. Feb. 1, 1922.)

Nitric Acid.—In the preparation of nitric acid from the gases obtained by the oxidation of ammonia, a portion of the gases is absorbed in towers in water or dilute nitric acid and the remainder is liquefied by refrigeration. After a preliminary cooling, during which no condensation occurs, the gases from the furnace are passed through coils or other acid-proof apparatus, cooled by means of cold water, to condense as much as possible of the water present and to give a dilute solution of nitric acid. The uncondensed gases then enter towers fed with water or the dilute acid obtained as above described by condensation. Before the unabsorbed gases are liquefied they are dried by treatment in one or more washing towers with liquid nitrogen peroxide, in the manner described in specification 164,734. The acid obtained by absorption of the nitrogen oxides in dilute nitric acid is treated finally with the liquid nitrogen oxides obtained by refrigeration of the unabsorbed gases. (Br. Pat. 172,979; not yet accepted. C. Rossi and C. Toniolo, Legnano, Italy. Feb. 8, 1922.)

Book Reviews

THE DISTRIBUTION OF GAS. By *Walter Hole.* Fourth edition, rewritten and greatly enlarged. London: Benn Brothers, Ltd. 700 pp., 749 illustrations. Price 50s. net.

This fourth edition of the standard work by Hole requires no introduction to American gas engineers. The author has apparently made a very thorough job of revision and has extended the work materially beyond the form in which the third edition appeared 8 years ago. Particular attention has been given in the new edition to the domestic use of gas and two entirely new chapters have been introduced, one on "The Industrial Uses of Gas" and the second on "Inferential Meters."

The volume represents an extended review of the standard English gas engineering practice. For the young gas engineer it is a most complete text book; for the experienced engineer it is a convenient reference volume for many details which cannot readily be borne in mind even by the most experienced operator. However, for an engineer in American gas practice the volume does not approach in value its undoubted merit for the English operator. Practice in the two countries is notably different in many respects and the usefulness of the volume in the United States is thereby seriously curtailed. It will, however, form a valuable reference book in the library of any gas engineering organization, as it is very suggestive of methods and equipment which must be considered in any new developments. However, for American operation it should not be trusted too fully in detail.

As in the earlier editions, the volume is addressed almost solely to those engaged in the production or distribution of public utility gas supplies. It will find little use in the library of the chemical engineer, as the methods and apparatus described are limited almost altogether to those involved in public utility practice. R. S. McBride.

* * *

ECONOMICS OF PETROLEUM. By *Joseph E. Pogue.* New York: John Wiley & Sons, Inc. 375 pp., 151 figures. Price $6.

"The purpose of this book is to present, in perspective, the more important economic facts relating to petroleum; to interpret the changes that are rapidly taking place in this field; and to project the trend of these changes into the immediate future." Thus the author states the object of this volume at the beginning of his preface. And rarely does one find an author who has so satisfactorily accomplished his purpose as has Pogue in the present work.

The author takes the industry from its broad economic foundations through to the intimate detail of the various special products from petroleum, and paints for the reader in true proportion a picture of the entire petroleum industry. Not alone does the picture include the business of the industry itself, but it also shows clearly the relation of the problems of petroleum production, transportation, refining and marketing to each of the important related industries which are users of petroleum products. This presentation of the industry and the related industries is done in a simple, clear way without that distortion or bias which has so commonly destroyed the principal value of otherwise worth-while contributions to the literature of the oil business. In this case the author brings a wide experience and intimate knowledge of the fundamentals of the business to his task without giving any evidence of partiality for producer, refiner or user, an accomplishment which makes his book a most valuable contribution to the subject.

Although written strictly from the standpoint of statistics and economics, the author does not allow these tools of industry to become an end in themselves. His analysis and graphical presentation of the important figures which are essential to an understanding of the business have been accomplished in a simple fashion but without sacrifice of accuracy. Thus the economics are given very practical value and the statistics made really useful in the service of industry.

The author is to be strongly commended for his use of large units in presenting the data instead of presenting nine or ten significant figures in most cases where it is well known that only three or at the most four figures really have any meaning. Thus in practically every case "the unit has been so chosen that the data could be expressed by three digits with a decimal point if necessary." The extensive use of graphical methods for presentation also is most satisfying. In this particular the volume is exceptionally useful to the reader who wishes to get quickly an approximate idea of trends in the industry. Moreover the graphical presentation in almost every case has been made without resort to complicated charts of obscure meaning.

The mechanical form of the book quite justifies the writer's expression of appreciation to those who have assisted in the mechanical preparation of the work. The author is particularly to be commended upon the use of running heads on the pages which mean something. Thus one can identify the major subject of a chapter by the heading of the left-hand pages and subdivision of the subject under discussion by the right-hand page heads. This is a very practical advantage, particularly in a volume such as this which discusses many detailed phases of a single broad subject.

The volume represents a most comprehensive consolidation in systematic form of the fragmentary information and data which have been scattered through much valuable literature of the past few years. It will now be available to a wide variety of readers in a convenient reference text. A great deal of the value of the book is the fact that it presents data from quite recent periods, in some cases extending well into or through 1921. Being to a large extent statistical in its nature, it is to be hoped that the author will find opportunity to prepare new editions at frequent intervals. If this is done, it seems certain that the work will become a standard text, not only with reference to the petroleum industry itself, but also in connection with the great problem which the author cites, "the coming necessity for increasing the over-all efficiency of petroleum—a problem that concerns not only the producers and refiners of oil but the manufacturers of appliances that consume its products as well."

The author might well have added at this point reference to those who use this fuel-burning equipment, for in many cases the user of petroleum products will find quite as much of value in this volume as will the producer. This is true of those in the natural gas, manufactured gas, automotive, oil-shale and many other related industries. The problems of each of these, in their relation to the petroleum business, is clearly set forth, and accurately interpreted in this work.

R. S. McBride.

* * *

AN INTRODUCTION TO THE ANALYTICAL CHEMISTRY OF THE RARER ELEMENTS. By *Louis J. Curtman, Ph.D.*, assistant professor of chemistry, chief of the division of qualitative analysis, College of the City of New York. 64 pp. New York, 1922. Published by the author. Price $1.25.

With the increasing industrial importance of the rarer elements has come a realization of the necessity for extending the usual courses in analytical chemistry so that the student may become familiar with the characteristic properties of this group of elements.

Dr. Curtman has prepared a sound foundation for this work by gathering together the characteristic tests for each of the rarer elements. All the reactions have been tried out carefully in the laboratory in order to eliminate those errors which somehow creep into the literature and are carried along with other data. The twenty-nine elements which are considered in detail are classified according to the usual analytical groups, but although some distinguishing tests are mentioned, no scheme for the separation of individual elements within a group has been included. It is to be hoped that Dr. Curtman will supplement this introductory text with one giving the analytical procedure for making such separations. Alan G. Wikoff.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Senate's Draft of Permanent Tariff Changes Duties on Certain Chemicals

In the tariff bill, which the Finance Committee has just reported to the Senate, the dye and chemical embargo is to be extended for 1 year from the passage of the act.

Among the other changes made in the House bill are the following: The specific duties on acetic anhydride reduced from 8c. to 5c., boric acid reduced from 2c. to 1½c., citric acid increased from 12c. to 18c.

There were slight increases in the lactic acid rates. Arsenic acid was made dutiable at 3c. per lb.; white arsenic, 2c.; formic acid, 4c.; gallic acid, 8c.; red oil, 1½c.; oxalic acid, 4c.; phosphoric acid, 2c.; pyrogallic acid, 12c.; stearic acid, 1½c.

The specific duty on potassium aluminum sulphate was reduced to ¾c. a lb., but the ad valorem rate for all other aluminum compounds was increased from 25 to 35 per cent. Amyl, butyl and isopropyl alcohol were made dutiable at 3c. per lb. Fusel oil was reduced from 6c. to 2c. per lb.

The rates covering ethyl and methyl alcohol were reduced from 15c. to 10c. per gal. Ammonium nitrate was put on the free list. Oxide of antimony was made dutiable at 1½c. per lb. and 25 per cent ad valorem. Gum arabic was taken from the free list and made dutiable at ½c. per lb. Half a cent was added to the rate of barium chloride. Barium hydroxide was inserted in the bill with a rate of 1¾c. per lb. The barium nitrate rate was increased ½c. The rate on barytes is fixed at 1¼c. per lb. Bismuth compounds were increased from 25 per cent to 35 per cent ad valorem.

As had been previously announced, intermediate and finished coal-tar products were made dutiable at 50 per cent ad valorem and 7c. per lb. and 60 per cent ad valorem and 7c. per lb. The ad valorem rates were increased from 30 to 50 per cent and from 35 to 60 per cent respectively. The bill instructs the Secretary of the Treasury to prepare standards of strength for each dye.

Compounds of cellulose were added to the bill and made dutiable at 35 per cent ad valorem. Potassium and sodium cyanides are made dutiable at 10 per cent ad valorem. The ad valorem duty for formaldehyde was stricken out and specific duty of 2c. per lb. inserted. A rate of 8c. per lb. is provided for solid formaldehyde and 10c. per lb. for hexamethylenetetramine. The rate on refined glycerine is reduced from 3c. to 2c. per lb., bromine is dutiable at 5c. per lb. and bromine compounds at 8c.

Duties on oils are fixed as follows: Coconut oil, 4c.; cottonseed oil, 3c.; peanut oil, 4c.; soya bean, 3c., the latter to be admitted free if it is to be used in the manufacture of articles unfit for food. Copra, palm nuts, rapeseed and other oil-bearing seeds and nuts were added to the free list, as was nitrate of potash.

England Stands Firm on Dye Protection

A recent attempt to repeal the British dyestuffs protective legislation failed in the House of Commons by a fairly large majority. In moving the repeal of the legislation it was charged that British Dyestuffs, Ltd., had furnished only very inferior products at very high prices and that the consuming trades were being seriously hampered by lack of satisfactory colors. The government warmly defended both the company and the protective laws.

New Chemistry Building for University of Missouri

The University of Missouri, Columbia, Mo., has taken bids and will soon award a contract for the erection of a new chemistry building at the institution, to cost $125,000.

Action of Senate Finance Committee in Extending Embargo Has Encouraging Features

While the action of the Senate Finance Committee in deciding to recommend the extension of the embargo on certain dyes and chemicals for 1 year is a disappointment in view of the inadequacy of the time period, the significant feature of the committee's action is the acceptance of the embargo principle. Moreover, it is confidently expected that either the time period will be extended by action on the floor of the Senate or the President will be empowered to extend it if he should deem it necessary. The hope is expressed that the Finance Committee itself will include such a provision in its bill.

It is pointed out that the President has at hand the service of the entire administrative machine to determine whether or not the embargo should be extended. The feeling among chemical manufacturers is that any impartial and intelligent survey of the situation will develop the absolute proof that the embargo must continue if there is to be vigorous development of the new organic chemical industry. If such a provision is placed in the bill, it is believed that development will go forward with full confidence that the requisite protection will be forthcoming.

In that connection it is pointed out that provision must be made for the establishment of a well-equipped laboratory, manned by experienced chemists, to aid the dye and chemical division of the Treasury Department. The customs service must have this adjunct, it is declared, to enable it to guard against false concentrations, undervaluation and false labeling.

Another Week of Sideshows at the Dye Investigation

There is now no doubt in anyone's mind, even including Senator King's, that the stories of an American dye monopoly are fairy tales. The investigating committee is being treated to many sidelights and personal animosities which if one is detached from the industry may have a slightly humorous flavor. All of the old tariff fights are being reviewed and some new attitudes are occasionally developed. On the whole the conduct of the investigation leaves a good taste in one's mouth. It has progressed fairly rapidly and the conclusions are likely to be definite.

Exoneration of Dye Makers Expected

That the Shortridge committee will exonerate the manufacturers of dyestuffs of the charges which were made against them is evident. The record will be unique in Congressional annals, for never before have such sweeping charges been made against any group and been subsequently found to contain so little meat. It is really one of the best things that could have happened to the industry, for it shows it in an extremely favorable light. It has given the organic chemical manufacturers an opportunity to spread on record a full account of their history and their needs. Nothing could have been more salutary for the industry than the necessity of showing its inmost soul to the public and the legislature. Its needs now come into stronger light than they did in the Senate and House committee rooms. The veiled and open hints that there was a monopoly which were freely used at those times by opponents of the industry are completely and forever eliminated by this investigation.

Prominent Textile Man Testifies in Favor of Embargo

Henry B. Thompson, president of the U. S. Finishing Co. and also president of the American Association of

Finishers of Cotton Fabrics, chairman of the Dye Advisory Committee of the War Trade Board and member of the Dye Committee of the Textile Alliance, testified at some length last week. His company manufactures 300,000,000 yd. of cloth per year and operates plants in Connecticut and Rhode Island. He took occasion to deny the charges made by Senator King that he had in any way benefited by his membership on the dye committees. He further stated that Mr. Poucher of the du Pont Co. did not dominate the committees, an additional charge from Senator King. He then went on to analyze the opposition to the dye embargo. There are three main groups. The first consists of the manufacturers of textiles who are selfishly interested in obtaining lowest prices for dyes. The second group is small but noisy. It is composed of manufacturers who are anxious to obtain a special color "without which their industry will perish from the face of the earth." Mr. Thompson did not think the position of these manufacturers was at all justified. He said that his company had been able to accomplish all of its numerous dyeing effects with American colors pieced out with German reparation dyes obtained through the Textile Alliance. The third group is the friends of the importers who will sign anything which the importers put in front of them.

Opposition to Dye Industry Will Drive Consumers Into the Hands of the Cartel

Mr. Thompson could not understand why adequate protection to the organic chemical industry should be opposed, when such opposition, if successful, would land us with the hands of the German dye cartel at our throats. In reply to a question by Senator Shortridge Mr. Thompson said that he was convinced that a protective tariff would not adequately protect the industry.

He presented some interesting figures on the price of about eighteen dyes which his company purchases on a competitive basis and showed that the price within the last 18 months had dropped 50 per cent as a result of the strenuous competition. This certainly indicated the reverse of a monopoly. In conclusion he said that users of dyes generally supported the present legislation and that the cotton industry as a whole would welcome its continuation.

Herty's Accuracy and Motives Attacked by Members of Metz' Staff

He was followed by Eugene R. Pickerell, of the staff of Herman A. Metz, who began by attacking both the accuracy and the motives of the report submitted by Charles H. Herty, president of the Synthetic Organic Chemical Manufacturers Association. The report makes five points: 1. The German pre-war prices of dyestuffs were no less than those obtained on the home market during 1921. 2. Variations in the home market price averaged 356 per cent. 3. Export sales prices varied 617 per cent during the same period. 4. German export prices to the U. S. were three to fourteen times the pre-war prices. 5. Germany can manipulate prices so as to offset the protection given by any duty.

Dr. Pickerell stated that these figures were not fair, that they represented eighty dyes picked out to show maximum variations, that the variations were entirely due to fluctuating exchange and that while many of the German dyes were down to pre-war basis the American dyes were selling at three times the pre-war values. He further states that the American toy and surgical instrument industry has more difficult problems to face than the dye manufacturers.

The dye manufacturers will answer these statements at the hearings this week.

Metz Fails to Produce Evidence That the Dermatological Institute Is a Commercial Organization

To the unbiased observer this particular controversy must seem irrelevant to the main subject and rather inspired by a personal malice than by an earnest desire to see justice done. The testimony of Jay F. Schamberg, director of the institute which manufactures salvarsan, was given last week. He was cross-examined by A. C. Vandiver, attorney for H. A. Metz. The substance of the cross-examination was to prove that the Institute should not be exempt from income taxes, since it was competing in the market with commercial firms. It developed in the testimony that all of the profits from the sale of salvarsan manufactured by the Institute are invested in research work and that not one penny of it is taken for personal profit. Furthermore that the Institute could not compete with Metz recently and the latter had obtained all the cream of the government orders. Senator Shortridge remarked that if institutions like the Dermatological Institute were not permitted to compete with commercial firms it would at once sweep away all charitable work by doctors and lawyers, eliminate free hospitals and reduce everything to a commercial basis. Dr. Schamberg said that the Institute in its whole existence could not boast of profits such as Mr. Metz had made in any single year.

Acceptance of Ford Offer Unlikely, but Congress Will Authorize Completion of Dams

That Congress cannot accept or reject the Ford or any other Muscle Shoals offer has been emphasized since the return to Washington of the Senators and Representatives who recently paid a visit to the project. To bargain and to adjust contracts is a function for which Congress is not equipped. For that reason there is increasing support for Representative Kahn's proposal that a commission study the problem and recommend the specific legislation desired. In the meantime the government can carry along the construction of the dam and in that way clear itself of any charge of a policy of delay. Since it will take 3 years to complete the dam, there would be ample time for the commission to deliberate and for Congress to pass upon the legislation which would be recommended and be in a position to make a more intelligent decision without having held up the project. This will permit the administrative departments of the government, which are accustomed to the negotiation of contracts, to approach the proposition in a business-like way.

One effect of the discussion of the various offers has been to make practically certain that Congress will appriate sufficient funds to keep the work going on the dam. There is reason to believe that the Senate will approve a rider on the War Department appropriation bill providing about $7,000,000 for the work during the next fiscal year.

Hearings on the whole proposition have been begun by the Senate Committee on Agriculture. The Kahn committee, which recently completed the hearings on the House side, is now meeting in executive sessions to determine its course.

Officers of Synthetic Organic Chemical Manufacturers Association Elected for 1922

The Synthetic Organic Chemical Manufacturers Association of the United States held its first annual meeting at the Hotel Pennsylvania on Friday, March 31.

Officers for the ensuing year were elected as follows: President, Charles H. Herty; vice-presidents: Dyestuff Section, C. N. Turner, Newport Chemical Works, Passaic, N. J.; Intermediate Section, Charles A. Meade, E. I. du Pont de Nemours & Co., Wilmington, N. J.; Pharceuticals Section, Herman Seydel, Seydel Manufacturing Co., Jersey City, N. J.; Fine Organic Chemicals Section, P. Schleussner, Roessler & Hasslacher Co., New York City; treasurer, Donald McKesson, McKesson & Robbins, New York City; board of governors, vice-presidents, *ex officio*, and August Merz, Heller & Merz, Newark, N. J.; F. P. Summers, Noil Chemical & Color Works, New York City; Dr. S. Iserman, Chemical Co. of America, New York City; F. E. Singer, Butterworth Judson Corporation, New York City; W. T. Cashman, Grasselli Chemical Co., Cleveland, Ohio; S. W. Wilder, Merrimac Chemical Co., Boston, Mass.; Dr. A. S. Burdick, Abbott Laboratories, Chicago, Ill.; Donald McKesson, McKesson & Robbins, New York City; F. L. McCartney, Monsanto Chemical Works, St. Louis, Mo.; James T. Pardee, Dow Chemical Co., Midland, Mich.; Dr. Charles H. Herty, *ex officio*.

World's Largest Dam Part of Plans for Hydro-Electric Development in France

A tremendous hydro-electric power development, projected by a financial and economic group in central France, has been welcomed by the Minister of Public Works and approved by the Superior Council of Public Works. The report of this body states that before the end of this year the total water power developed in France will be 1,500,000 hp., or twice the total developed before the war. During the next 15 years it is hoped that a supplementary 3,000,000 hp. will be added.

The undertaking comprises the construction of four dams and four electrical plants at the estimated cost of 400,000,000 francs. The largest of these dams will be 114 meters high, including the base, or 35 meters higher than the Roosevelt dam. A million cubic meters of masonry would be used in the construction and the cost would be approximately 100,000,000 francs. This wall would form a reservoir covering 1,000 hectares, including the sites of eight towns. The plant at the base would be equipped to generate 150,000 hp.

When these proposals have been realized, the rivers Rhone, Dordogne and a part of the Rhine, together with all the waterfalls in the central mountain region, in the Pyrenees and the Alps, will have been brought under contribution. Shortage of labor combined with high cost of materials may, however, interfere with the realization of existing plans. Net cost of the works required to produce 1 kw. varies between 1,500 and 2,000 francs or $135 to $180 at present exchange rates. About 3,500,000,000 francs, or $350,000,000, will be required during the next 15 years.

Estimates place the total available hydro-electric power of France at 8,500,000 hp. The principal purpose to which it is proposed to divert the power thus brought under contribution is electrifying the French railroads. Estimated annual saving in coal would be 3,000,000 tons, over 5,000 miles of track. It would also be employed in French blast furnaces. The Council of Public Works does not recommend the harnessing of French streams and rivers for purposes of local lighting and motive power, except to a minor extent, but holds that the power would be best employed in a centralized form.

Hydro-Electric Development of Colorado River Would Harness Country's Greatest Power Source

The Colorado River Commission, of which Secretary of Commerce Hoover is chairman, is considering the problem of utilizing the 6,000,000 hp. available and at the same time meeting the irrigation needs of that section. Meetings of the commission began on March 15, at Phoenix, Ariz. The commission includes representatives of the seven states that contain parts of the Colorado River basin, Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming.

The first construction in the great development recommended by the Reclamation Service would be a dam at Boulder Canyon, Arizona, 600 ft. high. This would make available 500,000 hp., or nearly as much as that developed now on both the American and Canadian sides of Niagara.

The progress in long-distance electrical transmission will yet bring all possible power of the river into national use, it is predicted.

Must Lower Freight Rate on Acid

Contentions of the American Zinc, Lead & Smelting Co. that the freight rate on sulphuric acid in tank car loads from Hillsboro, Ill., to certain Ohio River crossings are too high were upheld by the Interstate Commerce Commission in a decision handed down March 8. The smelting company manufactures sulphuric acid at Hillsboro. Its principal competition comes from the sulphuric acid manufactured at Copperhill, Tenn. On March 1, 1921, increased rates were put into effect from Hillsboro to the Ohio River. Since that time, however, there have been various readjustments in rates which have been to the advantage of the producers at Copperhill. Under the new ruling lower rates must be put into effect.

Pulp and Paper Industries in Maine Developing Hydro-Electric Resources

The Central Maine Power Co. has been very active during the past year in developing hydro-electric power. At a recent meeting all of the officers were re-elected. H. D. Eaton of Waterville is president.

The Kennebec Pulp Co. of Skowhegan, Maine, has lately undergone several changes. Water power will be replaced by hydro-electric power. One large motor of 750 hp. and four small motors will be installed. This mill has been closed since last summer. It is reported that it will furnish the Keys Fibre Co. of Waterville, Maine, a considerable quantity of ground wood pulp.

J. A. Harris, general manager of the Oxford Paper Co., Rumford, Maine, announced Thursday, March 2, that his company had taken over the interests of the Rumford Falls Power Co. The power company operates a modern hydro-electric plant with present installation to develop 31,000 hp. The paper company thus assures itself of ample water and power supply for present and future needs.

Rumors are circulating that hardwood furniture factories may be located in Maine in the near future. This seems very probable since evergreen forests cut some decades ago have been replaced by hardwoods which are now abundant. Hydro-electric power is available at low cost. Efforts to utilize hardwoods for pulp manufacture are being made, but are not likely to lead to important commercial results in the near future.

Seven Terra Cotta Firms Indicted by Federal Grand Jury for Practice of "Open Competition"

Indictments charging conspiracy and monopoly in restraint of trade were returned against the following manufacturers of terra cotta by the federal grand jury on March 27:

American Terra Cotta & Ceramic Co., Chicago, W. D. Gates, president; Denver Terra Cotta Co., Denver, George P. Fackt, vice-president; the Midland Terra Cotta Co., Chicago, Hans Mendrus, president; Northwestern Terra Cotta Co., Chicago, Harry J. Lucas, vice-president; St. Louis Terra Cotta Co., St. Louis, R. F. Grady, vice-president; Western Terra Cotta Co., Kansas City, William Timmerman, president; Winkle Terra Cotta Co., St. Louis, John G. Hewit, vice-president.

The indictments charge that the companies, as members of the National Terra Cotta Society, participated in the so-called Eidy plan of open competition, the same plan that was condemned by the United States Supreme Court in the hard-wood lumber case.

According to the indictments, the terra cotta society divided the country into eastern, central and western districts. Manufacturers in one, it is charged, withheld from competing in another.

The indictment charges that each company reported daily on its transactions to district headquarters, which in turn informed the other members.

New German Nitrate Plant Reported

The *Berliner Tageszeitung* reports that a new nitrogen company has been formed at Munich named "Cosag" (Continentale Stickstoffwerke Aktiengesellschaft). The capital is fixed at 40,950,000 marks. The company will erect its first nitrogen works at Golling, near Salzburg, and has acquired the right to exploit valuable lime deposits situated only a few hundred meters from the site of the new works. Rights have also been acquired in connection with the use of current from electrical works now in course of construction.

Discussions at National Foreign Trade Conventions

"Financing and Expanding Foreign Trade" will be the basic theme of the Ninth National Foreign Trade Convention, which will be held in Philadelphia, Pa., May 10, 11 and 12. Leaders in American industry, commerce and finance will be among the thousands of delegates from all parts of the country who will study the problem of how to finance and expand the nation's foreign commerce.

Farmers Register Protest Against Duty-Free Oils —Claim Soap Lobby Threatens Dairy Products

Farm organization delegates from fifteen different states made a concerted, eleventh-hour effort on March 24 to obtain a pledge from the Senate Finance Committee that tariff protection would be given dairy products, fats and oils, against Oriental and South Seas competition which threatens if the tariff oil schedule goes through as it now stands.

They savagely attacked the so-called "soap lobby," declaring its demand for duty-free vegetable oils would sacrifice the prosperity of nearly 40,000,000 farmers and endanger the $70,000,000,000 capital now invested in American farms and dairies.

Senator Townsend read a bundle of telegrams just received from Michigan dairymen and farmers and agricultural college experts, which denounced the growing tendency for substitution of cheap vegetable oils in daily foods, referring especially to "oiled" milk, lard compounds, salad dressings, filled cheese and the like.

Chairman McCumber of the Finance Committee seemed to agree with the trend of thought by saying: "It seems hardly proper that one section of the country should live under the protection of high duties while another section of our people should be forced to meet the competition of the world's free trade." He inquired if the farmers' committee would favor a tariff that taxed vegetable oils destined for food uses, but admitted free such oils as would be used in soap-making.

C. F. Creswell, statistician of the Dairymen's League, presented evidence showing the immense amount of soya bean oil, copra and coconut oil, peanuts and peanut oil which would flow into this country from Manchuria and the tropics, where the yellow and brown races have well developed and growing industries.

The Senate Finance Committee has received about 25,000 letters from laundries and grocery men, instigated by the "soap lobby," according to Senator Calder, so a bitter contest is expected by the farmers.

Garabed Bobs Up Again to Aid Agriculture

Taking a leaf evidently from Henry Ford's book, Garabed T. K. Giragossian, through the instrumentality of Representative Riddick of Montana, again has placed his unlimited energy invention before Congress, this time with the idea of "aiding agriculture by providing facilities for nitrate plants, water for irrigation, and for promoting more efficiency in travel and transportation, through the elimination of expense or labor for motive power."

The resolution which passed Congress Feb. 8, 1918, has been amended by striking out the assertion that Giragossian is the first and original inventor or discoverer of the process. The new resolution provides "that any invention or discovery similar to the claim of Garabed T. K. Giragossian shall not have come into actual and general public use and demonstrated in a substantial manner to be feasible and practical prior to the demonstration of the 'Garabed.'" The resolution also states that "Garabed" is not electricity.

While Congress is no more skeptical of this alleged discovery than it was in 1918, the original resolution was passed when the country was desperately in need of additional power. Congress was ready to grab at any straw which carried with it the barest possibility of speeding up the war program. Under present conditions it is regarded as practically certain that no serious consideration will be given this proposition by Congress.

Water-Testing Methods Described

"Field Examination of Water," by W. D. Collins, has just been prepared as a mimeographed summary of the recommendations of the U. S. Geological Survey, superseding its earlier report on methods of field assay of water. Methods are given for determination of turbidity, color, iron, chloride, carbonate and bicarbonate, hardness, sulphate and calcium, and for computation of results. Those desiring a copy of the report can get it on application to the author at the U. S. Geological Survey, Washington, D. C.

March Meeting of Lehigh Valley Section of the A.C.S.

The Lehigh Valley Section of the American Chemical Society met in the Administration Building of Muhlenberg College, Allentown, Pa., on Thursday evening, March 30. Prof. S. W. Parr, head of the department of applied chemistry, University of Illinois, spoke on "Fuels."

Dr. Parr's discussion centered on the theory of coking or carbonization of coals and on the results obtained by him in his researches. He has developed a method of coking the so-called non-coking Illinois coal so as to make it suitable for domestic purposes.

International Nickel Co. Centralizes Research and Development Activities

Robert C. Stanley, formerly first vice-president, was recently elected president of the International Nickel Co. Mr. Stanley has ordered a reorganization of personnel, involving as its chief feature a new department of development and research with headquarters at 67 Wall St., N. Y.

The new department of the company is the outgrowth of a gradually maturing conviction that a study of its products and their successful use in the hands of the consumer is the key to the extension of tonnage distribution. Research departments at the mines, smelters and refineries of the company, established during the last few years, have now been crystallized into a headquarters organization in intimate contact both with its own plant developments and with outside engineering developments, touching on the use of nickel and Monel metal in all fields. This department will be under the direction of A. J. Wadhams, manager. Associated with him will be Dr. Paul D. Merica, director of research.

Mr. Wadhams has hitherto been manager of the large Bayonne refinery of this company and has for years been in direct charge of the manufacture of all of the company's products, and through this experience is fitted to an unusual degree for his new work.

Trade Associations to Be Studied for the U. S. Chamber of Commerce

A committee has been appointed by the Chamber of Commerce of the United States to study trade associations. The committee will concern itself chiefly with the service which trade associations can render to business and to the public. The members of the committee are:

Philip H. Gadsden, chairman, Philadelphia; president, American Electric Railway Association and formerly member of Federal Electric Railways Commission; vice-president, United Gas Improvement Co.

Thomas S. Adams, New Haven, Conn.; secretary, National Tax Association; professor of political economy, Yale University.

Fred R. Babcock, Pittsburgh; formerly president, National Wholesale Lumber Dealers' Association and of the Pittsburgh Chamber of Commerce; president, Babcock Lumber Co.

Charles J. Brand, Pittsburgh; formerly chairman, Cotton Distribution Board, and chief of Bureau of Markets, Department of Agriculture; vice-president and general manager, United Fruit Growers, Inc.

Henry S. Dennison, Framingham, Mass.; formerly director of planning and statistics, War Industries Board, and president of the Taylor Society; president, Dennison Manufacturing Co.

James R. Maccoll, Pawtucket, R. I.; formerly president, National Cotton Manufacturers' Association and chairman executive committee, World Cotton Conference; treasurer, Lorraine Manufacturing Co.

J. D. H. Morrow, Washington; vice-president, National Coal Association.

Alfred Reeves, New York; secretary, National Automobile Chamber of Commerce.

George Rublee, New York; formerly member of Federal Trade Commission and delegate to Allied Maritime Transport Council.

Imports and Exports of Chemicals

Imports of chemicals on the free list during February were valued at $4,044,647. The imports of dutiable chemicals were valued at $2,713,180. This shows a decrease as compared with February of 1921, when imports of free list chemicals were valued at $5,306,361. The imports of dutiable chemicals in February, 1921, were valued at $2,129,903. The figures are those of the Bureau of Foreign and Domestic Commerce.

The principal increase in importations was in the gum group. There was a decided increase in the imports of chicle and in camphor. Imports of coal-tar products remained at practically the same level as in February, 1921. There also were increased importations of alkalis and alkaloids. There was a heavy decline in imports of calcium products.

Exports of chemicals continued to decline during February. The value of all chemicals exported was $7,665,830. In February of 1921 the value of chemicals exported was $10,559,429. As compared with February of last year, the principal decline was in the coal-tar group, in pigments, paints and varnishes, in fertilizers and in calcium compounds. Acetate of lime was an exception in this latter group. Exports of that commodity in February, 1922, were nearly double those of 1921. Exports of explosives increased decidedly, as did those of caustic soda.

Canadian Concern Lands Large American Order by Virtue of Low Merchant Marine Freight

Owing to the fact that the Canadian Government Merchant Marine was able to quote a low freight rate, the Sidney Roofing & Paper Co. has obtained an order for 1,400 tons of roofing felt from a concern in Los Angeles. This order will keep the plant, which since the fire last year has been moved from Sidney to Victoria, busy for 2 months.

In connection with the above it its interesting to note that the Canadian Government lost $2,210,724 in operating its merchant marine in 1921, excluding depreciation and interest charges. Interest owed the government for 1921 was $3,357,833.39. Depreciation was figured at $4,158,775.51.

Reorganization of Canada Pulp & Paper Co. Involves Unusual Legal Entanglement

With a view to the reorganization of the Canada Paper & Pulp Co., Ltd., which erected a plant and acquired extensive limits at Port Mellon, on Howe Sound, B. C., the Chartered Trust & Executor Co., as trustee for the holders of 7 per cent first mortgage gold bonds to the value of $1,000,000 in the paper concern, is suing the paper company and has named itself as one of the defendants, because it is also trustee for holders of a simultaneous issue of 6 per cent redeemable debenture stock, the owners of which are likewise interested in the reorganization. While this seems to be rather a complicated legal tangle, it is understood to be really a friendly suit to clear the way to a reorganization of the concern. The Western Pulp & Paper Co. was formed during the period of the boom in newsprint, but the plant now has been idle for several months.

Interstate Commerce Commission Regulations for Shipment of Explosives and Poisons

Regulations effective March 20 affecting the transportation of explosives and other dangerous articles have been promulgated by the Interstate Commerce Commission in Order 3666. The order includes regulations for the transportation of explosives by freight, including ammunition for cannon, chemical warfare ammunition and explosive bombs and mines of all kinds. Required methods of packing, marking and certifying these explosives are covered in detail. Rules for the handling and waybilling of acceptable explosives are expounded. A second section of the order covers the regulations for dangerous substances other than explosives, including prussic acid, bromacetone, brombenzylcyanide, carbonylchloride, chlorpicrin, cyanogen, mustard gas, police gas grenades and xylyl bromide.

French Chamber of Deputies Supports Private Operation of Alsatian Potash Deposits

The French Chamber of Deputies has recently been discussing the future régime to be applied to the Alsatian potash mines sequestrated by France. The commission formed to deal with the question had recommended that the mines be exploited by three companies to which concessions should be given. This recommendation was upheld by the government on the ground that competition among the three different companies would increase production and keep prices down. The Chamber voted against a counter-proposal by which the mines would remain entirely state controlled, but adopted by a vote of 289 to 250 a second counter-proposal by which the concession would be given to a single company, in which the workers themselves would have shares, in conformity with the law of April 26, 1917. The commission will now have to study this proposal and present another report.

Meeting of the American Electrochemical Society in Baltimore Announced

Preliminary announcements have been made of the program of the spring meeting of the American Electrochemical Society in Baltimore. The convention will meet first at the Emerson Hotel Thursday morning, April 27.

The morning will be devoted to a symposium on electric cast iron in charge of A. P. Hinckley and Bradley Stoughton. A golf tournament and visits to industrial plants will divide the honors in the afternoon. In the evening the members will have the privilege of hearing Prof. R. W. Wood of Johns Hopkins on the subject of fluorescence.

A number of timely papers are listed for the meetings Friday and Saturday morning as well as the presidential address of the retiring president, Acheson Smith.

It is urged that those who plan to attend should engage hotel accommodations at once. W. H. Boynton is acting as chairman of the local committee.

Present Status of Calvert Process for Alcohol From Water Gas

Owing to occasional references in current publications to the so-called Calvert process for making alcohol from water gas and hydrogen, inquiries have been made in England to determine the true status of the process.

The inventions of Dr. Calvert have to do with the production of both ethyl and methyl alcohols from carbon monoxide and hydrogen, the production of the latter being in a more advanced stage than that of ethyl alcohol, which is a later invention. A small test plant is now in process of construction, but present information does not extend beyond laboratory results. The production of both alcohols consists in running mixed carbon monoxide and hydrogen gases at controlled temperature and pressure over a catalyst producing either of the desired alcohols and an excess of CO. Approximate theoretical yields are not yet in sight.

Civil Service Examination Announced for Assistant Examiner, Patent Office

The U. S. Civil Service Commission announces an examination for assistant examiner in the Patent Office. Examinations will be held on May 10, 11 and 12 and on June 21, 22 and 23. The salary is $1,500 and applications must be filed on Form 1312. Subjects include mathematics, physics, mechanical drawing, language, technics and one optional.

Peat Bogs of Maine to Be Exploited

A contract probably has been, or will be, signed by the Peat Engineering Co., of Bangor, Maine, and others for the construction and operation of a peat plant, with sales rights in Penobscot County. Penobscot County includes the cities of Bangor, Dexter and Old Town. The stockholders of the Peat Engineering Co. have voted to ratify a contract with F. T. Dow, inventor of equipment to dry peat. This operation will be watched with much interest, as there are numerous peat bogs in Penobscot County.

Association of Chemical Plant Equipment Manufacturers Will Organize

The organization committee of the Association of Chemical Plant Equipment Manufacturers will call a meeting to be held in New York during the week of May 8 to perfect a permanent organization of the association.

It is expected that the meeting will be addressed by Secretary Hoover and Dr. Julius Klein of the Department of Commerce on the value of industrial associations. There will also be several other speakers who have had practical experience in running expositions and shows.

Definite dates of the meeting will be announced in a later issue.

Bureau of Chemistry Arranges Dust Explosion Exhibit

The engineers of the Bureau of Chemistry have arranged an exhibit showing the need for preventive measures to avoid dust explosions and fires. The exhibit is arranged in three panels. One panel is devoted to grain milling and other food product industries. The second panel is devoted to threshing machines and the method of avoiding danger from fires when threshing is done in dry weather. The third panel is devoted to cotton gin fires. These fires are of almost explosive violence once they are started. Accompanying the exhibit is a stereomotorgraph showing plants wrecked by explosion and fire. The entire exhibit may be obtained by applying to the Department of Agriculture in Washington. It should be in great demand by persons and organizations interested in fire prevention.

A.C.S. Intersection Meeting to Be Held at Akron

Members of the Cleveland Section of the A.C.S. will be the guests of the Akron Section on May 3. The day will be spent in visiting the industrial plants in Akron and in games of various kinds. A dinner will be held in the evening at which Prof. Edgar F. Smith, president of the American Chemical Society, will be the principal speaker.

Dr. W. C. Geer is chairman of the Akron committee.

Examination for Junior Technologist Announced

Examinations for junior technologist in the Bureau of Standards and elsewhere will be held on May 24, July 5 and Aug. 23. Subjects in which examinations will be held include general chemistry and elementary physics, 20 points; mathematics, including calculus, 25 points; practical questions on optional subjects, including the technology of rubber, leather, paper, textiles, oil, and general, 30 points; education, training and experience, 25 points. Salary at the start will be from $1,200 to $1,500 per year. Application must be made on Form 1312 to the Civil Service Commission.

Personal

D. D. Berolzheimer has been appointed manager of the information bureau of the Chemical Catalog Co., Inc., and of the service department of the *Journal of Industrial and Engineering Chemistry.*

J. Parke Channing, president of the Seneca Copper Co., 11 Broadway, New York, has resigned. First Vice-President Linton of the company will act as president until a successor is chosen.

O. L. Chormann spoke before the regular meeting of the Rochester, N. Y., Section of the American Chemical Society, April 3, on "Pasteurization of Milk Under Vacuum."

Colonel J. K. Crain is to succeed Major J. H. Burns as head of the Ammunition Division of the Ordnance Department of the Army, a division which includes the important nitrate section. Major Burns is relieved because of the statutory requirement limiting service in Washington to 4 years. He goes to San Francisco to become the corps-area ordnance officer for the Ninth Corps Area. Captain D. P. Gaillard, who has been in charge of the nitrate section of the Ammunition Division, has been made commanding officer at the Old Hickory powder plant. P. E. Howard has succeeded him as chief of the nitrate section.

Thomas French is establishing a works in New York for the manufacture of certain colors similar to those made under his patents in Canada.

Alvin C. Goetz, for the past 3 years with the byproducts division of the Southern Cotton Oil Co., has resigned to accept the superintendency of one of Darling & Co.'s fatty acid distilling plants at Chicago.

Charles E. Golding, of Trenton, N. J., manager of the Golding Sons' Co., producer of feldspar, flint, etc., has resigned to become head of the Golding-Keene Co., recently organized to engage in a kindred line, with headquarters at Trenton.

H. W. Hardinge has returned from a business trip through England, France and Belgium.

Dr. R. B. Moore, chief chemist of the U. S. Bureau of Mines, expects to sail on May 6 for a 2 months' trip to Europe on professional business. He will visit France, Germany, Austria, Czechoslovakia, Holland and Belgium.

H. C. Parmelee, editor of Chemical & Metallurgical Engineering, was married on April 10 to Miss Eugenia McAusland, of Washington, D. C. They will be at home after May 15, corner of Spring and Lefferts Roads, Yonkers, N. Y.

E. C. Reeder, for the past 5 years chief engineer of the Rosiclare Lead & Fluorspar Mining Co., in charge of exploration, development and construction work at Rosiclare, Ill., resigned on March 1, to enter the employ of the Hillside Fluorspar Mines, of the same place, in a similar capacity.

R. T. Stull, who for several years has been superintendent of the Columbus (Ohio) Experiment Station of the Bureau of Mines, has been appointed assistant chief of the bureau's mineral technology division. In that position he will have technical supervision over the work in non-metallics and in ceramics.

Prof. The. Svedberg, of the University of Upsala, Sweden, will organize and direct the research work in colloid chemistry at the University of Wisconsin during the second semester of 1922-23 and the summer session of 1923, and will also give two lectures each week on the subject and conduct two weekly seminaries. During the summer session of 1923, lasting 6 weeks, the lectures given during the second semester will be repeated for the benefit of educators and research workers who find it impossible to attend the university during the regular session. A seminary will also be conducted through the summer session.

Prof. Maximilian Toch delivered a lecture at Cooper Union on April 3, on "Chemistry and the Next War," which was illustrated by two reels of moving pictures showing post-war government experiments on bombing operations.

Dr. Charles Wadsworth, 3d, of Chicago, has joined the staff of Chemical & Metallurgical Engineering as Assistant Editor, with headquarters in New York. Until recently he was in the operating department of the Grasselli Chemical Co.

Obituary

William F. McNabb, of Pittsburgh, Pa., secretary and treasurer of the Vanadium Metals Co., Vanadium Building, that city, died on March 27, of self-inflicted injuries in a Mount Clemens, Mich., hotel, where he had gone to regain his health. He was 36 years of age and was prominently connected with local industry, being also treasurer and director of the Flannery Zinc Co. and assistant treasurer of the Pittsburgh Electric Furnace Co.

Market Conditions

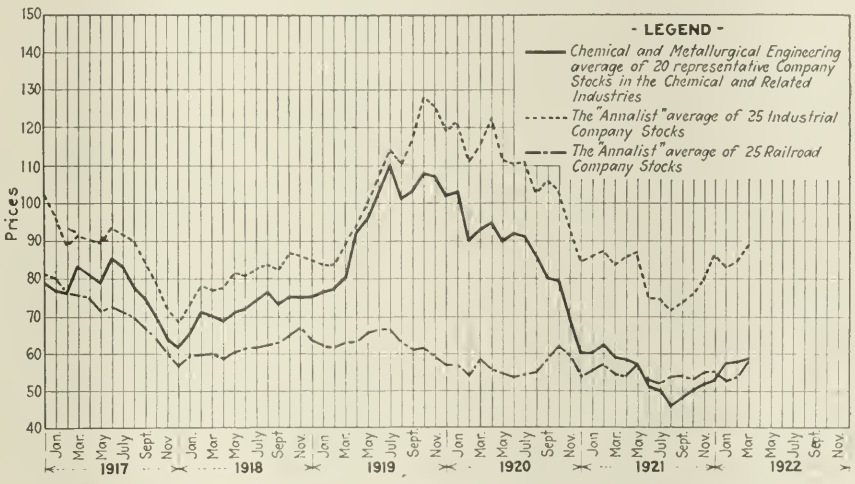
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

The Chemical Industries and the Stock Market

Coincident with the recent upward trend in wholesale prices there has been a noticeable recovery in the stock market. This return of confidence in business, while perhaps more or less psychological, augurs well for the immediate future of industry.

That the stocks of companies in the chemical and allied industries have followed somewhat the same trend as the general market is evidenced by the accompanying tabulation. For the purposes of this comparison, twenty representative companies operating in the field served by CHEMICAL & METALLURGICAL ENGINEERING were selected and the average price of their stocks was compared with the *Annalist's* averages for twenty-five general industrials and for twenty-five railroad stocks. It will be observed that the curve representing the chemical company stocks has followed with rather striking similarity that of the average for the industrials. The spread between the two curves was practically constant in 1917 and 1918. During the sharp rise that occurred in the first half of 1919 the two curves were almost together. While the chemical stocks, after reaching a peak in July, 1919, continued to show the same general tendencies as the industrials, the recoveries of the former were less effective and the falls more pronounced. The *Annalist* average reached its peak in October, 1919. Neither curve again attained this high level, although in April, 1920, the industrials came within a few points of its former high.


- LEGEND -
Chemical and Metallurgical Engineering average of 20 representative Company Stocks in the Chemical and Related Industries
The "Annalist" average of 25 Industrial Company Stocks
The "Annalist" average of 25 Railroad Company Stocks
Prices
150
140
130
120
110
100
90
80
70
60
50
40
Jan. Mar. May July Sept. Nov. Jan. Mar. May July Sept. Nov. Jan. Mar. May July Sept. Nov. Jan. Mar. May July Sept. Nov. Jan. Mar. May July Sept. Nov. Jan. Mar. May July Sept. Nov.
1917 1918 1919 1920 1921 1922

COMPARISON OF PRICES OF CHEMICAL, INDUSTRIAL AND RAILROAD STOCKS

In the decline of 1920 and 1921 it is of interest to note that both curves touched bottom in the same month, August, 1921. The chemical company stocks were practically 15 points beneath their previous low recorded in December, 1917. In the case of the industrials, however, the August, 1921, quotation was still at least a few points above that at the end of 1917. The present upward movement began in August of last year and has proceeded without interruption for the past 7 months. Apparently the average for the twenty-five railroad stocks has also participated in this advance, notwithstanding the fact that since 1918 the curves for industrials and railroads have had but little in common. The outstanding characteristic of the latter stocks during the last 5 years has been their comparative stability as evidenced by the absence of any wide fluctuations.

The companies whose stocks were used for this compilation were selected as representing the principal chemical and chemically controlled industries. The quotations used were the bid prices for common stock adjusted to the basis of a par of 100 and averaged on or about the first of each month. In the case of practically all of these companies their stocks are listed on the New York Stock Exchange. Included in the average are the following: Allied Chemical & Dye Corporation, American Agricultural Chemical Co., American Cotton Oil Co., American Linseed Co., American Smelting & Refining Co., American Sugar Refining Co., Central Leather Co., Corn Products Refining Co., Davison Chemical Co., E. I. du Pont de Nemours & Co., International Nickel Co., International Paper Co., Mathieson Alkali Works, National Lead Co., Texas Co., United Dyewood Corporation, United States Cast Iron Pipe & Foundry Co., United States Rubber Co., U. S. Industrial Alcohol Co., and Virginia-Carolina Chemical Co.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	158.36
Last week	156.75
April, 1917	207
April, 1918 (high)	286
April, 1920	261
April, 1921 (low)	140

The gain shown in the index number over last week is due to the rise in price of cottonseed and linseed oil, as well as ammonium sulphate. These higher prices more than offset the slight price reductions in acetic and citric acids, barium chloride, borax, caustic soda and caustic potash.

An Outside View of the Industrial Chemical Market

It is occasionally of interest to get an outside viewpoint on market conditions within the chemical industry. Such a view is afforded in the following statement extracted from a recent industrial letter of the Babson statistical services. While we are inclined to agree with Mr. Babson's views in regard to lowered costs and continued readjustment, we do not believe he is entirely justified in his inference that lower prices can be expected for such staples as alum, bleaching powder and caustic soda.

"The worst of the industrial chemical readjustment is definitely over, yet this does not necessarily mean that the minimum price basis is established. A lower plane is entirely probable. Industrial chemicals represent another group that experienced abnormal expansion to cope with the war demand. Even in the days of urgent demand there was no shortage. Consequently, our total producing capacity today, compared with actual needs, is exorbitant. Since early in 1920 competition has constantly increased.

"The price alignment has marked time more or less with the revision in producing costs, and the cost of production is

destined for lower levels. Incidentally, Europe is in the same category. Her producing ability is large and channels of consumption restricted. Our imports have naturally declined, but our exports have also recorded a drastic setback.

"We cannot disregard the fact that we are still in a period of depression, a condition that will not terminate for some time to come. Industrial activity will improve only gradually, particularly as some of our major industries have yet to complete the transitionary process. The demand for industrial chemicals this year will not be large. The average price is fully above 1913. From a comparative standpoint this is not high, but the unusual conditions that prevail suggest conservatism in such chemicals as alum, bleaching powder, caustic soda and soda ash. A constant supply is the primary incentive."

Better Technology an Imperative Need in the Chilean Nitrate Industry

That Chilean nitrate will continue for a long time to be an important source of fixed nitrogen, in spite of developments which may be made in the technology of nitrogen fixation, is the opinion of Paul F. Holstein of Chicago, an American chemical engineer with 10 years' experience in the nitrate fields, having been assistant manager of one of the American plants. In a recent interview he summarized some of the more important factors affecting the economic outlook for this industry.

Facts which must not be lost sight of are that over $200,000,000 has been invested in this industry and that in the past it has been possible by working the richest caliche to obtain a very substantial return on the investment and still sell under a high government tax. Under such conditions pleas for improved technology received scant attention. More recently, however, it has become necessary to work deposits containing only 17 or even 15 per cent of nitrate instead of 30 to 50 per cent and in addition competition has arisen in the form of synthetic nitrogenous materials.

A thorough study of methods for reducing the production costs of Chilean nitrate is becoming imperative. There are two well-defined lines of approach—the government tax and technology.

Since the beginning of the industry the nitrate tax has enriched the Chilean treasury by about $500,000,000. About two-thirds of the income of the Chilean Government is derived from this source and there is not much in the way of an alternative, so that the tax will probably remain, unless the industry should be seriously threatened. In such an event the government would have to take drastic measures for self-preservation.

Turning to the technology, much room for improvement is seen in the average plant and it has been estimated that a 40 per cent reduction in cost should be possible through improved processes. Better recovery, more efficient fuel utilization, and improved mining methods are problems which, when solved, will do much to decrease the cost of production. In many of the plants at present 30 to 33 per cent of the total cost of the finished nitrate at the plant is charged to fuel, while placing the ore at the plant accounts for 45 per cent more.

Since prices are controlled through a central association, it would seem quite possible for this organization to assist in the technological development rapidly becoming essential to the existence of the industry in the face of competition.

The New York Market

New York, April 10, 1922.

A slight improvement was reflected in the volume of chemical business during the past week and although conditions in general are far from normal, the tendency is toward betterment. Caustic soda producers report a heavy call for contract shipments and large tonnages have been moved from the works. There was also a decided improvement in the demand for copper sulphate, and heavy orders have been placed for foreign and domestic consumption. Barium chloride is still very scarce and prices have shown a net gain over the week. Sulphide of soda developed a firmer tone, owing to the reduction of imported stocks.

Arsenic.—There were a few sales noted at 7¼c. per lb. during the week and quotations ranged from 7¼@7½c. per lb. Futures were offered at 6¾@7c. per lb., depending upon quantity.

Barium Chloride.—Scarcity at present has created a very strong market and prices are steadily advancing. It was very doubtful if better than $87 per ton could be done at the close of last week. Some sellers were holding for $90 per ton. Domestic producers have been quoting $75 per ton, but practically all these sources are sold up to the latter part of June. Demand is very brisk.

Carbonate of Potash. — The 80-85 per cent material is showing additional strength in the resale market and large manipulators are not willing to quote below 5c. per lb. for prime goods. Quotations range from 4¾c. per lb. upward.

Caustic Soda.—Resale dealers quote the market at $3.60 per 100 lb. for export, April shipment from works. The market quieted down considerably during the week and foreign inquiries were not very noticeable. Producers, however, report a steady demand for contract shipments and quote the market firm at 2½c. per lb., basis 60 per cent, f.o.b. works, in carload lots.

Copper Sulphate. — There was a decided improvement noted in this commodity, especially from South American countries. The domestic inquiry has also shown improvement and the agricultural demand at present is very active. Considerable business was transacted to Middle Western farmers. Leading factors quote large crystals at 5½c. per lb. in carlots and $5.40 per 100 lb. for the smaller crystals. Some producers report a sold up condition on all large crystals.

Hyposulphite of Soda.—There were a few sales recorded during the week on the basis of $2.90 per 100 lb. for imported material. Domestic producers quote 3c. per lb. f.o.b. works. The demand has recently shown more activity and larger sales were recorded.

Prussiate of Soda.—Keener competition and a quiet inquiry have had a tendency to weaken quotations for imported material and sales were reported down to 16½c. per lb. The movement was practically confined to resale dealers.

Soda Ash.—Prices for spot material remained quotably unchanged. Carlots in single bags are quoted at $1.80 per 100 lb. and barrels at 2c. per lb. Leading producers quote contracts for light 58 per cent at $1.20@$1.25 per 100 lb. for single bags and $1.45 for barrels, basis 48 per cent, f.o.b. works.

Coal-Tar Products

There has been a marked improvement in this industry since our last report. Indications all around appear more favorable and the stability of prices throughout the list has restored the confidence of buyers. Resale material is not very plentiful. Producers report a livelier inquiry and it is very significant that passing business is being transacted by first hands. Price changes during the week have been very few. Those close to the pulse of trading believe that the recent recovery to more normal conditions is a very good sign that the bottom has been reached.

Cresol.—First-hand sales of U. S. P. goods are reported at 12@15c. per lb. Ortho-cresol is finding a fair outlet at 16@18c. per lb. The demand is moderate and confined chiefly to small quantities.

Naphthalene.—There has been a much better demand from various sources of seasonable character and resale dealers report additional inquiries. Prices are maintained in first hands. Balls are offered at 8c. per lb., flakes at 6½c. and crushed at 6@6½c. per lb.

Aniline Oil.—Supplies are liberal and the general condition of the market is hardly steady. Buyers have not shown any inclination to operate on a large scale. Producers quote the market at 16½c. per lb.

Benzaldehyde.—Small-lot sales have been the only feature of the market. Sales of the U. S. P. are reported at $1.25 per lb., while the technical is moving at 45c. per lb. The demand is moderate.

Toluidine.—Sales of the mixed have been transacted at 30c. per lb., with smaller lots held up to 35c. The demand is rather quiet, with passing transactions of a small nature.

The Chicago Market

CHICAGO, ILL., April 6, 1922.

The main feature of the industrial chemical market during the past 2 weeks was the firmness of prices. Practically no declines were to be noted and while actual advances were few, spot prices were very firm. Imported material is especially firm, with most stocks at a low point. Dealers and manufacturers are both apparently enjoying a good volume of business and seem to be fairly well satisfied. The trading is mostly in small-sized lots but it is noticeable that a few buyers are beginning to buy ahead.

GENERAL CHEMICALS

Caustic soda is in a firm position and is moving fairly well in small lots. Ground caustic, 76 per cent, is quoted at $4.35@$4.50 per 100 lb. and solid at $3.75@$4. *Caustic potash* is very firm, with spot stocks light. The high test, 88-92 per cent material is quoted at 6¾@7c. per lb. *Potash carbonate* has shown some signs of firmness and 96-98 per cent material is available at 10@12c. per lb. *Soda ash* is reported to be moving well and is unchanged at $2.30 per 100 lb.

Potash alum lacks quotable change at 5@6c. per lb. for the lumps and 6@6½c. for the powdered. *Sal ammoniac* is moving well at 7¾@8¼c. for the white granular. *Copper sulphate* is reported to be moving well and is very firm at 6@6½c. per lb. *Bleach* is moving fairly well at 3c. per lb. for large drums. *White arsenic* is in good demand and supplies are available at 8c. per lb. There is a good movement of *carbon bisulphide* and prices are firm at 6¾@7c. per lb. *Carbon tetrachloride* is unchanged as to price and is moving fairly well at 10½@11c. per lb. *Formaldehyde* is moving very well, but the price is weak due to competition and the weakness of the methanol market. Agents quote barrels at 9½@10c. per lb. and kegs at 11@12c. *Furfural* is enjoying a fair demand and is quoted in single drum lots at 50c. per lb. *Epsom salts* are moving in a routine way at 2¾@3c. per lb. for the U.S.P. crystals. Glycerine is rather quiet and refiners have announced nothing new in the way of prices. The c.p. material in drums is quoted at 16c. per lb. delivered. *Lead acetate* is quiet, with 12@13c. per lb. quoted on the white crystals.

Nothing new has developed with bichromates. The *potash salt* is quoted at 11¾@13c. per lb. according to the seller and *soda* at 9@9½c. The market is still bare of *potassium ferricyanide*. *Potassium ferrocyanide* is very firm and is moving well at 32@35c. per lb. *Permanganate of potash* is rather neglected and supplies are available at 18c. per lb. *Bicarbonate of soda* is moving in a routine way at 2¼c. per lb. There is a somewhat better demand for *sodium hyposulphite* and the price is unchanged at $3.95 per 100 lb. for the pea crystals in barrels.

LINSEED OIL—NAVAL STORES

Linseed oil continues to move very well in consuming channels. The price is firm and at least a few factors expect higher prices. Today's market was 86c. per gal. for the boiled oil in 5-bbl. lots and 84c. for the raw oil.

Turpentine is reported to be moving briskly and the price is firm. Today's market was 84½c. per gal. for 5-drum lots. *Rosin* is moving somewhat slowly and less than carlots of the WW grade was quoted today at $8.35 per 280 lb.

The Iron and Steel Market

PITTSBURGH, April 7, 1922.

Obviously it is necessary to dig beneath the surface to make an appraisal of the actual condition and prospects in the steel market. The superficial developments are increased demand, increasing production and stiffening prices in some steel commodities, definite advances in others. Superficially there is a great similarity to conditions that have existed in the early stages of all the periods of activity in the steel industry. It must be remembered that the steel trade has always been one of periods of activity interspersed by periods of inactivity. In periods of inactivity there have been starts toward full activity that were not carried to the end, and it has not always been possible to distinguish the one from the other.

At the present time opinion is divided. The facts as to orders are not subject to dispute, the question being as to the rate of consumption. Some argue that when buying of steel has been so heavy with consumption as it has been lately, increased consumption will bring heavier buying in future. Others argue that as consumption does not support the present rate of production the buying will decrease, part of the buying of late having been against replenishment of stock.

PRICES

Bars and shapes recently became quotable at 1.50c. as a general market price, as noted in this report a week ago. Plates seem now also quotable at the advanced figure, making the three heavy rolled products at 1.50c., against about 1.35c. a month ago. There are no rigidly maintained prices, however, in these commodities, concessions being no doubt given in some instances, while on the other hand small and undesirable orders command as high as 1.60c.

Effective yesterday, pipe mills decreased the preferential on plain end pipe from three points to one point, and on pipe with threads and not couplings from two points to a quarter point, beyond the regular discounts for pipe with threads and couplings. Shading of regular published prices has largely disappeared. In some quarters it is thought probable that a small advance in the whole pipe list will soon be made.

Practically all the sheet mills have now completed booking of business at the old prices and the $3 a ton advance announced some time ago by most of the mills as to become effective about April 1 may be regarded as in force. Meanwhile business has been brisk in actual shipping orders as well as in second quarter contracts. The new prices are: Blue annealed sheets, 2.40c.; black, 3c.; galvanized, 4c.; automobile sheets, 4.50c.

Wire products are very firm, plain wire being 2.15c. and wire nails $2.40. Demand for nails is excellent and for wire products in general is very fair.

PRODUCTION INCREASED

The rate of steel ingot production is now between 33,000,000 and 35,000,000 tons a year, having increased rather sharply in the past fortnight. The rate was about 29,000,000 tons at the end of February, and averaged 23,000,000 tons last October and November. Much question is raised as to the disparity between production and consumption, it being urged in some quarters that there is no appearance of such activity in steel consumption as was visible in 1912 and 1913, each of which years saw a production of 30,000,000 tons of ingots. Depletion and replenishment of stocks make a great difference, a fact illustrated by the production of ingots last July at only 11,000,000 tons a year, when obviously consumption must have been at a much greater rate.

The coal strike involves much more idleness at non-union mines than was expected, the lower Connellsville in particular being affected. There will be more drawing upon stocks of coal and coke in April and less non-union production than was expected. The strike at the union mines was generally expected to last 2 months or more, and an interesting question now is whether strikes in non-union districts will last long enough to be a factor at the end.

COKE AND PIG IRON

The Connellsville coke market has stiffened a trifle, spot and prompt furnace coke appearing firm at $3.50, when a week ago the market was quotable at $3.25@$3.50, there being odd lots to be picked up at the lower figure. Many furnacemen express themselves as quite averse to bidding for coke in case of a scarcity, preferring to bank furnaces and thus help their pig iron market, rather than pay extra prices for coke and thus help the coke market.

Pig iron is showing somewhat more activity in most districts and prices are stiffening. The valley market remains quotable at $19.50 for bessemer, $18 for basic and $19 for foundry, but confident predictions are made that the next important sales of basic and foundry iron will be at 50c. advance.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.38 – $0.40
Acetone	lb.	$0 10 – $0.10½	.10¾ – .12
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3.00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	.11 – .11¼	.11½ – .12
Boric, powder	lb.	.11¼ – .11½	.11½ – .12½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1.10 – 1.20	1.25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11 – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04¼	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06 – .06¾	.06¾ – .07
Nitric, 42 deg	lb.	.06½ – .06¾	.07 – .07¼
Oxalic, crystals	lb.	.11½ – .12	.12½ – .13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08¾ – .09½
Picric	lb.	.23 – .25	.26 – .32
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	11 06 – 12 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21 00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33 00 – 34.00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.26½ – .28
Tartaric acid, imported, powdered	lb.	..... –	.27½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1 10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½ – .04	.04¼ – .05
Alum, chrome lump	lb.	.07½ – .08	.08¼ – .08½
Aluminum sulphate, commercial	100 lb.	1 65 – 1 85	1.90 – 2.40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06½ – .07	.07½ – .07¾
Amylacetate tech	gal.	..... –	2.00 – 2 40
Arsenic, white, powdered	lb.	.07¼ – .07½	.07¾ – .08
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	87 00 – 90.00	91 00 – 95.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07¼ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55.00	..... – .....
Bleaching powder	100 lb.	1 60 – 1 75	1 80 – 2 75
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05¼ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24.50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01¾ – .02	.02¼ – .02½
Calcium peroxide	lb.	..... –	1.40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.89 – .91
Carbon bi-sulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – ....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.37 – .40
Cobalt oxide	lb.	..... –	2 00 – 2 10
Copperas	ton	15 00 – 16 00	16 50 – 30.00
Copper carbonate, green precipitate	lb.	19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.50 – 5 60	5 65 – 6.15
Cream of tartar	lb.	..... –	.23½ – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – 1 00
Formaldehyde, 40 per cent	lb.	.08½ – .09	.09½ – 10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32 00	..... – .....
Fusel oil, ref	gal.	..... –	2 15 – 2 50
Fusel oil, crude	gal.	..... –	1.25 – 1 50
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	15½ – .16
Iodine, resublimed	lb.	..... –	4 05 – 4 15
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09½ – .12
Lead arsenate, powd	lb.	.14 – .14½	.14¾ – .15½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07¾	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1 00 – 1 80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.10⅜ – .10½	.10½ – .10¾
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – .05¼	.05½ – .06
Potassium chlorate, crystals	lb.	.06½ – .06¾	.07 – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6.10 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07⅜ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.26 – .26½	.26¾ – .27
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07¼	.07½ – .08
Salammoniac, gray, granular	lb.	.07¼ – .07½	.07¾ – .08
Salsoda	100 lb.	1.45 – 1.55	1.60 – 1.85
Salt cake (bulk)	ton	17.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04¼ – .04½	.04¾ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07¾	.08 – .08¼
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.22½ – .26	.26½ – .27½
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.60 – 3.65	3.70 – 4.20
Sodium hyposulphite	lb.	.03 – .03¼	.03½ – .03¾
Sodium nitrite	lb.	.08½ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.16½ – .16¾	.17 – .17¼
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.85 – 1.00	1.10 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04⅜ – .04½	.04¾ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran	lb.	.05½ – .06	.06¼ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16½ — .17
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.28 — .30
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.50 — .52
Cresylic acid, 95-97%, dark, in drums	gal.	.45 — .47
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.15 — 1.20
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .70
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	11½	15
Pyridine	gal.	1 75 —	2.75
Resorcinol, technical	lb.	1 30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls	lb.	.23 —	.24
Salicylic acid, U. S. P	lb.	.25 —	.26
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	25 —	.27
Tolidine	lb.	1 20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices same as previous report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.10	—	5.15
Rosin E-I	280 lb.	5.20	—	5.25
Rosin K-N	280 lb.	5.85	—	6.60
Rosin W. G.-W. W	280 lb.	7.00	—	7.25
Wood rosin, bbl	280 lb.	6.25	—	....
Spirits of turpentine	gal.	.87	—	.87
Wood turpentine, steam dist	gal.	.85	—	....
Wood turpentine, dest. dist	gal.	.70	—	.70
Pine tar pitch, bbl	200 lb.	.....	—	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	—	9.50
Retort tar, bbl	500 lb.		—	9.00
Rosin oil, first run	gal.	.36	—	.....
Rosin oil, second run	gal.	.38	—	.....
Rosin oil, third run	gal.	.46	—	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.			$1.90
Pine oil, pure, dest. dist	gal.			1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.			.46
Pine tar oil, crude, sp.gr.1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.			.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.			.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.			.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.			1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.			.35
Pinewood creosote, ref	gal.			.52

Fertilizers

Sulphate of Ammonia, f.a.s	100 lb.	$3.75

All other prices remain quotably unchanged.

Crude Rubber

Quotations same as report of April 5th.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10	—	$0.10¼
Castor oil, AA, in bbls	lb.	.11½	—	.12
China wood oil, in bbls	lb.	.13½	—	.13¾
Coconut oil, Ceylon grade, in bbls	lb.	.08¾	—	.09
Coconut oil, Cochin grade, in bbls	lb.	.09½	—	.09¾
Corn oil, crude, in bbls	lb.	.11	—	.11¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.10	—	.10½
Cottonseed oil, summer yellow	lb.	.12	—	.12½
Cottonseed oil, winter yellow	lb.	.13¼	—	.13
Linseed oil, raw, car lots (domestic)	gal.	.79	—	.80
Linseed oil, raw, tank cars (domestic)	gal.	.75	—	.76
Linseed oil, in 5-bbl lots (domestic)	gal.	.82	—	.83
Olive oil, denatured	gal.	1.12	—	1.15¼
Palm, Lagos	lb.	.07¾	—	.08
Palm, Niger	lb.	.06	—	.06¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10	—	.10
Peanut oil, refined, in bbls	lb.	.12½	—	.13
Rapeseed oil, refined in bbls	gal.	.84	—	.85
Rapeseed oil, blown, in bbls	gal.	.86	—	.87
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.10¾	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¼	—	....

FISH

Light pressed menhaden	gal.	$0.54	—	....
Yellow bleached menhaden	gal.	.57	—	....
White bleached menhaden	gal.	.56	—	....
Blown menhaden	gal.	.61	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$900 00	—	$1,100.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70 00	—	110 00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	15 00	—	17 50
Barytes, ground, white, f.o.b. mills	net ton	17.00	—	23 00
Barytes, ground, off color f.o.b. mills	net ton	13.00	—	21 00
Barytes, floated, f.o.b. St. Louis	net ton	23 00	—	24 00
Barytes, crude f.o.b. mines	net ton	8.00	—	8 00
Casein	lb.	.10½	—	.12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	—	8 00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8 00	—	9 00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12 00	—	20 00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12 00
China clay (kaolin)ground, f.o.b. Virginia points	net ton	13.00	—	20 00
China clay (kaolin), imported, lump	net ton	14 00	—	20 00
China clay (kaolin), imported, powdered	net ton	30 00	—	35 00
Feldspar, No. 1 pottery grade	long ton	6 50	—	6 75
Feldspar, No. 2 pottery grade	long ton	5 75	—	5 90
Feldspar, No. 1 soap grade	long ton	7 00	—	7 50
Feldspar, No. 1 Canadian, for mill	long ton	22.00	—	22 50
Graphite, Ceylon lump, first quality	lb.	.05	—	07
Graphite, Ceylon chip	lb.	04	—	.05½
Graphite, high grade amorphous crude	ton	18.00	—	45 00
Kieselguhr, f.o.b. mines, Cal	per ton	40 00		
Kieselguhr, f.o.b. N. Y	per ton	55.00	—	60.00
Magnesite, calcined (crude)	per ton	12.00	—	15.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05½
Pumice stone, domestic, ground	lb.	.06	—	.07
Shellac, orange fine	lb.	.86	—	.87
Shellac, orange superfine	lb.	.88	—	.89
Shellac, A. C. garnet	lb.	.68	—	.69
Shellac, T. N.	lb.	.83	—	.84
Silica, glass sand, f.o.b. Indiana	per ton	1.25	—	1 50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	—	4 50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16 00	—	16 00
Silica, building sand, f.o.b. Pa	per ton	2.00	—	2 75
Soapstone	ton	12.00	—	15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	—	12 00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	—	12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	—	20.00

Refractories

Magnesite brick, 9 in. straight (f.o.b. works) net ton... $45

All other quotations remain unchanged.

Ferro-Alloys

Spiegeleisen, 18-22% Mn.....gross ton $30 — $35

Other prices remain same as previous report.

Ores and Semi-finished Products

Quotations remain quotably unchanged.

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12 625
Aluminum, 98 to 99 per cent	19 00
Antimony, wholesale lots, Chinese and Japanese	4 50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	29 50
Lead, New York, spot	4 90
Lead, E. St. Louis, spot	4 475–4.50
Zinc, spot, New York	5.30
Zinc, spot, E. St. Louis	4.80

OTHER METALS

Silver (commercial)	oz.	$0.65½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2 00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90 00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	49.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.48	$2 38
Soft steel bars	2 38	2 28
Soft steel bar shapes	2.38	2 28
Soft steel bands	2.98	2.88
Plates, ¼ to 1 in. thick	2.48	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Gadsden Clay Products Co. will construct a new power house at its plant and make other extensions and improvements. Gordon Hood is secretary and treasurer.

TROY—The Standard Chemical & Oil Co. is considering plans for the rebuilding of the portion of its plant No. 1, destroyed by fire, March 22, with loss estimated at about $75,000.

MONTGOMERY—The Sloss-Sheffield Steel Co. has tentative plans under consideration for the construction of an addition to its plant, including blast furnace with daily output approximately 250 tons.

RUSSELLVILLE—The Muscle Shoals Rock Asphalt Co., recently organized with a capital of $1,000,000, has acquired property totaling about 3,000 acres of asphalt rock lands and will build a local refining works with daily output of about 1,000 tons. C. E. Dexter, Louisville, Ky., is president.

Florida

ORLANDO—The Yowell-Drew Co. has acquired the local plant of the Orlando Pottery and has plans under way for a number of extensions and improvements. New equipment will be installed. N. P. Yowell is president.

Indiana

EVANSVILLE—The Atomized Products Corp., 6th St., has plans under way for the construction of a 2-story and basement addition, to cost about $75,000, including equipment. B. V. Cain is general manager.

ANDERSON—The International Rubber Co. of America, organized under Delaware laws with capital of $20,000,000, has acquired the local plant of the Quality Tire & Rubber Co. for a consideration of about $200,000 at a receiver's sale. The new owner will use the plant as an initial unit and will make necessary improvements. The company is said to be negotiating for the acquisition of the other plant of the Quality company, located at Elyria, O. J. D. Wiggins is president and general manager; M. D. Ganger is vice-president and superintendent.

EVANSVILLE—The Southern Indiana Gas & Electric Co. will build a large gas retort in connection with an addition to its local gas plant. Frank J. Haas is general manager.

Iowa

DAVENPORT—Fire, March 30, destroyed a portion of the plant of the Mammoth Glucose Co., with loss estimated at about $300,000, including machinery. The southwest wing of the structure was demolished.

DUBUQUE—The Globe Portland Cement Co., 416 McKnight Bldg., Minneapolis, Minn., will soon break ground for the construction of its proposed new local cement mill, comprising a number of buildings, estimated to cost about $1,500,000, including equipment. General building contracts for the work have been let. The C. L. Pillsbury Co., 1200 2nd Ave. South, Minneapolis, is engineer.

Louisiana

ALEXANDRIA—The Alexandria Oil & Refining Co. will soon commence the erection of an addition to its local oil refinery and will install equipment to double approximately the present output. H. T. Clark is president.

MONROE—C. H. Cole and associates are organizing a new company with capital of $250,000, to acquire and operate the local plant of the Monroe Cotton Oil Co. Negotiations for the purchase of the mill are being concluded and possession will be taken at an early date. The new owners plan for the installation of new machinery and will make a number of other improvements in the plant.

ST. ROSE—The Empire Oil & Gas Co., operating the former refinery of the Corson Petroleum Co., has preliminary plans under consideration for the construction of a large addition, to cost approximately $1,000,000, including equipment.

Maryland

CUMBERLAND—The Potomac Glass Co., manufacturer of tableware and glass novelties, is planning for the early occupancy of its new plant addition now nearing completion, and which has been designed to double the capacity. The extension will include a 10-pot furnace and auxiliary equipment, and represents an investment of about $100,000. It will give employment to more than 250 men. George L. Wellington is president.

BALTIMORE—The Rennous-Kleinle Division of the Pittsburgh Plate Glass Co., 3221 Frederick Ave., has revised plans under way for the construction of a 4-story and basement addition, 75 x 205 ft., estimated to cost about $50,000. Bids will soon be asked.

SALISBURY—The Standard Oil Co., Pratt and Commercial Sts., Baltimore, has acquired property on the east branch of the Wicomico River, Salisbury, as a site for a new distributing plant. Construction will soon be commenced on a number of steel tanks, pumping plant and other departments. The company has also acquired property at Cedar Ave. and 33rd St., Baltimore, 100 x 100 ft., and will use the site in connection with its local distributing plant.

Massachusetts

MARLBORO—The Dennison Mfg. Co., Framingham, Mass., manufacturer of paper products, has awarded a contract to the Aberthaw Construction Co., 27 School St., Boston, for the erection of a 4-story plant, 80 x 270 ft., on Maple St., Marlboro, estimated to cost about $500,000, with machinery. It will give employment to more than 500 operatives. Monks & Johnson, 99 Chauncey St., Boston, are architects.

Nevada

RENO—The Candelaria Mines Co. is completing plans for the construction of a new reduction plant on local site, with cyanide unit to have an initial capacity of 200 tons per day, and crushing department 400 tons daily.

New Jersey

TRENTON—The Keystone Pottery Co., New York Ave., has filed plans for the erection of a 1-story addition to its plant. The company specializes in the production of sanitary ware.

GLEN RIDGE—The Matchless Metal Polish Co. has acquired the plant of the Rare Metal Products Co., Bloomfield Ave. near Hillside Ave., which it has been occupying under lease. The plant consists of a main 3-story mill, with power plant, and will be used exclusively by the new owner. The site approximates 2½ acres of land, allowing for later proposed expansion.

New York

LOCKPORT—The A. W. Jack Corp., North Transit Road and Mill St., manufacturer of asbestos mill board and kindred products, will call for bids at once for the erection of a new plant on site adjoining its present works, to consist of a series of five buildings, brick and reinforced concrete, estimated to cost about $350,000, including machinery. Ground will be broken early in May and it is expected to have the plant ready for service by the close of the year. George F. Hardy, 309 Broadway, New York, N. Y., is engineer.

LITTLE FALLS—The Barnet Leather Co., 81 Fulton St., New York, N. Y., is completing plans and will soon take bids for the erection of an addition to its tanning plant at Little Falls, devoted for the most part to the manufacture of calf leathers. It will cost about $100,000, including equipment. Thompson & Binger, 280 Madison Ave., New York, are architects.

BROOKLYN—The Brooklyn Union Gas Co., 176 Remsen St., has completed plans for the erection of a 1-story gas-purifying house at its plant at Smith and 5th Sts.

LONG ISLAND CITY—Fire March 29 destroyed a portion of the 2-story plant of the Imperial Paint Co., 84 10th St., with loss estimated at about $50,000.

LOCKPORT—The Board of Works is planning for the installation of a new filtration plant at the waterworks, with storage reservoir, estimated to cost $360,000. A proposition to authorize James P. Wells, Cutler Bldg., Rochester, N. Y., engineer, to prepare plans is before the Board of Aldermen.

Ohio

FRANKLIN—Fire March 20 destroyed a portion of the local plant of the Vulcanite Roofing Co., manufacturer of paper composition roofing, with loss estimated at $250,000, including buildings and equipment. The company forms the Roofing Division of the Beaverboard Companies, Inc., Buffalo, N. Y., with headquarters at 2246 West 49th St., Chicago, Ill. Tentative plans for rebuilding the plant are being considered.

Pennsylvania

PITTSBURG—The Pennsylvania Chemical & Research Co., care of Loomis & Satterwaite, 410 Lloyd Bldg., architects, has awarded a contract to the Truscon Steel Co., Oliver Bldg., for the erection of a 1-story laboratory at Hays, Pa., 30 x 100 ft.

SHAMOKIN—J. E. Shipman & Son, manufacturers of fertilizer products, have commenced the erection of a new plant to replace their works recently burned.

CLEARFIELD—The Elk Tanning Co. is considering plans for the rebuilding of the portion of its plant destroyed by fire, March 28, with loss estimated at about $300,000, including equipment.

PHILADLEPHIA—The E-Z Chemical Co. has leased the 3-story building at 640-42 Rodman St. for a local plant.

WESTFIELD—The Pennsylvania Potash & Fertilizer Co. plans for the erection of a new plant on local site.

Tennessee

CONCORD—H. J. Winfrey & Sons are planning for the construction of two new kilns at their lime works, and will take bids until about May 1.

JACKSONVILLE—The Nashville Pulp & Paper Corp. will commence the erection at an early date of a number of new plant units at its works, Old Hickory Station. Other portions of the plant are now in course of construction. The entire works will consist of about eight complete operating units, estimated to cost close to $1,000,000. R. G. Cullen is engineer.

Texas

FREEPORT—The Freeport Sulphur Co. has leased the sulphur properties of the Texas Co., Houston, Tex., at Hoskins Mound, near Brazaria, Tex., and plans for the immediate development of the land. A complete surface plant will be installed and other production facilities established, estimated to cost in excess of $500,000. It is proposed to be ready for operation in about 10 months.

Virginia

HARRISONBURG—H. W. Dickey, operating the Harrisonburg Sanitary Pottery, is planning for the rebuilding of the portion of the plant, recently destroyed by fire, with loss of about $25,000.

Washington

SPOKANE—The Frantz Oil Corp., Frank Frantz, president, recently acquired by the Mutual Oil Co. of Wyoming and now operated as a subsidiary organization, has plans under way for the erection of a new oil refinery at Spokane, to have a capacity of about 1,000 bbl. per day and estimated to cost approximately 300,000, with equipment. Work will be commenced late in April.

WELLSBURG—The Eagle Glass & Mfg. Co. has awarded a contract to the Truscon Steel Co., Oliver Bldg., Pittsburgh, Pa., for the erection of three 1-story buildings at its plant, with main structure 50 x 100 ft. H. W. Paull is president.

KANAWHA CITY—Fire March 27 destroyed a portion of the local plant of the Libbey-Owens Sheet Glass Co., with loss estimated at about $200,000, including equipment. It is planned to rebuild. Headquarters of the company are in the Nicholas Bldg., Toledo, Ohio.

New Companies

THE FARRELL RUBBER MFG. CO., East Rutherford, N. J., has been incorporated with a capital of $100,000, to manufacture rubber products. The incorporators are John L. A. E., and Thomas A. Farrell, 42 Paterson Ave., East Rutherford.

THE GENERAL PAINT & VARNISH CO., Detroit, Mich., has been incorporated with a capital of $25,000 to manufacture paints, varnish, shellac, etc. The incorporators are Ward H. Peck, Herbert H. Burgess and George E. Cowles, 4344 West Euclid Ave., Detroit.

THE LEBANON BRASS MFG. CO., Lebanon, Pa., has been incorporated with a capital of $10,800, to manufacture brass and bronze products. Frank H. Wise, Lebanon, is treasurer.

THE FARM CHEMICAL CO., Penn Yan, N. Y., has been incorporated with a capital of $5,000, to manufacture agricultural chemicals and other chemical products. The incorporators are K. Van Blarcom, M. J. Rapalee and S. E. Short. The company is represented by C. S. Shepard, Penn Yan.

THE IMPROVED OIL & REFINING CO., Okmulgee, Okla., has been incorporated with a capital of $100,000, to manufacture refined petroleum products. The incorporators are Paul M. Pope and W. B. Bahn, Oklahoma City, Okla.; and R. L. McClure, Okmulgee.

THE SCIENTIFIC CHEMICAL CO., Wilmington, Del., has been incorporated under state laws with a capital of $100,000, to manufacture chemicals and chemical byproducts. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE UNIVERSAL CHEMICAL CO., 16 Beach St., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by Harry Schlosberg.

THE TOMASEK TERRAZZO MOSAIC CO., 3147 West Van Buren St., Chicago, Ill., has been organized under state laws to manufacture mosaics and other fine ceramics. The incorporators are James E. Tomasek, Edward O. Degrenier and Alexander Campbell.

THE WOODLEY PETROLEUM CO., New York, N. Y., has been incorporated under Delaware laws with capital of $25,000,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE SHAMROCK COTTON OIL CO., Shamrock, Tex., has been incorporated with a capital of $30,000, to manufacture oil products. The incorporators are F. A. Bailey and N. L. Carter, both of Shamrock.

THE CUBAN DOMINICAN SUGAR CO., 101 East Fayette St., Baltimore, Md., has been incorporated with a capital of 1,100,000 shares of stock, no par value, to operate a sugar refinery. The incorporators are Joseph W. Murphy, Frank J. Horan and James B. Guaragha.

THE UNITED LEATHER CORP., New York, N. Y., has been incorporated with a capital of $2,000,000, under Delaware laws, to manufacture leather products. The incorporators are Harold E. Edwards, M. C. Fargis and E. M. Pickert. The company is represented by the Corporation Trust Co. of Delaware, Dover, Del.

THE MITCHELL OIL CO. OF NEW JERSEY, Newark, N. J., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are Theodore G. Hindenlang, Howard W. and George H. Lambert, 9 Clinton St., Newark.

THE FAIRMONT MOLDING CORP., Norfolk, Va., has been incorporated with a capital of $50,000, to manufacture metal castings. W. M. Hannan, Jr., is president, and R. B. Howton, secretary, bothh of Norfolk, Va.

THE MOTH K-L CO., Cranford, N. J., has been incorporated under Delaware laws with a capital of $1,250,000, to manufacture insecticides and other chemical products. The incorporators are P. B. Littlehall, Cranford; M. G. Reese, East Orange, N. J., and H. E. Hilty, New York, N. Y. The company is represented by the Registrar & Transfer Co., 900 Market St., Wilmington, Del.

THE AMERICAN SHALE BRICK CO., Martinsburg, W. Va., has been incorporated with a capital of $100,000, to manufacture brick and other burned clay products. The incorporators are Charles L. Magee, Washington, D. C.; James N. Dyson and F. Vernon Aler, Martinsburg. The last noted represents the company.

THE REX CHEMICAL CO., Salem, Va., has been incorporated with a capital of $1,000,000, to manufacture chemicals and chemical byproducts. The incorporators are Victor Yonce and R. B. Shelor, both of Salem.

THE IVANHOE COPPER CO., Wilmington, Del., has been incorporated under state laws with capital of $600,000, to manufacture refined copper and kindred metals. The company is represented by the corporation Service Co., Wilmington, Del.

THE DAULER OIL CO., Pittsburgh, Pa., is being organized by George B. Berger, Frank S. Delp and W. F. Hughes, to manufacture refined oil products. The company is represented by Calvert, Thompson & Wilson, 1737 Oliver Bldg., Pittsburgh.

THE INDUSTRIAL AROMATIC CO., Newark, N. J., has filed notice of organization to manufacture oil products. The company is headed by J. deSala Mendes, 201 Sherman Ave., Newark.

THE MISSOURI CLAY MINING CO., Poplar Bluffs, Mo., has been incorporated with a capital of $100,000, to operate clay properties, and manufacture burned clay products. The company is headed by John Denton, Ozark, Mo.

THE WILLIAM A. BANKS CHEMICAL CO., Pittsburgh, Pa., is being organized by Robert Carson, E. M. Haller and Carl E. Glock, Pittsburgh, to manufacture chemicals and chemical byproducts. The company is represented by J. M. Graham, 1712 Oliver Bldg., Pittsburgh. Application for a state charter will be made on April 18.

THE TOMLINSON PAINT & VARNISH CO., 2213 North Crawford Ave., Chicago, Ill., has been chartered under state laws, to manufacture paints, varnishes, oils, etc. The incorporators are Edwin W. and Charles N. Tomlinson, and William Sporleder.

THE TIGER OIL CO., Tulsa, Okla., has been incorporated under Delaware laws, with a capital of $1,000,000, to manufacture petroleum products. The incorporators are H. R. McGill, Burton Hartley and Herbert Miller, all of Tulsa. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE NEW NORMA CHEMICAL CO., Memphis, Tenn., has been chartered under state laws to manufacture chemicals and chemical byproducts. The incorporators are D. E. Chamberlin, Gerald A. Cotter and W. H. Englehard, all of Memphis.

THE P. J. BOUR CORP., Pittsburgh, Pa., is being organized by P. J. Bour, George H. Lepper and George H. Sherman, to manufacture heat-and slag-resisting cements and other refractory products. Application for a state charter will be made on April 17. The company is represented by Saul Schein, 1506-10 Berger Bldg., Pittsburgh.

THE POLLYANNA OIL CO., Minneapolis, Minn., has been incorporated under Delaware laws, with a capital of $400,000, to manufacture petroleum products. The incorporators are E. C. Carmen, R. G. Powell and Gordon Cain, Minneapolis. The company is represented by the Corporation Registry Co., 900 Market St., Wilmington, Del.

THE GREAT EASTERN OIL CO., 1119 Fidelity Bldg., Baltimore, Md., has been incorporated with a capital of 600 shares of stock, no par value, to manufacture oil products. The incorporators are George S. Price, George C. Hepp and Marion W. Thomas.

THE VIC RUBBER CO., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture rubber products. The incorporators are S. and M. Gromet, and S. Kaplan. The company is represented by H. H. Feigin, 261 Broadway.

THE EVANSTON GLASS CO., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture glass specialties. The incorporators are Ralph R. Swarthout, William J. Ross and Ralph D. Matteson, 30 North Dearborn St., Chicago.

THE MICHIGAMUA OIL CO., Ann Arbor, Mich., has been incorporated with a capital of $25,000, to manufacture refined petroleum and other oil products. The incorporators are A. M. and John J. Cox, and R. F. Weslie, all of Ann Arbor.

JOHANESON, WALES & SPARKE, INC., New York, has been incorporated with a capital of $100,000, to manufacture pulp and paper products. The incorporators are W. M. Wilson, A. M. Hanson and G. S. Webster, Jr. The company is represented by G. M. Spencer, 120 Broadway, New York.

THE COSMOPOLITAN OIL CO., Indianapolis, Ind., has been incorporated with a capital of $500,000, under Delaware laws, to manufacture petroleum products. The incorporators are Everett C. Arnold, Asher Buck and Frank A. Moore, all of Indianapolis. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE MOORE BRASS WORKS, Wilmington, Del., has been incorporated under state laws, with capital of $50,000, to manufacture brass, bronze and kindred products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ARLINGTON ANILINE WORKS, INC., Peabody, Mass., has been incorporated with a capital of $20,000, to manufacture colors, dyes and affiliated products. Arthur A. Krivian is president; and Bernard Lander, Roxbury, Mass., treasurer.

THE U-MIX-IT CHEMICAL CO., 11 Winthrop St., Hartford, Conn., has filed notice of organization to manufacture chemicals and chemical compounds. M. H. Miller heads the company.

Industrial Notes

THE ORTON & STEINBRENNER CO., of Chicago, Ill., and Huntington, Ind., manufacturer of locomotive cranes, clam-shell and orange-peel buckets and coal crushers, has made arrangements with J. Ross Bates, formerly connected with the Wonham Bates & Goode Trading Corp. of N. Y. and Boston, to represent it in the New England States and New York City. Mr. Bates has offices at 136 Liberty St., New York City, and 128 School St., Watertown, Mass.

THE UEHLING INSTRUMENT CO., manufacturer of CO_2 recorders and other fuel economy equipment, will be located at its factory, 473 Getty Ave., Paterson, N. J., instead of at its former address, 71 Broadway, New York City.

SANDVIK STEEL, INC., announces the consolidation of its general steel and steel belt conveyor departments in Suite 2001, Woolworth Bldg., New York City, with the following executive officers: W. D. Thomas, president and general manager; Anders Johnson, vice-president; Gurrick M. Spencer, secretary, and Harry Carlson, sales manager.

THE WHITLOCK COIL PIPE CO., Hartford, Conn., announces that in addition to its regular agents and representatives it has recently obtained the services of George D. B. Van Tassel, superheater expert, of Detroit, Mich., who will represent the company's interests in Detroit and vicinity.

THE CARBORUNDUM CO., Niagara Falls, N. Y., announces the appointment of Harry Fowler as district sales manager of the Cincinnati territory, to succeed Charles R. Cox. Mr. Cox has been transferred to the main office at Niagara Falls to take up new duties on sales statistics.

THE MCCLAVE-BROOKS CO. has appointed the Mahler Machinery & Supply Co., 1445 Syndicate Trust Bldg., St. Louis, Mo., as its sales representative for that district for McClave combustion systems, including stokers, grates, steam blowers, boiler fronts, etc.

THE CELITE PRODUCTS CO., Chicago, Ill., announces that during the last 3 months there have been a number of changes in its sales organization, including the establishment of branch offices in Boston, Buffalo, Cincinnati and Minneapolis. F. W. Emerson is in charge of the Boston office, W. D. VanArnam in the Buffalo territory, L. M. Lindsey in the Cincinnati office and E. R. LaBelle at Minneapolis. A change has been made in the New Orleans office, and J. C. Etheredge is now district manager for that territory.

THE OLIVER CONTINUOUS FILTER CO., 33 West 42nd St., New York, will demonstrate at its New York laboratory the application of the Oliver continuous filter to pulp washing during the convention in New York of the pulp and paper industry the week of April 10. All pulp and paper men will be welcome at this demonstration.

THE COMBUSTION ENGINEERING CORP., New York, announces the opening of a new branch office at 1137 Guardian Bldg., Cleveland, O., which will be in charge of Frank Henderson, who has been associated with several of the prominent stoker companies in that territory.

THE ELECTRIC FURNACE CO. has moved its general and sales offices from Alliance, O., to Salem, O. By this action all departments of the company will be consolidated at its works, Wilson St. and Pennsylvania Railroad, Salem, O.

THE CHAIN BELT CO., Milwaukee, Wis., has announced the appointment of G. F. Sherratt as manager of the Pittsburgh office in the Union Arcade Bldg. Mr. Sherratt will be in charge of all the company's chain and engineering business in the Pittsburgh territory and is equipped to render

engineering service on power transmitting and material handling problems. The Chain Belt Co. specializes on chain and material handling equipment for all industries. The products of the company are manufactured under the trade name of "Rex." The Ward Equipment Co. of Pittsburgh will continue to handle the complete line of Rex concrete mixers and pavers, and the United Equipment Co. the Rex traveling water screens.

W. E. MEGRAW, safety director of the H. H. Robertson Co.'s plant at Ambridge, Pa., was handed a fac-simile of the Rice Safety Award bronze tablet, because of the total elimination of accidents in 1921, at the recent fourth annual banquet of the Western Pennsylvania division of the National Safety Council. Mr. Megraw in a brief talk accepted the award on behalf of the 124 employees who had achieved a record heretofore believed impossible in accident prevention work. This is particularly interesting because in addition to the usual industrial hazards, the men are constantly unloading and handling steel sheets, coating them with asphaltic compounds heated to from 300 to 400 deg., often under severe fume conditions, moving the sheets and the finished product from place to place, and at times working on lines through which hot oils are piped.

THE WESTINGHOUSE ELECTRIC & MFG. CO. announces that owing to increasing activity in the power and railway divisions of the Pittsburgh office the two divisions will be separated. Burton Steveson, who has been manager of both divisions, will continue as manager of the power division and F. G. Hickling has been appointed manager of the railway division.

THE BUTTERWORTH-JUDSON CORP., manufacturer of acids, intermediates and dyestuffs, has canceled its contract with L. M. Bowes, under which Mr. Bowes, doing business as the Standard Color Co., was sole seller of Butterworth-Judson dye products. It is the intention of the Butterworth Judson Corp. to market all of its products through its own selling force. After April 8 the sales offices of the corporation will be located at 30 Church St., New York City. The expansion of the sales department necessitated this changing to larger quarters.

THE WESTON ELECTRICAL INSTRUMENT CO., of Newark, N. J., announces the appointment of the following sales representatives: Shiefer Electric Co., Inc., with offices at Rochester, Buffalo and Syracuse, N. Y., for upper New York State and Erie, Pa.; L. D. Joralemon, Otis Bldg., Philadelphia, Pa., for Pennsylvania, Delaware, Maryland and the District of Columbia, and the Warren C. Graham Co., Carondelet Bldg., New Orleans, La., for Louisiana, Mississippi and lower Alabama.

Capital Increases, Etc.

THE MADISON GLUE MFG. CO., 97 Beekman St., New York, N. Y., has filed notice of increase in capital from $10,000 to $100,000.

THE MAMER BRICK CO., Benton Harbor, Mich., has filed notice of increase in capital from $60,000 to $160,000, at the same time changing its name to the Mamer Co.

THE MANATI SUGAR CO., 112 Wall St., New York, N. Y., is disposing of a bond issue of $8,000,000, the proceeds to be used for general financing, refinery operations, extensions, etc. Regino Truffin is president.

THE STANDARD CLAY CO., a Delaware corporation, has filed notice of organization to operate at Brazil, Ind., with capital of $300,000, to manufacture brick, pipe and other burned clay products. The company is represented by Albert F. Price, Brazil.

THE COLUMBIAN BRONZE CORP., Freeport, L. I., has filed notice of increase in capital from $450,000 to $1,250,000.

THE BINGHAMTON GLASS CO., Binghamton, N. Y., has filed notice of increase in capital from $60,000 to $150,000.

THE UNION BAG & PAPER CORP., Woolworth Bldg., New York, N. Y., with plants at Hudson Falls, N. Y., and other points, is arranging for a bond issue of $15,000,000, of which about $7,000,000 will be offered for sale at an early date.

THE NOCO OIL PRODUCTS CO., St. Louis, Mo., has been organized to take over and consolidate Cleage & Co., St. Louis, Mo., and the Noco Petroleum Co., Kansas City, Mo., and operate oil refineries. Thomas D. Cleage heads the new organization.

THE UNION OIL ASSOCIATION, Los Angeles, Cal., has filed notice of incorporation with capital of $30,000,000, to take over the properties of the Union Oil Co. of Cal., including refineries, pipe lines, etc.

Industrial Developments

RUBBER—The Thermoid Rubber Co., Trenton, N. J., has adopted a capacity day-time operating schedule at its plant. It is planned to inaugurate a night shift at an early date.

The Goodyear Tire & Rubber Co., Akron, O., has increased production from 20,000 to 22,000 tires a day at its local plant, as compared with an output of about 13,000 tires daily during last November. A large increased working force is being employed.

The Goodyear Rubber Co., Middletown, Conn., has increased operations from 4 to 5 days a week at its local plant, giving employment to more than 250 persons.

The General Tire & Rubber Co., Akron, O., is increasing production at its plant, with tire department running at close to regular capacity. The first quarter of the present year has produced a 65 per cent increase in sales as compared with the corresponding period of a year ago.

CERAMIC—Potteries in the East Liverpool, O., district are increasing operations, with bulk production of the 30 plants devoted to general ware and kindred products averaging in excess of 86 per cent of normal at the present time.

The St. Joe Brick Works, Slidell, La., operated by M. P. and C. W. Schneider, have adopted a full-time production schedule on a basis of 40,000 bricks per day, giving employment to more than 100 men.

OIL—The Sapulpa Refining Co., Sapulpa, Okla., has arranged for the immediate resumption of production at its local refinery, following a shut-down for a number of weeks. The plant has a rated output of 5,500 bbl. per day.

PAPER—The S. Y. Beach Paper Co., Seymour, Conn., has resumed operation at its local mill, with employment of about 80 men, following a shut-down for more than a year. The company will make a number of improvements in the plant, with the installation of additional equipment for increased output.

IRON AND STEEL—The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., has placed operations on a capacity basis in the open-hearth department at its Ensley, Ala., works. During the past month the company has blown in three blast furnaces, all devoted to basic iron. Record production is being developed in the line of ingots and billets.

Two of the largest works of the Carnegie Steel Co., at Homestead and Duquesne, Pa., are now operating in all departments, following the blowing in of blast furnaces and resumption at the 72-in. and 110-in. mills. The works have been idle, in part, for some months past. The company will soon blow in the furnace No. 1, at its New Castle, Pa., plant, the only unit now idle at the mill; this will place the works on a 100 per cent basis for the first time in more than a year. Operations have been resumed at the mills at the Mingo Junction, O., plant of the company, with addition of about 100 men to the working force. This plant will soon go on a 100 per cent basis, with the employment of approximately 200 more men. Another blast furnace has been blown in at the Edgar Thomson works of the company at Braddock, Pa., making 7 out of 11 units in service at the mill.

The Brier Hill Steel Co., Youngstown, O., is arranging to blow in another stack during the present month.

The Republic Steel Co., Youngstown, O., is operating at four of the six finishing mills at the plant, and plans to increase production at an early date.

The steel plate mills in the Pittsburgh, Pa., district are now operating in excess of 80 per cent of capacity. Based on pre-war figures, this would be greater than 100 per cent of normal plant output.

The Sloss-Sheffield Steel Co., Birmingham, Ala., is planning for an early increase in production at its North Birmingham plant, giving employment to a number of additional men. Steady production is being maintained at the byproduct coke-oven plant of the company in the North Birmingham district.

The Midvale Steel Co. is planning for the immediate blowing in of one of the blast furnaces at its Coatesville, Pa., plant. The stack has been idle since last November.

TIN PLATE—The American Sheet & Tin Plate Co. has resumed operations at the four remaining mills at its Guernsey works, near Cambridge, O., developing full production for the first time since last November. At the Elwood, Ind., plant, the company has started two more double mills in operation, bringing the works to 90 per cent of capacity.

COKE—The H. C. Frick Coke Co. is arranging for the early resumption of operations at its Whitney plant in the Scottsdale, Pa., district, following an idle period of 13 months. A total of 250 ovens will be lighted for initial service. The company has added 750 ovens to the active list at the Uniontown, Pa., works.

Coming Meetings and Events

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

AMERICAN WELDING SOCIETY will hold its annual meeting April 26-29 at the Engineering Societies Building, New York City.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the third Monday of April, instead of the second Monday as usual.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY and the AMERICAN PULP AND PAPER ASSOCIATION are holding annual meetings at the Waldorf-Astoria, New York, this week.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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A Development Committee For the American Chemical Society

AT ITS meeting in Birmingham 2 weeks ago the American Chemical Society took official action which, if followed to a logical conclusion, will have a profound bearing on the future development of the organization. By vote of the Council, the president is to appoint a committee of seven to consider the Society's aims and purposes, its present activities, its needs, its service to members and its general efficiency in accomplishing the objects to which it is dedicated.

This is a timely step. The A.C.S. is the last of the great national engineering and scientific bodies to take stock of its activities and determine by a careful survey how closely it is in harmony with the spirit of the times. The need is even greater because the Society has grown rapidly in numbers; and expression of the views of the membership and participation in Society functions have become increasingly difficult. In fact the bulk of the membership is probably inarticulate on most of the Society's problems. This is inevitable in some degree, but the constant effort should be to improve a society's machinery to make it more satisfactory and efficient.

What are some of the things to be considered by the development committee of the A.C.S.? First, there is the problem common to all our national bodies—a direct consequence of the length and breadth of our land—of regional representation in the directorate of the Society, based on the geographical distribution of the membership. Another problem arising from the same source is how to afford a scattered membership opportunity to participate in conventions and sectional gatherings.

A possible solution lies in discontinuing one of the two general meetings per year, either spring or fall, and substituting therefor an appropriate number of intersectional meetings in different parts of the country. This plan, combined with a generous distribution of annual meetings, would encourage participation by a larger number of members. Further, the papers for the annual meetings could then be more carefully scrutinized before acceptance, and the quality of the programs raised accordingly.

Another subject for investigation relates to grades of membership. Who is a chemist? Everyone who belongs to the A.C.S.? By no means! And yet by appropriate regulation it would be easily possible to grade membership in the A.C.S. so that the term "member" or "fellow" would be a guarantee that rigid qualifications had been complied with. No one could feel hurt if he were unable to meet the requirements, but he could take professional pride if he were able to measure up to the standard. And it would help to answer the question, "Who is a chemist?"

Other matters for consideration by the committee will arise out of the publishing activities of the society. The A.C.S. is in the publishing business in a large way. Is it satisfactory to the members? How is it managed? What does it cost? What changes or improvements are desired, if possible? The Society's finances undoubtedly will also come under the scrutiny of the committee and the membership in the interest of effecting possible economies. In short, every activity and policy of the Society will be laid open to friendly criticism if the investigation is conducted as thoroughly in the A.C.S. as it has been in the other national bodies.

It is the intention to complete the investigation within 6 months and to have the committee report at the Pittsburgh meeting next fall. This will necessitate active work in getting the views of local sections on the various questions, possibly holding open hearings in some important centers, so that recommendations can be formulated within the allotted time.

In our judgment a vast amount of good can come to the Society as a result of this action. Professional bodies, like business companies, need occasional overhauling. They get into ruts and lose the spirit of progress. Above all they fail sometimes to keep in touch with their members until dissension arises with all its undesirable and unfortunate consequences. Much of the success of the investigation will depend on the composition of the committee—a matter to which President SMITH undoubtedly will give the most careful attention. The rest will depend on the spirit in which the committee works and the extent to which the membership co-operates.

The Senate Tariff Bill

IN ANOTHER part of this issue we publish a brief review of the salient features of the Senate tariff bill. The Finance Committee's revision of the measure passed by the House last July contains many provisions of vital importance to our chemical industries. Outstanding among these is the temporary extension of the embargo on dyes and synthetic organic chemicals—an action viewed with satisfaction only by those who have been most pessimistic of the legislative situation.

Continuing the dye and chemical control act of the emergency tariff for 1 year (or 2 at the discretion of the President) doubtless offers encouragement for the resumption of manufacturing activities, but it is questionable if it is sufficient to attract the new capital necessary to round out the complete development of the dye industry. Manufacturers in a position to know tell us that in the average dye plant a complete turnover of equipment and process is necessary within a period of about 10 years. To cope with such a situation and at the same time to continue the development and exploration into new fields requires definite assurance that this work will not be wiped out in 1 or 2 years.

The dye embargo will probably meet some opposi-

tion in the Senate, but it is hoped that the favorable light thrown on the industry during the recent investigation of the Senate Judiciary Committee will react in its favor. The attitude of the farm bloc is not yet known, but announcement has recently been made that the agrarians have chosen Senator NICHOLSON of Colorado to lead their attack on the chemical and metal schedules. It will be recalled, with no little apprehension perhaps, that Senator NICHOLSON'S predecessor was the "doubting Thomas" whose tactics succeeded in defeating the Longworth bill in 1920.

Not unwelcome among the other changes in the chemical schedule is the substitution of specific duties for about thirty ad valorem rates. These are thereby removed from the field of controversy regarding the method of valuation which will be carried in the final draft of the law. The wide discretionary powers given to the President add to the uncertainty of the tariff, but if wisely used may offer a workable solution to the problems arising from changing economic conditions.

In analyzing the many provisions of the chemical schedule we have thought it desirable to offer a tabular comparison with the rates in the House bill and in the existing tariff law. The preparation of such a table entails a number of difficulties. For example, the basis for assessing ad valorem duties in the Senate bill is the same as in the act of 1913—namely, foreign market value—but it is not the American valuation plan used in the Fordney bill. Furthermore, many of the paragraphs show slight changes in phraseology, which must yet be interpreted by the customs authorities and therefore render comparisons difficult and hazardous. For these and many other reasons we are convinced that the bill itself deserves the careful study of all who are directly affected by its provisions.

Raising the Standard Of University Instruction

APPARENTLY, a certain section of the readers of technical periodicals feel that the editor knows everything—or at least knows somebody who can tell them what he doesn't know. Of course, this is a very flattering compliment, and one which tickles even a dormant vanity.

So the editor gladly tells SMITH the composition of magnalite, and obtains for JONES a few facts about the manufacture of tin oxide, or sends BROWN a list of competent chemists, with a gentle reminder that technical advice should come from consultants.

Once in a while a request arrives which excites some speculation—not so much because of the information it seeks as a wonder about just what is going on in the head of the correspondent. For instance:

"Could you send me some matter on the subject of steel, as an alloy, chiefly from the mechanical and structural viewpoint? I am to give a lecture on this subject at —— University shortly, and would be very grateful for any slight assistance. The matter need not be very extensive, as my time is limited."

Now the university which is to hear the lecture is no mean institution, and the lecturer is a man who assuredly is expert in a certain branch of philosophy. But what imp has given both the university and the lecturer the idea that he is competent to instruct anyone in "steel as an alloy," even in a limited time? Dozens of engineers who know something about steel as an alloy for machines and structures live within an hour's travel of this university, thirsty for knowledge. It would be curious to know if one of the best of them would accept a similar invitation to expound the creeds of Homoousians and Homoiousians, and then write to the editor of *Christian Science Monitor* for data.

Aluminum and Magnesium

IT IS tempting to start this essay with some hackneyed phrases like "It never rains but it pours." New alloys are being described in great number. Particularly alloys of the light metals, alloys devised and studied by the more progressive establishments which find themselves able to produce war-time supplies of aluminum, magnesium or silicon, and only disarmament conferences in the offing! If widespread popular use of these now relatively scarce metals should follow their development for army and navy, the history of heat-treated alloy steels for projectiles and armor plate would only repeat itself.

The development of uses for aluminum is well known. Shortly after its discovery it was hailed as "the coming metal," but these prophecies have yet to be fulfilled. Its white color and the fact that it needed no enamel to keep it from rusting have given it a great vogue for household utensils. Large quantities of castings are also used where lightness, durability and attractive color are desirable. It has even become a very serious competitor to copper for high-tension transmission lines—for equal duty the supporting towers can be set so much further apart and the transportation charges be so much reduced that the larger cost of aluminum per pound is often more than wiped out.

But it waited for the discovery of some method to harden and strengthen aluminum before it could be used as a structural alloy; this has been done in the alloy "duralumin" and in the new "A," "E" and "Y" alloys developed by the English during the war. Even yet such structural uses have been confined to aircraft, and perhaps will largely remain so until engineers have developed a new designing technic which will enable them to make members combining strength and lightness, the dual advantages, to a high degree and without wasting much metal. Furthermore the cost of the principal metal, aluminum, must be reduced from its present 20 cents per pound before it can successfully compete with expensive alloy steels, two or three times as strong, even if three times as heavy.

Meantime, here comes magnesium—an essential component, although in small percentages, of the hardened aluminums. It in turn is 40 per cent lighter than aluminum, and if sufficiently pure, is apparently no more susceptible to corrosion. Its price is still high, ranging about $1 per pound, but this doubtless could be considerably reduced if any large tonnage were absorbed by industry. Magnesium also is the basis of a series of well-advertised alloys called "Electron," originated in Germany, and of Mg:Al alloys developed in this country.

It needs little imagination to convince one that the surface of this metallurgical field has only been scratched. The possibilities are almost limitless. It will be developed by many men in many different places, but what they find cannot help but be of interest to any engineer who is interested in making some new or old engine serve mankind less wastefully—that is to say, to all real engineers.

A Record in Rail Production

PRODUCTION of rails 100 lb. and over per yard in 1921 was the greatest in the history of the rail industry, the output being 849,566 tons, the heaviest production of such sections previously having been 766,851 tons, in 1916. It has been more or less customary for many years past to speak of there being a "controversy" between the rail producers and the railroads, but the word is not altogether fitting. There has been a difference of aim. The railroads wanted a higher quality of rail, with little extra cost over the base price, while the rail mills favored the using of heavier sections. It would appear from the statistics of production that the rail mills have been making progress in having their contention put into practice, for the ratio of rails 100 lb. and over to rails 85 lb. and over but under 100 lb. has been steadily increasing. The 1921 production was as follows, in gross tons:

Under 50 lb.	211,568
50 to 84 lb.	214,936
85 to 99 lb.	902,748
100 lb. and over	849,566
Total	2,178,818

The total production of rails in 1921 was small. Since 1898 there have been only 2 years, 1908 and 1914, with lighter production. The record high production was made in 1906, with 3,977,887 tons. Statistics of rail production, of course, furnish no key to the manner in which track is being maintained. In 1887 and nearby years there was much building of new railroad, with heavy rail production, as well as imports. In 1906 and nearby years there was much laying of secondary track, together with particularly great replacement because old and light section rails were being destroyed rapidly by the heavier rolling stock recently introduced.

Even at the present time there is some rail wear, necessitating replacement, that will proceed more slowly in future, through rails being replaced by heavier sections. If the rails ever catch up with the rolling stock, by improvement in quality and increase in section, annual replacement requirements of the railroads will represent a relatively unimportant portion of the total steel output of the country. It is recognized, of course, that as the section is increased the tonnage required to lay a given length of track is correspondingly increased.

The industrial use of rails has been increasing steadily with the growth of industrial operations, or even more rapidly. In 1913 the production of rails 45 lb. and lighter was 470,405 tons, whereas in 1920 the production was 489,043 tons, an 81 per cent increase, while for 1921 production, naturally enough, dropped to 211,568 tons. The proportion of light or industrial rails to rails required by the regular steam roads has greatly increased.

The bessemer rail has practically disappeared. In 1907 production was 13 tons bessemer to 1 ton open-hearth. In 1911 open-hearth passed bessemer. In 1921 there was 36 tons of open-hearth to 1 ton of bessemer. In 1912-13 a total of about 6,000 tons of electric rails was produced, for experimental purposes, while there has been practically no such production since then. The alloy-treated rails, which ran about 150,000 tons in both 1911 and 1912, have almost disappeared. Doubtless there is a connection between these facts and the increased vogue of rails 100 lb. and over in section.

The Spring Meeting In Birmingham

BIRMINGHAM is a considerable distance away from most other places—except Shelby County, Alabama, where the rigors of the Volstead act are modified with "corn." When the Alabama Section urged the American Chemical Society to be its guest for the 1922 spring meeting the state was full of chemists, and Muscle Shoals, which is a certain Irish twist in the Tennessee River, was getting ready to do something, and there were any number of willing hands there to help things along. But hard times can make great changes, and the curious illusion that qualifies American business in chemistry has also spread over Alabama. There, just as with us here in the North, merchants who have "bought into" chemistry regard research and scientific control as the first luxuries which, under pressure of hard times, a corporation should rid itself of. So there were very few Alabama chemists available at the time of the meeting, although those few did yeoman's service in looking out for the three hundred and fifty-odd registrants.

The effect of such a meeting on the city of Birmingham and environs would be hard to tell. Probably it is slight. But the enthusiasm of the men at the meeting was very great. They get closer acquainted when there are not so many, and the discussions are more informal and intimate. We doubt if the Educational Section has ever had so illuminating a meeting. This was in part because Dr. SMITH presided, and his presence is always a guaranty of the best kind of company. Then again, the subjects were well chosen, and the participants felt themselves pretty well acquainted.

Very important was the symposium on distillation which opened the meetings of the Division of Industrial and Engineering Chemistry. Organic chemistry has grown into a division of importance. It was always numerically rich in papers, but in later years some of the papers have proved to be very interesting. The Petroleum Section, soon to be dignified as a Division of the Society, maintained the high standards set in its two previous meetings at Rochester and New York. Rubber, cellulose, physical and inorganic, sugar, dye, water—in fact all the branches of chemistry represented at the divisional and sectional meetings—report encouraging progress and many noteworthy contributions.

H. G. Wells on Modern Alchemy

YOU can usually find something of interest in H. G. WELLS' books if you persevere and read far enough! After writing about half a million words on History, Mr. WELLS freshens up—possibly after a cheering session at tea and muffins, and jots down the following thoughts, only too true:

"As scientific men tell us continually, and as 'practical' men still refuse to learn, it is only when knowledge is sought for her own sake that she gives rich and unexpected gifts in any abundance to her servants. The world of today is still much more disposed to spend money on technical research than on pure science. Half the men in our scientific laboratories still dream of patents and secret processes. We live today largely in the age of alchemists, for all our sneers at their memory. The 'business man' of today still thinks of research as a sort of alchemy."

ENSLEY BLAST FURNACES, TENNESSEE COAL, IRON & RAILROAD CO.

Birmingham Meeting, American Chemical Society

Report of the Sixty-third Meeting, April 3-7, 1922—Council Meeting—Addresses at General Sessions—Abstracts of Papers Presented at the Industrial, Physical and Inorganic, Rubber, Sugar, Dye and Water Divisions and at Educational, Historic, Cellulose and Petroleum Sections

BIRMINGHAM, Iron City of the South, threw wide her gates on April 3 to 7 for the convening of the sixty-third meeting of the American Chemical Society. In point of attendance the spring meeting fell short of most of the Society's recent gatherings, for less than 400 members were registered, but this loss in numbers was more than compensated by the better opportunities for developing acquaintanceships and stimulating good fellowship. Southern hospitality was seen at its best. The local committees, the members of the Alabama Section, the industries and the generous-hearted citizens of the Birmingham district did much to make the excursion into the Southland one of the most memorable in the history of the Society.

The Council Meeting

The Council met at 4 p.m. at the Southern Club, with President Smith in the chair. He believed the past year had been one of progress in building up a better understanding of what chemistry means in the public mind. There is, however, still a great deal to be done and he urged on members of the Society the need constantly to expound the relations of chemistry to progress.

The Society has had an annual deficit to meet for 3 years past, so that the directors, in order to avoid loading it with debt, had planned for certain restrictions in expenditure. These consisted in refusing the additional quotas asked for and needed by the editors of *Abstracts* and the *Journal*, in cutting down the appropriation for the *Industrial Journal*, and in omitting the publication of the formula index. They did this with great regret, but sound financing made it necessary to limit the budget to their means. President Smith then called upon Secretary Parsons to read a letter from President F. P. Garvan of the Chemical Foundation in which he advised that that corporation would make good any deficit of the Society up to $25,000, in order to avoid the retrenchments decided upon, to the end that the progress of chemistry in America may not be inhibited for lack of proper information. The thanks of the Society were voted to the Foundation, to President Garvan, and also to Messrs. Parsons and Howe for negotiating the gift.

The Priestley committee made its report and asked to be discharged. A portrait has been provided and funds for a medal are in hand. President Smith, as chairman of the committee, showed a replica of the medal in bronze, and we take pleasure in saying that it was designed by an artist, and that the die provides for a medallion which is beautiful in appearance. This is a consummation devoutly to be wished, inasmuch as other greatly sought prizes in chemistry are nothing more than sculptured whisker exhibits in gold with names in raised letters. The Priestley medal is to be given once in 3 years for distinguished services in chemistry, and the committee of award is to consist of the president, the last past president, the secretary and the treasurer of the Society, and the editors of its journals. Dr. Smith was thanked for his splendid work as chairman of the committee.

Note was made of the passage of the patent bill, and the Society was congratulated on the fact.

The charges brought against American chemical industry have been well threshed out before an investigating committee in Washington, and the industry completely vindicated.

The scientific monographs are a complete success, and the technological monographs are coming along with equal promise of merit. The outlook for these works, both in pure science and in technology, is very favorable.

The deaths of Giacomo Ciamician, honorary member, and of Charles Baskerville were duly recorded and proper resolutions were spread upon the minutes.

It was voted that the Council of the Society urge the publishers of chemical books to adopt a uniform practice of printing the date of the writing or revision of every work issued. For lack of such regularity questions of priority often are held in abeyance.

The Cellulose and Petroleum Sections asked to be made regular divisions of the Society, and it was voted that they formulate bylaws and submit these for approval at the Pittsburgh meeting in September.

In order to establish regularity in the organization of divisions it was voted that 3 years shall elapse after the formation of a Section before it may become a Division.

New local sections were authorized at the Hawaiian Islands and at Sacramento, Cal., and, subject to the waiver of the Pittsburgh Section, one for northern West Virginia at Morgantown was authorized.

Next Spring Meeting in New Haven

The invitation of the New Haven Section and the Corporation of Yale University to meet at New Haven in the spring of 1923 was accepted.

Although it may not be voted on more than 1 year in advance, Dr. Smith advised that Philadelphia was planning for a great sesquicentennial exposition in 1926, and that the Philadelphia Section was urgent in the hope that the Society would meet there at that time.

Prof. William McPherson was elected director to succeed Major H. E. Howe, who, on assuming editorship of the *Industrial Journal*, became ex-officio a member of the board.

The felicitations of the Council were extended to Prof. Henry Clay White on the completion of his 50 years of service at the University of Georgia.

It was voted that the Council bear in mind that when eminent contributions are made for research or to further the advancement of chemistry, they be duly acknowledged and recorded at its meetings. The munificence of George F. Baker in building the laboratory at Cornell was a case in point.

In regard to the selection of alternates for local councilors it was ordered that the manner of selection be left to the respective Sections, but that individual councilors shall not have the power to name their own proxies.

Beginning Jan. 1, 1923, the name of the *Journal of Industrial and Engineering Chemistry* is to be changed to *Industrial and Engineering Chemistry.*

In order to consider lines of activity and measures of reconstruction that may be desirable for the Society, including a possible distinction between professional and non-professional members, it was voted that the president appoint a committee of seven to report at the Pittsburgh meeting.

It was also voted that the intersectional meetings be encouraged and that the Society approve of them.

The meeting concluded, after a dinner tendered by the Alabama Section, with reports of the various committees. In regard to maintaining an employment bureau, the sense of the meeting was that, while the Society should not undertake it, the maintenance of such a bureau by the Chemists Club or by a separate corporation be encouraged.

The General Meetings

The first general meeting was opened in the ballroom of Hotel Tutwiler on Tuesday at 10 a.m. by J. F. Carle, chairman of the local executive committee. After expressing the pleasure of the local section in having the Society meet with them, Mr. Carle introduced Nathan L. Miller, Lieutenant Governor of Alabama, who welcomed the visitors in behalf of his state. He spoke of the natural resources of Alabama which could not have been developed without the aid of the chemical profession. In referring to the water-power possibilities at Muscle Shoals recently brought to the attention of the entire country, Governor Miller said: "Whether the Ford offer is accepted or rejected, one thing must be said to his credit, and that is that by his offer he has saved this wonderful development from the junk pile. Wherever cheap power is, there is manufacturing and where there is manufacturing a great field is offered for the chemist."

W. E. Dickson, City Commissioner, was next introduced by Mr. Carle, and extended the welcome of the city of Birmingham in behalf of the municipal government. President Smith thanked the distinguished hosts in the name of the American Chemical Society, and continuing in his characteristic and delightful manner, he reviewed chemistry's recent contributions to the health, happiness and prosperity of the country. Deprecating the strife which has grown up recently between the so-called "pure" and "impure" branches of science, Dr. Smith urged a united effort in demonstrating the relation of chemistry to the welfare of the general public.

A resolution of respect to the memory of Prof. Charles Baskerville was read by Ellwood Hendrick and unanimously approved by the assembly. Similar resolutions were introduced by Prof. W. A. Noyes in observance of the death of the following eminent contributors to the science of chemistry: Giacomo Ciamician of Bologna, Italy, Adolph von Bayer of Bavaria, and Emil Fischer of Berlin.

Development of Forest Product Industries in the South

Problems confronting the forest product industries of the South were outlined in a comprehensive manner by Carlile P. Winslow, director, Forest Products Laboratory, Madison, Wis.

Enormous original timber resources in this part of the country have been developed in the past 30 years to an extent which has given direct support to from 30 to 75 per cent of the working population of the different states. However, the peak of production has been passed and a decrease to less than half the present output may be expected within the next 15 or 20 years. Since conditions in the South are more favorable to the rapid and cheap growth of timber than in any other part of the United States, immediate reforestation should relieve the situation and prevent the development of a crisis.

The practical solution to the future timber supply lies largely in definitely showing that the growing of timber is profitable. This can be accomplished to a large degree by well-directed and progressive research to determine how to utilize existing wastes and how to produce at a profit the products and byproducts existing and available in the raw material. Mr. Winslow devoted a major part of his paper to the possibilities for development in naval stores, turpentine and rosin production by steam distillation and extraction from chips, destructive distillation of hard and soft woods, newsprint paper from resinous woods, ethyl alcohol from wood waste, hydrolyzed sawdust for cattle feed, wood preservation. The elimination of waste by the use of dimension stock cutting in the secondary wood-using industries and by careful use of wood for boxes and containers was also emphasized.

Industrial Development of the South

William H. Stone, Associate Editor, *Manufacturers Record*, presented an inspiring address on "The Remarkable Development of the South and Its Relation to the American Chemical Industry." He illustrated the progress of the South since 1880 by comparing it with what the South was accomplishing prior to 1860 and what conditions were for 20 years preceding the Civil

War. Prior to 1860 the South was rapidly outstripping New England and the Middle States in its total per capita wealth, production of agricultural products, railroad construction and manufacturing. After the Civil War, however, the South was in desperate financial and industrial straits until about 1880, when recovery began. Mr. Stone quoted numerous statistics from the "Blue Book of Southern Progress" to show developments in the Southern States since 1880, particularly in the growth of population, capital invested in manufactures, production of pig iron, bank deposits, and in the production of various non-metallic mineral products. For nearly all of these, the 1919 figure is double or more than double the corresponding figure for the entire United States in 1880 and in some instances is equal to the country's production in the census years of 1900 and 1910. These figures show clearly that the South has not been a laggard in the utilization of her natural resources. In concluding his address, Mr. Stone quoted several eminent chemical authorities to show that the South has great potentialities for the development of a chemical industry.

Manufacture of Phosphoric Acid in the Electric Furnace

The first paper at the afternoon session on Tuesday was delivered by Theodore Swann of Birmingham, who discussed the manufacture of phosphoric acid in the electric furnace. Mr. Swann, who is president of the Federal Phosphorus Co., described that company's operations at Anniston, Ala., where an electric furnace plant of eight furnaces with a total transformer capacity of 20,000 kw. is now in use. Electric power is supplied by the Alabama Power Co. from its hydroelectric plant on the Coosa River and is delivered to the furnaces at 44,000 volts.

The process consists in charging a mixture of phosphate rock, coke, sand and iron borings into an electric furnace and smelting to liberate the phosphorus. A ferrophosphorus, analyzing 24 to 25 per cent of phosphorus, is tapped off. Such phosphorus as is not absorbed by the iron is carried off in the furnace gases and oxidized by the air to P_2O_5. The furnace gases and phosphorus fume are then blown through a condensing apparatus and an electrical precipitator, where a strong phosphoric acid, containing as much as 90 per cent H_3PO_4, is collected. The iron in this product is said to be about 0.06 per cent and the As_2O_3 content 0.02 per cent.

A concentrated fertilizer using a high strength liquid phosphoric acid (62 per cent P_2O_5) to produce ammonium phosphate offers a promising possibility for this process. By adding potash to this compound a fertilizer containing three to five times as much plant food as the ordinary fertilizers is obtained. The development of such a product is of course dependent on its intelligent use by the farmer.

Petroleum Research

"There is urgent need of a promoting and co-ordinating agency to foster general petroleum research of a fundamental character, the results of which can be used by all those engaged in the development of the industry." So declared Dr. Van H. Manning, director of research of the American Petroleum Institute, in his address on "The Pioneer's Field in Petroleum Research." Although investigations and research of the highest order are being conducted in governmental, educational and industrial laboratories, this has been largely at the expense of unnecessary duplication of effort and of financial loss. The increasing necessity for greater efficiency and economy in the production and utilization of petroleum is a responsibility resting heavily upon the shoulders of American chemists.

Dr. Manning described his present paper as the first gun in a campaign to bring the problems of the chemist and of the industry to the attention of the corporations and others who are in a position to endow the undertaking of such a comprehensive research program. As indicative of the character and scope of the work which should be undertaken, a list of approximately seventy problems of the petroleum industry has been compiled by Dr. Manning and mimeographed copies were distributed to all who were interested in petroleum research. Many of the problems presented are too large for any single individual or institution to cope with unaided; others are so great as to require the collective resources of the nation's educational, governmental and industrial research departments; still others may require the establishment of entirely new research facilities.

This research program, which later was indorsed by the Section of Petroleum Chemistry, may be said to represent a broad picture of the future work which must be done in the production, transportation, refining, marketing and utilization of petroleum and its products.

Recent Developments in Chemistry of Rubber

A very clear résumé of recent work in rubber chemistry was given by Dr. W. C. Geer.

Crude rubber is apparently formed in certain glands of the rubber tree and put into the latex in the form of solid particles about 0.0005 mm. in diameter, so that 1 c.c. would contain about 50,000,000. The latex averages about 28 per cent rubber hydrocarbon, 60 per cent water, the remainder being resins, proteins and mineral matter. The proteins exert a protective action on the colloidal particles which varies among different species. Bacterial action upon the proteins starts immediately in the fresh latex, so that the coagulation must be carried out without delay.

Coagulation may be effected in various ways, but there is a decided need for a thorough chemical study of the whole subject. After washing, the soft dough or coagulum produced by the action of acetic acid on latex contains about 92 to 94 per cent of rubber hydrocarbon.

Dr. Geer emphasized the declining importance of wild rubber and predicted that it would soon practically disappear. He said that London was the financial center, Singapore the shipping center and Akron the manufacturing center of the industry.

One reasonably reliable means of determining the botanical origin of rubber is the acetone soluble, as determined by analysis. It is not, however, a guide to the quality of vulcanized rubber.

Brief reference was made to the importance of studies on the diffusion of gases through crude and vulcanized rubber. A rubber mixture in which poison gases are insoluble would be very desirable.

Much work has been done in recent years on the chemistry of vulcanization. It used to be thought that sulphur vulcanization did not take place until the melting point of sulphur had been reached, but it is now recognized that vulcanization is a function of time as

well as temperature, so that the amount of sulphur combined is proportional to the time at constant temperature. With 3 per cent of sulphur, a soft rubber is obtained, no compound between rubber and sulphur being formed. With excess sulphur, combination takes place up to 32 per cent, but the only compound formed is the monosulphide. As yet the mechanism of vulcanization is not well understood and it is not possible to remove the sulphur and get the rubber back.

Organic accelerators increase the turnover and have beneficial effect upon many of the properties. In this connection credit should be given to the Diamond Rubber Co. for pioneer work. In 1906, George Oenslager experimented with aniline as accelerator and in June, 1907, A. H. Marks used thiocarbanilide. Some modern accelerators are so powerful that the mixture will vulcanize over night at room temperatures.

In the case of fillers, particles of large size are not as strength-giving as smaller ones. The use of carbon black and zinc oxide is based not only upon fineness but also upon some other factor, probably interfacial tension or specific adhesion to rubber. Contrary to a common impression, fillers have a definite use and some of them cost more than the crude rubber, so that they are certainly not added to cheapen the mixture. The service test is the final judge of any mixture and the phenomenon of aging is receiving careful attention.

packing of food under actual factory conditions, the effect of various factors has been determined, among them preheating before sealing, exhaustion of air from the cans, life of typical spoilage bacteria, etc. Hydrogen sulphide, residual free oxygen in the pack, excessive treatment of hominy with lye and other causes of food discoloration are also important problems as yet unsolved.

No accurate basis for evaluating tin plate for can-making is known. The steel base, according to some authorities, should have carbon, silicon and sulphur respectively less than 0.2, 0.025 and 0.1 per cent and phosphorus between 0.05 and 0.1 per cent. But little is known as to the effect of extending the rolling time, annealing, methods of rolling, effectiveness of pickling or method of tinning. Usual practice demands open-hearth base for can ends, but bessemer steel is used for the bodies of the cans. The perforation of cans by fruit acids still remains a big problem and one not likely to be settled until more sound metallurgical research has been completed on these questions.

Informational Needs in Science and Technology

The circumstances leading to the organization of the Research Information Service of the National Research Council and the ambitious plans of that division for the cataloging and dissemination of scientific information

Carlile P. Winslow, Edgar F. Smith, Ellwood Hendrick, H. C. Parmelee, R. B. Moore, W. D. Collins, Rev. Father Coyle, W. H. Stone

In conclusion, Dr. Geer indicated the future of the industry and stated that the developments in the chemistry of rubber have resulted in improvements in the industry.

Research for the Canners

Problems of the canning industry which require research begin with the planting of suitable seeds and extend to the shipping, storage and spoilage of canned goods on the shelf of the merchant. Dr. W. D. Bigelow, director of the Research Laboratory of the National Canners' Association, discussed these problems broadly, with special emphasis on the importance and scope of those still awaiting solution. Food poisons and food values, including vitamines, both need attention, but the urgent industrial questions relate to processing of the canned goods to prevent spoilage. The three major and interrelated studies of Dr. Bigelow's laboratory are: (*a*) Determination of thermal death point of spoilage bacteria; (*b*) rates of heat penetration into foods during cooking or sterilization; and (*c*) effect of acidity (p_H number) on bacterial life.

The major troubles of the food canner are involved in spoilage or deterioration. By studies of experimental

was the basis of the address "Informational Needs in Science and Technology" by Charles L. Reese, chemical director of E. I. du Pont de Nemours & Co. Much time is lost and work is duplicated because of the fact that the tremendous fund of man's previous experience and knowledge is not conveniently available. The war emphasized the need for some central clearing house for scientific information and many individual attempts were made to organize such bureaus. Most of these have been abandoned because of economic pressure, although some are struggling to achieve self-support and profit. Dr. Reese expressed the belief that a general informational clearing house should be an endowed public service organization independent of the need of self-support or of gain.

As an example of the importance of classified information in connection with research, the speaker cited the information bureau of "das Königlische Materialprüfungsamt," which claims to be able to answer 80 per cent of the problems put up to it supposedly demanding experimental research.

The Research Information Service of the Research Council has been available for 3 years. Foremost

among the principles of policy are the desirability of developing a general clearing house for scientific information rather than a depository of knowledge, the conduct of free informational service for the promotion of research and the development of complete co-ordinated machinery for gathering, classifying and disseminating information.

It is proposed to extend this service eventually to an international scope, embracing the entirety of human knowledge.

Chemistry in the Old South and the New

Dr. F. P. Venable, past president of the Society, spoke on "Chemistry in the Old South and the New." He pointed out Charleston, S. C., as vying with Philadelphia in scientific inquiry during Colonial days, and he gave a short sketch of Prof. Emmet of the University of Virginia and of his distinguished pupil J. Lawrence Smith, who was later U. S. Commissioner to Turkey to aid that government in the development of Turkish mineral resources and in the growing of cotton. He also told of the work of Prof. Mallet, his own guide and mentor, of his atomic weight determinations, his production of ordnance for the Confederacy during the Civil War, his work on zirconium in which he proved Berzelius to be in error in his conclusions; his long professorship of industrial chemistry at the University of Virginia, and his many contributions to science.

The Civil War was followed by 10 years of so-called reconstruction which was worse than the war, and everything was wiped out. Work had to be done under the stress of extreme poverty. When the speaker was 23 years of age, completing his education in Germany, he received the call to take charge of the department of chemistry at the University of North Carolina. He had indeed full charge of it, inasmuch as his only assistant was a negro preacher. The laboratory was a cellar, now used for coal storage. The water supply came from a hogshead and their force pump was operated by this same darkey preacher-motor-power; and it was irregular. Iron sulphide was made at a blacksmith's forge and the work had the unexpected effect of instigating a revival in the church of his assistant, who had smelled the fumes of fire and brimstone, and with this experience he was inspired to lead sinners to the anxious seat and to rescue them as brands from the burning.

The university was closed during reconstruction days, and when it opened its income from all sources was $10,000 a year. Half of its alumni had been lost in the war. Today it has 2,000 students, an annual income of $750,000, and last year the Legislature appropriated $2,000,000 for new buildings and equipments.

He related many experiences and concluded with the statement that generally speaking in institutions of learning of the South, both state and private, the sciences are receiving important consideration. On the other hand, there is much need for more research. Many of those in control of these institutions oppose research as not within their scope, and this is an error which should be corrected. He said also that those in charge of Southern industries must awaken to the fact that this is a new world, and that they must be guided by science if they would prosper.

The Public Meeting

At the public meeting held in the auditorium of Hotel Tutwiler on Wednesday evening, Prof. Marston T. Bogert of Columbia University, past president of the Society, delivered an address on "The Flower Fields and the Organic Chemist. Perfumes, Natural and Synthetic." He outlined the very slight knowledge that we possess of this Cinderella of the senses, and indicated the belief that olfactory phenomena are of a chemical nature. He gave Boni's scale of three groups of odors, Zwaardemker's nine primary odors, and Henning's "smell prism" of six. He brought out the theory of correspondence between various odors and notes on the muscial scale, and he recalled Henning's dictum that we recoil from certain odors through the association of fear rather than from unpleasant sensations produced in the nose. He recalled the tradition that "over-indulgence in smell among a people is said to characterize a period of moral decadence." We are disposed to doubt this, however, and to attribute the dictum to the early Christian fathers, who were instigated by the anchorites to the belief that the world was straightway coming to an end, and that smelling was sinful because of its sex associations.

His talk was replete with miscellaneous information. For instance he said that 1 part in 8,000,000 of musk may be easily detected, but that so may 1 part in 10,000,000 of vanilla. Butyl mercaptan is noticeable in dilutions of 1 part in 460,000,000, and he said there are soil odors recognizable in even greater dilutions.

The Ainus of North Japan track their enemies by scent, just as a dog tracks game. The sense is more generally developed in men than in women. And since our senses are magnified as they are made to do the work of others that have been lost, he said Paris perfumers are training men blinded in battle to become perfumery experts.

Sharks have an olfactory organ 12 ft. square. Bears hate the smell of musk, but are especially fond of the odor of asafœtida. Bedbugs follow up the scent of their victims in seeking prey. Ants have a curiously combined tactile and olfactory organ which enables them to sense shape and odor at once. They know the age of one another by this means.

In Athens a popular place of meeting was at the perfumers' shops. Solon prepared a law that only men should be permitted to buy or use perfumery—and we should like to read the discussion that followed. The Arabs were formerly the great perfumers of the world, and they supplied Greece and Rome in the days of their respective greatness.

The lecture was followed by lantern slides showing the perfumery industry of France.

Division of Industrial and Engineering Chemistry

A short business meeting preceded the reading of papers before the Division of Industrial and Engineering Chemistry. A letter from Prof. J. R. Withrow recommended that no concerted action be taken by the American Chemical Society on the A.S.T.M. specifications for lime. P. H. Walker presented a report from the committee on methods of analysis and specifications for soap and soap powder, A. H. Campbell, chairman, representing the results of 4 or 5 years' work. It was adopted. H. E. Howe said that the committee on oils and fats, W. D. Richardson, chairman, was active and that a progress report would undoubtedly be ready for the Pittsburgh meeting. W. D. Collins reported progress for the committee on standardization. The gas chemists expressed a desire to hold a section meeting at Pittsburgh.

The feature of the technical program was a sympo-

sium on distillation, the fourth of a series of symposia. Plans for the program were upset in several cases, however, by the refusal of employers to permit the presentation of purely fundamental data. Automatic heat control was suggested as the topic for a symposium at Pittsburgh. Prof. R. E. Wilson felt that it should be extended to include all methods for process control.

Symposium on Distillation

Efficiency and Capacity of Fractionating Columns

Two viewpoints were taken in considering the efficiency and capacity of fractionating columns—the theoretical and the practical.

Prof. W. K. Lewis took up the theoretical phase and showed how it was possible to modify Sorel's mathematical treatment so that computation is simplified and graphical presentation of results is possible. As in Sorel's method, the enrichment from plate to plate was determined by equating the energy and material input and output, assuming that equilibrium was reached between the vapors and the liquid through which they bubbled.

Although the equations are applicable generally, they were developed for specific mixture, alcohol-water, in order to facilitate presentation. Considering a column in continuous operation with the feed entering at the middle of the column, the following equation was derived for the rate of enrichment or the rectification between any plate n above the feed and the next higher plate, $n + 1$:

$$\frac{dx}{dn} = k\left[(y_n - x_n) - \frac{V_c}{O_{n+1}}(y_c - y_n)\right]$$

where:

$\frac{dx}{dn}$ = rate of increase in concentration of liquid per plate.

k = fractionation efficiency of tower and plates; ratio of plates theoretically required to actual requirement.

y_n = mol fraction of more volatile component in vapor.

x_n = mol fraction of more volatile component in liquid.

V_c = mols of distillate produced per unit time.

O_{n+1} = mols of overflow from plate $n + 1$ to n.

y_c = mol fraction of more volatile component in the distillate produced.

Assuming perfect rectification, the equations developed were used to calculate the theoretical minimum number of plates required for a given rectification, by combining them with experimentally determined relation between x and y for mixtures under consideration. The result is an integral which may be evaluated graphically.

These equations were checked against experimental data on alcohol-water and hydrocarbon mixtures and found to agree satisfactorily.

As a further demonstration of the applicability of these equations, a practical problem was worked out—that of continuously rectifying a 10 per cent alcohol solution to produce a 94.5 per cent product and leave only 0.1 per cent in the waste. Factors to be determined were overflow or heat consumption, height of column or number of plates, point at which feed should be introduced. Plotting the results of the calculations indicated the following solutions to the problems:

The minimum overflow for rectification was found to be 3 mol per mol of product. When the influence of the amount of overflow per unit of distillate upon the number of plates required was considered, it was again apparent that an overflow of at least 3:1 was necessary. At this ratio an indefinite number of plates would be required as the curve became almost parallel to the axis. At an overflow of 4:1, 67 plates would be necesary; at 6:1, 36 plates, while at 20:1, 25 plates would suffice. Beyond this point there was no further appreciable drop, as the curve became parallel to the other axis. An economic balance between the cost of a column and the cost of heat to operate it can be struck from such a curve.

The feed should enter the column on that plate at which the enrichment curves for the bottom and the top of the column intersect. The author stated that so far as he knew this was the first method for determining the point at which the feed should enter. It would seem that in commercial practice the feed is often introduced too high up in the column.

H. E. Howe, W. Lee Lewis, Charles L. Reese, Van H. Manning, J. E. Teeple, William McPherson, Francis P. Venable, M. H. Ittner, B. R. Tunison

W. A. Peters, Jr., chairman of the symposium, explained how Prof. Lewis' method had been applied to plate columns of both sieve and bubbler cap type and to packed columns. It was found more convenient to use an arithmetical equation based upon Prof. Lewis' differential equation and also to use latent heat fractions instead of mol fractions. The relation existing between the compositions of the vapor rising from one plate, the liquid refluxing from the plate above and the heat balance in the theoretical column is given by the equation

$$X_{n+1} = \frac{y_n - y_c(1-\rho)}{\rho}$$

X_{n+1} being the equivalent latent heat fraction of the light boiling material in the liquid on the $n + 1$ plate; y_n the equivalent latent heat fraction of the light boiling material in the vapor rising from the nth plate; y_c the equivalent latent heat fraction of the light boiling material in the distillate; ρ the ratio of the heat required to volatilize the liquid run back divided by the total latent heat in the vapor passing up through any horizontal cross-section of the column. Equivalent latent

heat fraction is a term used to designate the heat required to volatilize the amount of light boiling material in 1 lb. of the mixture on or above the given plate divided by the latent heat required to volatilize 1 lb. of this mixture.

From this it is apparent that when ρ, y_c and y_n are known, X_{n+1} can be determined, which fixes the value of y_{n+1}, so that liquid and vapor composition at any point in the theoretical column may be determined.

Comparison between actual and theoretical columns may be made by determining ρ, y_n and y_c from a run on a given mixture and calculating the theoretical column which will give the same values for y_n and y_c with the same value for ρ. The number of plates calculated divided by the number actually required gives the efficiency factor, k, of the actual column. For filled columns divide by the height of the filled column. It was found more convenient to use the reciprocal of this efficiency, called the height of equivalent theoretical plate, *H.E.T.P.*

This method was first applied to a 28-in. sieve plate column with twenty-eight plates separating acetic acid and water, the distillate containing 98.52 per cent water and the liquid on the top plate 98.14 per cent water.

LOCAL COMMITTEE

Left to Right—A. G. Overton, J. T. MacKenzie, J. P. Montgomery, F. W. McMeans, J. R. Harris, R. W. Allen, J. F. Carle, M. Kuniansky, A. K. Boor and T. Swann.

Calculating one theoretical plate at a time, the fifteenth plate was found to give a liquid containing 98.1 per cent water and a vapor with 98.6 per cent. Thus fifteen theoretical plates will do the work of twenty-eight in the sieve plate column, so that the average efficiency k is $15 \div 28 = 0.536$.

Tests with alcohol-water mixtures in a standard 36-in. Badger bubbler cap plate column gave a value of 0.70 for k when less than 90 per cent alcohol by weight was contained in the mixture.

In order to account for the increased efficiency, two tests were made in the same bubbler cap plate column. k was found to be 0.45 for acetic acid-water and 0.694 for the alcohol-water, showing that there is a marked difference in the efficiency of the same column for different mixtures, although there is no difference between plate columns of either type under comparable conditions of immersion and size of perforations.

In the case of packed columns the efficiency was found to vary inversely as the diameter of the packing, while even greater divergence was noted between the efficiency for different mixtures than in the case of the plate columns.

The increased efficiency of packed columns when small packing is used is offset somewhat by the cost of the smaller fillings. In determining the cost it is necessary to consider the capacity factor, which for practical design purposes may be measured by the maximum vapor velocity which a given column will stand without priming. Small hollow cylinders make an ideal filling material and the author announced that his company had patented a method for making ¼- to ⅜-in. hollow cylinders at an estimated cost of about $30 per cu.ft., which is in sharp contrast to the figure of $250 per cu.ft. quoted by a London firm for ¼-in. rings patented by Dr. R. Lessing and described in *J. Soc. Chem. Ind.*, 1921, vol 40, pp. 115-119.

Assuming the lower figure for the small rings, a comparison was made between the cost of a cast-iron bubbler cap plate column and a column packed with ¼-in. cylinders, each to be equivalent to fourteen theoretical plates and to deliver 41 gal. of 92.5 per cent alcohol per hour with an average value of 0.8 for ρ. From the data for maximum vapor velocity, the diameter of the plate column must be 24 in. and of the packed column 18 in. The height will be twenty plates and 4.7 ft., respectively. A cast-iron column of this size actually cost $1,300 in 1919, but could probably be made now for $1,000. The cost for the packed column was estimated as $365. In the case of acetic acid-water separations the cost of the packed column was not found to be much lower ($1,200, against $1,350), but the life should be much longer.

A valuable feature of this method is that it makes possible direct comparisons between laboratory and plant fractionating columns, so that a large column can be designed to make any desired separation which has been made in a laboratory column.

Plate Efficiency of a Continuous Alcohol Still

A paper by Clark S. Robinson on the plate efficiency of a continuous alcohol still was summarized by Prof. W. K. Lewis. Three tests on an alcohol column gave widely varying plate efficiencies, ranging from 24 to 56 per cent. In discussion it was pointed out that in most of the earlier data on this subject either the heat consumption or the concentrations on the plates was omitted.

Simple Distillation of Hydrocarbon Mixtures

Prof. W. K. Lewis presented the results of work done with C. S. Robinson on the simple distillation of hydrocarbon mixtures. Gasoline is a mixture of hydrocarbons whose boiling points range from 50 to 200 deg. C. The usual test is an Engler distillation. The refiner would like to know what his plant results are going to be from such a laboratory distillation. Prof. Lewis found that with a mixture of 65 per cent benzene and 35 per cent toluene the curve for simple distillation calculated from Raoult's law checked the Engler curve within 1 deg. except near the end of the curve. This deviation was found to be due to rectification which could be eliminated by slightly superheating the still head. This method may be applied to gasoline.

Benzene Purification

A very thorough discussion of the steps involved in the purification of benzene from absorption in straw oil was given by S. S. Heide. The crude is first fractionated to give 70 per cent of 90 per cent crude benzene, 13.5 per cent of 90 per cent crude toluene, 4.5

per cent each of crude light solvent and crude heavy solvent and a residue containing 5 per cent wash oil and 2.5 per cent naphthalene. The working up of each fraction was then considered in detail.

Wood Turpentine

C. A. Lambert described the production of wood turpentine from stumps, downwood or slabs by steam distillation. A charge of 14 tons gives 112 gal. of crude wood turpentine, which upon refining gives 60 per cent pure wood turpentine and 40 per cent pine oil. The physical properties of each 5 per cent fraction were presented in tabular form.

Calculation of Heats of Vaporization

There being no adequate data on heat of vaporization of liquids, Prof. W. K. Lewis and Harold C. Weber pointed out the possibility of calculating these from Hildebrandt's modification of Trouton's rule and from vapor pressure curves.

Glycerine Distillation

Recent developments in distillation systems for the production of dynamite and chemically pure glycerine were outlined by J. W. Bodman. Steam for the spray in the still is supplied by the sweet-water evaporator which is made a part of the unit under vacuum. By means of suitable heat exchangers over 90 per cent is recovered directly as dynamite glycerine as compared with 75 per cent under the older systems. In addition to this and the reduced steam consumption, floor space is economized.

General Papers

Whitewashes and Alkaline Paints

Investigations carried out in the research laboratory of the National Lime Association on whitewashes and aqueous lime paints were summarized by Dr. G. J. Fink.

Of the siccatives used, those such as casein, which with lime form insoluble films, proved to be the best, while those which are water-soluble, such as glues, are not so satisfactory for exteriors. Several alkaline salts were used for accelerating the solution of casein, trisodium phosphate proving to be the most satisfactory. Among the addition agents used with lime in mixtures containing no definite siccative alum and table salt were effective in improving the workability and permanence of the whitewashes. Several formulas developed and tested were shown to be superior to most of those in common use.

Discontinuous Extraction Processes

L. F. Hawley made a study of Turrentine's kelp char extraction process (*J. Ind. Eng. Chem.*, 1921, vol. 13, p. 605), according to the theory of discontinuous extraction formerly developed (*J. Ind. Eng. Chem.*, 1917, vol. 9, p. 866). By using Turrentine's data in the mathematical theory of the process it is shown that the incomplete extraction is due to the fact that complete solution of the potassium chloride was not obtained in the first treatment of the raw material. The other conditions of extraction were so efficient that the final recovery was only slightly less than the theoretically perfect recovery with the solvent ratio and number of treatments employed in the process.

In answering the question, "Can We Afford to Make Potash in America?" R. Norris Shreve reviewed conditions in the domestic industry and drew up a balance sheet of debits and credits to show the necessity for tariff protection.

Fuels, Engineering and Chemistry

Eight of the papers of this Division dealt with problems of fuels chemistry or fuels engineering and formed virtually a second symposium. A. C. Fieldner and G. W. Jones, of the Bureau of Mines, presented further results on their studies of internal combustion engines, discussing particularly "carburetor adjustment by gas analysis." The relation of the pounds of air per pound of gasoline varies widely with commercial service station adjustments. The results of road trials on various cars shows that about 13.5 lb. of air per pound of gasoline burned is the average ratio for maximum power; 15 lb. for theoretical complete combustion; and about 17 lb. for maximum efficiency (miles per gallon). The carbon dioxide percentage in the exhaust which corresponds to these several air-gas ratios is definite. For example, 12 per cent CO_2 in the exhaust is equivalent to a carburetor adjustment for maximum power. An ordinary adjustment corresponds to about 70 per cent completion of combustion on the average, whereas a good carburetor adjustment easily reaches 85 per cent combustion.

With some carburetors, adjustment by methods of analysis at one rate of operation permits good operation at other rates. Such carburetors are regarded as properly designed. Other carburetors have the reverse direction of trend in curve with change in rate of operation and consequently cannot be accurately adjusted for all rates of use. Using the method of gas analysis on the exhaust as the basis of adjustment, these investigators have found generally that 20 to 60 per cent increase in mileage per gallon is easily attained. Methods for sampling of exhaust gases and for adjustment of carburetors on the road are described fully.

Classification and Analysis of Coal

S. W. Parr, of the University of Illinois, proposed in his first paper a new classification of coal based upon its heating value per unit of coal substance and the per cent of volatile matter contained. Former methods of classification were based largely upon the ratio of the volatile matter to the fixed carbon of the coal. Parr proposes to determine the unit heat value of coal substance by subtracting from the total B.t.u. 5,000 times the percentage of sulphur and dividing the remainder by 1 minus the sum of 1.08 times the ash plus 0.55 times the sulplur. This gives a true heat value for the coal substance itself without regard to the percentage of the ash or sulphur contained.

A large number of data were presented to show that wide variation in the heat value of coal substance would be found on identical coal by the ordinary method of calculation. The variation with different ash or sulphur content on coal from the same seam or mine is usually 125 to 250 B.t.u. and sometimes reaches 1,100 B.t.u. But the Parr formula calculated on different samples from the same seam or mine invariably gives agreement within the limits of experimental error for the heat value determination. The discrepancy between clean and dirty fractions from coal washing were usually less than 50 B.t.u., in only one or two cases reaching 80 B.t.u. The results are so accurate that it is possible to detect by this means the county within the State of Illinois from which coal comes or to identify the seam from which it comes. In other words, this method gives a significant characteristic of any particular type of coal independent of the variation of ash or sulphur in

the particular sample examined. This is true not only for mid-continent coals but also for samples from South Africa, Brazil, West Virginia and other bituminous coal territory and also for cannel coals, sub-bituminous and anthracite.

Parr proposes a chart using the heating value per unit of coal substance as one co-ordinate and the volatile percentage as the other. This classification groups the coals as follows:

	Heating Value Per Lb. of Coal Substance
1. Brown lignite	11,500-12,500
2. Black lignite	12,500-13,500
3. Sub-bituminous	13,500-14,000
4. Western bituminous	14,000-15,000
5. Eastern bituminous	15,000-16,000
6. Anthracite	15,500-16,000

Thus it is noticeable that on the basis of heat value alone the lignites and younger bituminous coals are differentiated sharply, but the actual percentage of volatile enters to distinguish between coals of similar heat value but of different percentage of volatile ranging in the order anthracite, semi-anthracite, low volatile bituminous (Pocohontas type), Eastern bituminous and cannel coal, all of which have about the same heat value per unit of pure coal.

Parr also reported on a method for the ultimate analysis of coal by use of sodium peroxide fusions. He considers this method quite good enough for engineering work and particularly important where calculation of stock losses is desired. The calculation determines the hydrogen content of the coal by subtracting from the total heat the heat from the carbon (8,080 calories per gram), and that from the sulphur (2,777 calories per gram), and dividing the remainder by 24,450 (the heat value of hydrogen in calories per gram). Calculation is also made on the assumption that the nitrogen in the coal is 1.25 per cent (a figure quite generally applicable), and thus a determination of oxygen in the coal is possible by subtracting from 100 the sum of the percentages of carbon, sulphur, hydrogen and nitrogen. In discussing this paper by Parr, W. K. Lewis and A. C. Fieldner outlined briefly other crude engineering methods for similar calculation of ultimate analysis.

Heat Value Of Wood

A third report by Parr gave data on the heating value of wood as follows: Oak, 8,550 B.t.u. per pound; pine, 8,836; birch, 8,458. These three woods when thoroughly air-dried contain moisture removable at 105 deg. C., as follows: Oak, 8.35 per cent; pine, 8.88 per cent; and birch, 10.18 per cent.

Melting Point Of Coal Ash

A. C. Fieldner, W. L. Selvig and W. L. Parker, of the Bureau of Mines, Pittsburgh laboratories, reported on comparisons of the standard gas furnace and micropyrometer methods for determining the fusibility of coal ash. In the air the micropyrometer method does not agree at all well with the gas furnace method, but when used with a reducing atmosphere about the sample the agreement is good for ash samples melting not higher than 2,600 deg. F. With samples melting above this point the micropyrometer method gives distinctly different results than the furnace method. In the case of the micro method, the vitrification or fusing of fine edges of the ash particles is observed. In the case of the furnace method using cones, it is the slagging of the mass as a whole which is observed. On chain grates coals which slag are objectionable. With underfed stokers only vitrification of ash substance is sufficient to give trouble. Therefore for the two types of furnace use the two methods of laboratory determination may be correspondingly significant. However, as yet this practical feature of the work has not been settled. In the investigation the Bureau of Mines has had the cooperation of the Bureau of Standards, the New York Consolidated Gas Co., the United Gas Improvement Co., and others. In these co-operative tests it has been found that the micro methods check to about the same extent in most cases as do the furnace methods—that is, ranging over about 100 deg. F. between different laboratories. The same man working with one apparatus usually finds variation of not over 40 deg. F. between tests on the same sample.

Coke Properties And Use

H. J. Rose, of the Koppers Co. laboratory, Pittsburgh, presented a paper on the determination of specific gravity of coke. He points out that the fineness of grinding is important. He recommends water as the wetting medium with 200-mesh coal boiled for 30 minutes. His results are not yet definite as to whether or not a vacuum must be used to get complete wetting in the pores.

S. P. Kinney and G. St. J. Perrott, of the Bureau of Mines, Tuscaloosa Station, reported preliminarily on "The Shatter and Friability Tests for Metallurgical Coke." The general conclusion which these investigators have reached is that friability-test results are of no meaning whatsoever. Results of the shatter test are of little greater significance. The average deviation of tests on the same coke, even though made as carefully as possible, will be several per cent. Hence it is altogether impractical to use this test as a guide for oven operation. Results were presented on work done by all of the customary methods, including the drop test, the bag test, the revolving drum method, etc.

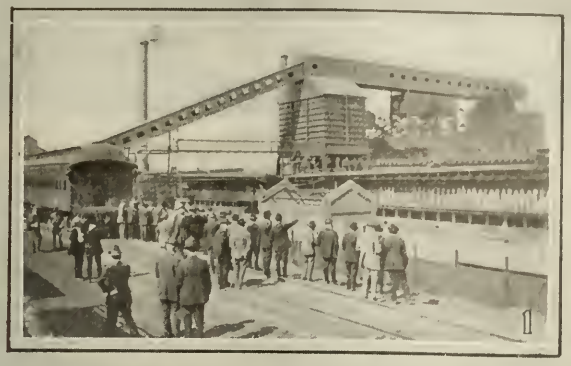
G. St. J. Perrott and H. W. Clark reported very fully on the results of their investigation in Salt Lake City, where they participated in the Bureau of Mines' study of the smoke problem of that community. Their results on coking of Utah coals have already been published in Chem. & Met. In this report they developed somewhat further the estimate of cost of coke and of the market for byproducts in that territory. Their figures indicate that it will be impractical for a coke plant to be established in Salt Lake City of sufficient size to meet the need for smokeless fuel if coke is to be substituted for bituminous coal generally. The market for byproducts in that territory is wholly inadequate to absorb at a favorable figure the output of a plant of that size.

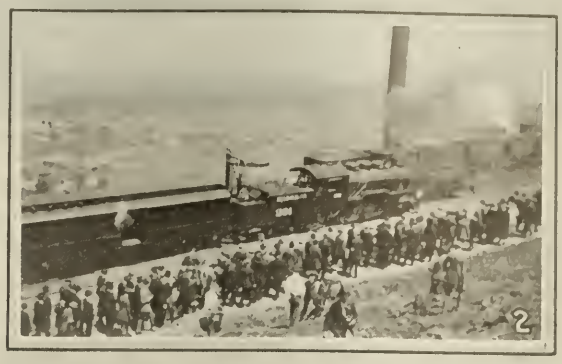
Section of History of Chemistry

The Section of History of Chemistry has a good start, and so long as Drs. Edgar F. Smith and C. A. Browne are in the saddle, the Section is sure to thrive. Dr. Smith presented a sketch of Dr. Thomas Cooper, an Englishman by birth, a brilliant student at Oxford, but so radical in his views and so outspoken and insistent in his opinions that waves of trouble were always rolling about him. He was a jurist and served as Circuit Judge in Pennsylvania, he practiced medicine successfully, and was finally appointed to the chair of chemistry at South Carolina State College at Columbia. Dr. Browne harked back to early references to chemical warfare, while Father Coyle of Holy Cross College, Worcester, Mass., told a thrilling list of the achievements of a Jesuit priest

A. C. S. Birmingham, 1922

The T. C. I. Special and Visit to Muscle Shoals





1. Arriving at the byproduct plant of T. C., I. & R.R. Co.
2. Arrival at Iskooda Mine, No. 14.
3. The barbecue at Bayview.
4. Close-up of the barbecue.
5. Arrival at the blast-furnace plant of T. C., I. & R.R. Co.
6. The all-day party at Sheffield.
7. Inspecting Wilson Dam.
8. Crossing the construction bridge at Wilson Dam.

BYPRODUCT COKE OVENS, TENNESSEE COAL, IRON & RAILROAD CO.

named Anastasius Kirchen who lived 1602-1680, invented the magic lantern as an incident, but who was in effect one of the fathers of modern chemistry. A number of other interesting papers were presented.

Section of Chemical Education

The Symposium on Chemical Education was carried on under the chairmanship of President Smith, and it proceeded without a dull minute. The papers had to do with high school and first year college chemistry and the training of chemical engineers. In teaching high school chemistry, for instance, the question was raised whether it was not better to begin with metals and more tangible things than with gases and the difficulties of the gas laws to young minds. It seemed to resolve itself into the conclusion that the first thing to accomplish is to arouse the interest and curiosity of the pupils—and when this is accomplished the rest is easy.

What to do with high school chemistry in college was a harder question. In some colleges preliminary teaching of the subject is not recognized, and in others freshmen are divided into those who have had chemistry and those who have not, but this does not always work out well. Many who have "had chemistry" and even passed their examinations don't know anything after all, while others are well prepared. It was a hard nut to crack. At one university they have two classes scheduled for the same hour, and at the end of the first month many who have entered the more advanced class drop back into that which is elementary. But even that is not satisfactory, and the problem seems not yet solved.

There was considerable discussion on what the function of the first year's course in chemistry is, whether formative or informative. Father Coyle of Holy Cross College, Worcester, Mass., believed that the study of chemistry develops character. But the question would not down as to whether the first year of chemistry belongs properly in the secondary school or in college.

The "Project Method" of Teaching Chemistry

Prof. Gordon of the University of Maryland outlined a very interesting "project method" for teaching chemistry. This consists in re-writing the book, leaving out whatever may be easily discovered. It brings the classroom into complete co-ordination with the laboratory, for what is left out in the book and discussed in the classroom becomes the subject for study in the next laboratory period. The vacant spaces are filled in by the students, and the books are checked up before they are taken out of the laboratory. In the first half hour of the class following the laboratory period there is a quiz on what has been done, and a correction of all errors made, while the latter half of the hour outlines again work which is to be completed in the laboratory. It works well with about 400 students, on a basis of 2 hours lecture and quiz to 3 hours laboratory. It challenges the students to think, and they get credit for their thinking.

In the afternoon session the Massachusetts Institute of Technology plan was outlined, in which students spend a fifth year in industries, and there followed a general discussion, with papers interspersed, of chemical engineers.

Industrial Chemists Wanted

It seemed generally agreed that in 4 years' time it is impossible to train a good chemist and a good mechanical engineer at once. Either the chemistry or the mechanics must suffer. It was suggested that what is wanted is industrial chemists, and not mechanical engineers with a smattering of chemistry. In response to the question of what a chemical engineer should be, credentials offered by applications for positions were quoted, in which, in very defective English, the applicants had shown their studies of chemistry, physics and mathematics to be in the ratio of 12 to 1 to 1½. In other words, they had "boned up" on chemistry and did not know anything else. What to do with those roughnecks in professional life seemed another unsolved problem. Somebody proposed that applicants for positions be required to send moving pictures of themselves at table, and phonograph records of their colloquial discourse.

Teaching Methods in Vogue Elsewhere

Prof. Bogert of Columbia described methods in vogue at Columbia and Prof. Charles W. Evans circulated a series of charts which he had found very helpful in teaching organic chemistry. Lively discussion was elicited by Prof. H. A. Webb of Teachers' College, Columbia University, who presented a paper on "Standard Tests in Science, Especially Chemistry." These were drawn up on the basis of "mental tests." They show up the unpreparedness of students in an amazing manner, and enable the authorities to weed out much earlier in the process than otherwise those who cannot learn. By standardizing they make marking easy: the professor's secretary can do it by means of a key, whereas if tests are not standard there are scarcely two instructors who mark alike. Against the system is its somewhat mechanical nature of treating all students alike when they are individually different, and the fact that its whole merit is lost if advance copies of the questions get around. But a number of professors seemed to feel that a great advance had been made in the art of examining, and that these new standard examination papers should be warmly welcomed.

Prof. J. P. Montgomery of the University of Alabama told of his plans for chemistry courses, and Prof. Edward G. Mahin of Purdue presented a paper on "Science or Athletics?" It doesn't take much imagination to picture the plight of a professor of science who is trying to lead his students along into the paths of

wisdom, and to compare the piffling unimportance of his message with that of the cheer leader. It was a sad paper, that viewed the matter with alarm, but it found such favor among the auditors that the author was urged to have it published. Somebody suggested that it wasn't athletics that dragged students down as much as the quality of the young men themselves that could not reach up. But that was not a popular view.

The foregoing is a record of impressions rather than a detailed report of the meeting. Dr. Smith's frequent and illuminating comments and anecdotes made it really a memorable occasion; and if we had the space we would gladly tell more. If nothing definite was accomplished, it was, nevertheless, full of leads and in this respect it was said by a number of those present that, for their own purposes, it was the best meeting ever.

Section of Petroleum Chemistry

The Petroleum Section, first organized a year ago at the Rochester meeting, is one of the youngest sections to become a Division of the Society. This authorization, recently approved by the Council, is to take effect at the Pittsburgh meeting in September, 1922. The encouraging progress made as a section speaks well for the future success of the new Division of Petroleum Chemistry.

In the absence of Chairman T. G. Delbridge, Vice-Chairman D. K. French of Chicago presided at the two sessions on Wednesday, April 5, during which a number of interesting papers were read and several important items of business transacted. Some changes were proposed in the Section's constitution and bylaws, and after discussion by Dr. W. F. Faragher and the secretary, Dr. W. A. Gruse, the following resolution was adopted as a definition of the scope of the Petroleum Division: "The Division of Petroleum Chemistry shall devote its attention to the chemistry of petroleum and its products and not to the preparation of standard methods of tests and specifications; however, it shall at all times be the spirit of the Petroleum Division to co-operate if desired with other scientific societies and agencies interested in this field." In other words, a clear line of division is made between the Petroleum Division's activities and those of the A.S.T.M. committee D-2 and similar agencies interested in marketing and buyer-and-seller problems.

Physical Properties of Petroleum Oils

The first paper on the program was presented by A. P. Bjerregaard, chief chemist for the Empire Refineries, Inc., who discussed the effect of temperature changes on the volume of petroleum products, as well as the losses by evaporation and from entrapped air. His conclusions on these important questions and other useful data regarding the expansion of petroleum oils have been published in a pamphlet, which is being distributed from the company's offices at Tulsa, Okla.

An interesting discussion of viscosity measurements and the surface tension of petroleum oils followed the reading of papers by C. K. Francis and H. T. Bennett of Tulsa, of W. H. Herschel of the Bureau of Standards and W. A. Fulweiler and C. W. Jordan of the United Gas Improvement Co., of Philadelphia.

Blended Motor Fuels and Knocking

Thomas Midgley, Jr., of the General Motors Research Corporation, read a paper by T. A. Boyd and himself in which he discussed the detonation characteristics of aromatic and paraffine hydrocarbons such as met with in blended motor fuels. Knocking in internal combustion engines has been shown to be dependent on the chemical composition of the fuel and its pressure of detonation and not on pre-ignition, to which it is generally attributed. The compressions to which aromatic hydrocarbons can be subjected without detonation are very high as compared with the initial compressions that can be employed when paraffine hydrocarbons are used. But little has been known regarding the relation of the composition of blends to their detonation tendencies, one of the reasons being the lack of a suitable apparatus for conducting such tests. The laboratory of General Motors has, however, developed a special instrument consisting of a small auxiliary cylinder tapped into the cylinder head of a gas engine. The piston of this small cylinder is held firmly in place by a strong spring, but in such a way that its vibrations can be measured electrically. With the use of this instrument accurate measurements were made for a wide range of blended fuels and values were given for the limiting compression ratios at which the different blends will give combustion that is free from detonation.

Corrosion of Petroleum Refining Equipment

Ralph R. Matthews and Philip A. Crosby in two previous papers[1] had shown that in distilling mid-continent petroleum in a so-called pipe still, HCl was formed due to the hydrolysis of $MgCl_2$ in the brine associated with the crude oil. The authors used ammonia in their fractionating columns and succeeded in combating the corrosion at a comparatively small cost. This article, together with photographs of the corroded parts, will be published in an early issue of Chemical & Metallurgical Engineering.

Extraction of Gasoline From Natural Gas

F. M. Seibert, in a paper prepared by F. E. Hosmer and himself, reviewed the natural-gas gasoline industry from 1904, when two plants produced a total of 16,000 gal., to 1920, when 650 plants had an output of 483,000,000 gal. He then outlined one of the methods of gas extraction in which a great deal of progress is now being made. The author referred to the low-pressure evaporation method in which the crude product is utilized to furnish refrigeration for cooling the gas after being subjected to pressure.

After discussing briefly the use of solid absorbing materials such as activated charcoal and silica gel, attention was directed to the liquid absorbents of which either crude oil, mineral seal oil, naphtha or low-grade gasoline is used. In the crude oil process it was stated that the best results could be obtained by subjecting the gas to about 50 lb. pressure at ordinary temperatures and absorbing the gasoline at a saturation ratio up to 25 per cent.

Research Program Indorsed

The concluding feature of the Section's program was a conference on the promotion of research on petroleum. Naturally the research program outlined by Dr. Van H. Manning in his address before the general meeting of the Society formed the basis of this discussion. Willing co-operation was expressed by Dr. Bjerregaard and others. Finally by official action the Petroleum Section went on record as indorsing Dr. Manning's program and voted to appoint a committee, which should include

[1] Chem. & Met. Eng., vol. 22, No. 11, p. 491, and vol. 23, No. 23, p. 1128.

representatives of the Bureaus of Mines and Standards, and which should co-operate with Dr. Manning in promoting joint research on the chemistry and chemical technology of petroleum.

Division of Sugar Chemistry

The color of sugar and sugar products and use of various materials for decolorizing them were the subjects of discussion in one group of papers presented before this Division. There were also, of course, several important reports on analytical methods and apparatus for testing of sugar or its byproducts.

The color of the solution of a sugar is certainly not a good index of purity. This fact was well demonstrated by the data presented by F. W. Zerban, who discussed "The Color Range of Cane Sirups and Molasses." Data on about 1,000 samples were reported to show the relation between the color as tested on diluted specimens in the Hess-Ives instrument in comparison with the "purity." Only 56 per cent of the samples follow the rule of color relationship normally expected, according to Zerban's data. He presented a curve of the relation between these properties for products of Louisiana plants using the sulphitation process and developed a mathematical expression of the curve. However, this curve did not apply to Cuban molasses at all. It was shown also that where carbon had been used in connection with the processing the color was lighter than would normally correspond to the purity for similar materials not so treated. The importance of color rather than purity in fixing the commercial value of a sugar was made clear by a discussion of the results.

Decolorizing Principle of Bone Char

A preliminary report on "The Decolorizing Power of Bone Char," by P. M. Horton, was presented by C. E. Coates. Horton discussed the earlier work of Hall and of Patterson on the influence of nitrogen in bone black upon its decolorizing power. The earlier workers claim that the nitrogen-bearing bodies were the active element or at least contributed largely to the activity. Horton digested samples of the material on the water bath for 1 hour at 90 deg. C. with concentrated sulphuric acid, filtered, diluted, obtaining a gelatinous flocculent precipitate. Another sample was digested for several days with acid at room temperature and the precipitate similarly obtained. Both precipitates were dialyzed free from acid and tested for decolorizing value. It was found that when the acid was eliminated thus, the results reported by the earlier workers were not duplicated. It is therefore concluded that the activity of the char when affected by treatment is due to a change in the structure or surface of the carbon and not simply to the removal of the nitrogen-bearing material. The earlier workers probably mistook the decolorizing effect of the acid remaining in the nitrogenous material for a property of the material itself.

Bone Black vs. Activated Charcoal

C. E. Coates strongly advocated the manufacture of plantation standard granulated sugar either with or without activated char instead of shipping the plantation sugar to a refinery "owned by the trust." Emphasizing the importance of uniform size, color and purity of the finished granulated sugar for maintenance of regular trade, he insisted that small plants handling about 50 tons of sugar per day were reasonably efficient units for neighborhood operation. Even though probably not as efficient as big plants, they can be operated well enough to pay profits to plantation sugar mill owners, for the additional investment would be between $25,000 and $50,000, especially if no additional buildings were required. Any animal or vegetable chars, including bone black, require care for refinery use. Activated carbon can be used with much cheaper installation than is possible with bone black, but certain disadvantages are sometimes met, for chars are sold on a royalty basis, often with exaggerated claims as to their possibilities, and no standard procedure for use has been generally established. Difficulty in filtration of material decolorized by activated char is met if great care is not used; but with proper chemical research and development, Prof. Coates believes there is some net advantage for the activated char in comparison with bone black. He states the loss in reactivation is 1 to 2 per cent, but care and proper treatment is essential or the value after processing is seriously decreased. Reactivated char costs $15 per ton for recovery, in contrast from six to ten times this price for new material. It can be used thirty to fifty times before discarding and the total cost of the char should be about 2c. per 100 lb. of sugar refined. This is a trifle higher than bone black cost, but the investment is sufficiently less to offset the difference.

Color and ash absorption by bone black and by decolorizing carbons was discussed by W. B. Horne, who claimed that the carbons, though superior in color absorption, removed no ash. Tests of carbon fixed on a porous earthy base gave encouraging results for ash as well as for color removal. Dr. Horne assumes in his comparison that removal of 0.2 per cent of ash from the raw sugar by bone black gives a 1 per cent increase in sugar recovery; however, he does not reconcile this with the ratio of 2 to 1 commonly reported by refiners. His cost comparisons are all on the 5 to 1 assumption.

C. E. G. Porst, director of research of the Corn Products Refining Co., with M. Moskowitz, discussed plastometer tests on alkaline thin boiling cornstarches, giving a mathematical and experimental report of results. Alkali addition produces a firmer paste almost up to the neutral point, but further addition weakens the paste, though it makes it smoother, translucent and of better spreading power.

M. Louis Baissac of the Island of Mauritius informally discussed some of the conditions and problems of sugar production in the tropical islands of Australasia. Much plantation white sugar is made in that territory, but no decolorizing carbons are used there as yet. The luxuriant growth of vegetation in some of this country is well shown by the yield on certain special plots of cane where 15 to 17 tons of finished sugar per acre have been manufactured in certain seasons.

Division of Physical and Inorganic Chemistry

The growing interest in colloids was reflected in the fact that one-third of the papers of this Section were devoted to colloidal or closely related subjects. The start is being made to place the study of the physical properties of colloids on a quantitative basis. Important additions to colloidal science, followed shortly by industrial applications, are bound to result from this method of treatment.

Whenever a capillary tube method is used to measure the viscosity of a viscous liquid there is an error due to incomplete drainage which is larger the greater the

viscosity and the shorter the time of drainage. This error may be as great as 1.5 per cent. A table should be worked out for the corrections required for oils of different viscosity and for varying drainage periods, according to Bingham and Young of Lafayette College. The present unsatisfactory means for comparing the yield value and mobility of a paint with its so-called painting consistency was pointed out by Bingham and Bruce. A committee recently appointed to report on standard samples of paint had been able to make only rather rough estimates. By plotting the volume flow against shear the results lie on a straight line within the error of the stop watch used. This line when extrapolated to zero volume flow should give a value accurate to a very few per cent of the minimum yield value of any given plastic material. In the discussion it was brought out that starch pastes follow a slightly curved line and gelatine a straight line.

Crystalline Structure

Two papers were presented on the lattice structure of crystals. Dr. Sosman showed a model to help explain the idiosyncrasies of silicon dioxide in its various minerals, while Dr. Wherry is of the opinion that the electrons are held rather rigidly in the crystalline lattice and that frequently an electron is shared by more than two atoms. The conception of the "domain" of the atom was defined as the space reserved for each atom as bounded by planes which bisect the lines joining atomic centers. The fact was pointed out that very few of the atomic domains were in the simplest geometric forms but occurred usually in truncated modifications thereof.

Papers by Edward C. Franklin and by Cady and Elsey described some interesting reactions taking place in anhydrous ammonia and pointed out the similarity of nitrogen and oxygen compounds—e.g., nitric acid and its counterpart, ammono-nitric acid or hydrazoic acid.

Glue and Gelatine

Dr. R. H. Bogue of the Mellon Institute read an interesting paper on the connection between the hydrogen-ion concentration and the properties of emulsoid colloids. In the determination of the content of jelly a concentrated solution of magnesium sulphate is used to precipitate out the jelly which is least soluble at its isoelectric point. In studying the joining strength, so important for glues, the optimum acidity produced a change in the viscosity of a 1 per cent solution by only 7 centapoises from the least favorable concentration. The determination of viscosity with an ordinary pipette involves a change of about 10 centapoises for every second read on the stopwatch—far too crude a measure. At the isoelectric point the ions of electrolytes are most easily washed out. There are a very great number of plant operations where the concentration of the hydrogen ion should be known and controlled.

Ash-free gelatine was prepared by Sheppard and Sweet of the Eastman Research Laboratories by passing a 220-v. direct current through a 5 per cent gelatine near its isoelectric point. Then on precipitating with redistilled acetone but 0.01 per cent ash was left. The elasticity as shown by twisting various cylinders of different concentrations of gelatine did not have any special properties at the isoelectric point. The interfacial tension against toluene, on the other hand, was found, by the drop number method, to exhibit maxima at the isoelectric point for most concentrations and at a variety of temperatures. The addition of aluminum salts caused a shift of the maximum to the alkaline side. Inorganic gels are formed either by an interlacing of threads or by films surrounding the disperse medium, according to Dr. Harry B. Weiser of the Rice Institute. A study of the behavior of dibasic organic acids and ethereal salts on water surfaces was described by King and Wampler in light of recent work by Langmuir and Harkins. In general, the adsorption of the dibasic acid is less than that of monobasic acids, although the results among different acids are somewhat irregular. Prof. Jack P. Montgomery of the University of Alabama described the adsorption of alkali halides by barium sulphate as being almost in the order of molecular weights. Lithium chloride was scarcely adsorbed at a concentration up to a millimol in 50 c.c.

New Apparatus

An interesting thermoregulator has been developed by E. B. Starkey and Prof. Gordon, as shown in Fig. 1. The tarnishing of the surface of mercury where the make and break occurs is done away with. The capillary tube contains air, but the oxygen is eliminated with the first spark or two. Toluene is placed in the bulb and the amount can be regulated through the stopcock *S* when working at different temperatures.

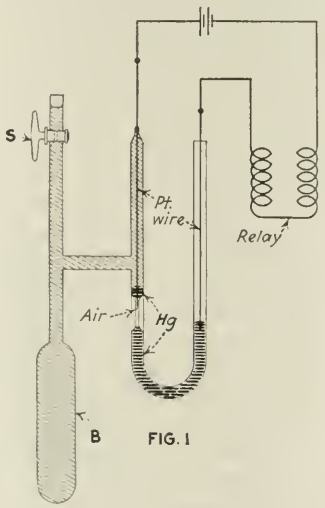


FIG. 1

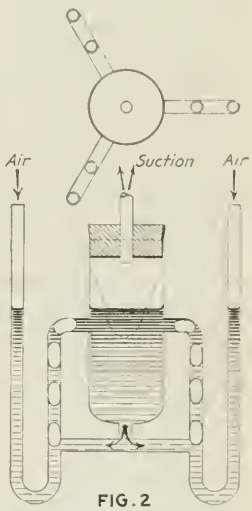


FIG. 2

FIGS. 1 AND 2—SKETCHES OF NEW APPARATUS
1—A thermoregulator with a clean mercury contact surface.
2—A simple cell for rapid electroanalysis.

A simple and easily constructed cell for rapid stirring of the electrolyte was described by Prof. Edgar of the University of Virginia. By applying water-pump suction to the top of cell, as shown in Fig. 2, air is drawn up through the three side arms so rapidly that a marked vortex is produced. This eliminates any tendency to entrain spray and permits very rapid analytical depositions.

Section of Cellulose Chemistry

The work of the Forest Products Laboratory stood out prominently in the meetings of the Cellulose Section, at which thirteen papers were presented and discussed. The report of the committee on the preparation of standard cellulose was accepted with certain modifications. In this connection W. O. Mitschlering, Atlas Powder Co., read a paper on the "Use of Standard Cellulose." The object of the investigations reported was to introduce a normal cellulose into experimental laboratories. It was found that when normal cellulose was used for nitrating purposes, the spent acid obtained was purer than that from the nitration of ordinary

plant cellulose, the product was more uniform and the loss of cellulose during nitration was lower. A revised method for testing the viscosity of cellulose solutions was devised by which the cellulose passes into solution immediately and is tested in a neat falling sphere viscosimeter designed by the author.

Harold Hibbert presented a résumé of work done by himself and co-workers on the synthesis of various cyclical acetal derivatives. The value of the work as stated by Dr. Hibbert lies in the fact that such derivatives are very closely related structurally to the pentosanes, hexasanes, starch and cellulose. It is hoped that from a knowledge of the behavior of these synthetic products toward acids, alkalis, bisulphites, etc., valuable information will be obtained relative to the action of sulphites, for instance, on related derivatives present in wood. Knowing the limits within which the stability of such materials lie may result in information which will make possible increased yield of paper pulp by the bisulphite process.

Work of Forest Products Laboratory on Hydrolysis and Fermentation

Five of the papers from the Forest Products Laboratory were read by E. C. Sherrard. One of the most interesting discussed the manufacture of "Ethyl Alcohol From Western Larch." The idea prompting the investigation was that since the butt logs contain 10 to 25 per cent galactan they constitute the best source of this material and that if a similar quantity of sugar is obtainable from larch cellulose in addition to that in the galactan, this would be an excellent source of alcohol. Galactan was extracted with hot water, hydrolized and fermented. The residue from the water extraction was hydrolized (15 minutes at 115 lb. steam) with sulphuric acid, and the resulting sugars extracted. The average yield was 39.9 gal. of 95 per cent alcohol per ton of dry wood, the largest yield ever obtained from any wood. The importance of this work to the paper maker is obvious, since by extracting the chips with water before pulping, an easily convertible sugar may be obtained.

A discussion as to the structure of celluloses from different sources was brought forth by a paper on the "Effect of Concentrated HCl on Different Celluloses," by E. C. Sherrard and A. W. Froehlke. Several cellulose samples from woods and cotton were treated with HCl and the change of angular rotation observed. Curves in which specific rotation was plotted against time show marked differences, indicating differences in the structure of the celluloses.

Additional evidence of differences in the chemical structure of wood cellulose from that of cotton cellulose was offered as a result of investigations by E. C. Sherrard and G. W. Blanco into "Some of the Products Obtained in the Hydrolysis of White Spruce." In this work, the volatile products, the soluble materials and the fibrous residue have all been studied. The best cooking conditions were determined. The yield of volatile acids was found to be 1.9 per cent of the dry wood used, the yield containing four times as much acetic as formic acid. Methods for the identification and determination of various sugars were developed. A yield of furfural was obtained equal to twice the yield of volatile acids.

"Sugar Formation in a Sulphite Digestor," by E. C. Sherrard and C. F. Suhm, discussed the rate of sugar formation during the pulping process and the effect of the formation on the quality of pulp. It was found that the rate of sugar formation is influenced mostly by the temperature and the concentration of free SO_2. Time is also a factor, since prolonged cooking increases sugar production, but at the expense of cellulose.

"The Results of Analyses of Some American Woods," read by L. F. Hawley, presented the work of the Forest Products Laboratory on Western woods as possible substitutes for those species which are becoming scarce. The acetic acid content, pentosane, methoxy and furfural content of eight species was determined. Dr. Hawley also presented some recent results on the distribution of methoxy groups in the products of wood distillation, by L. F. Hawley and S. S. Aiyar.

"The Analysis of Western White Pine and Eucalyptus," by S. A. Mahood and D. E. Cable, gave interesting figures on the yield of acetic acid from the two woods and a comparison of their lignin and alpha cellulose content.

Symposium on Production of Cattle Feeds From Waste Cellulose

A symposium on the production of cheap cattle feed from wood waste brought out some interesting discussion. E. C. Sherrard described the acid hydrolysis of sawdust for production of feed and the experiments of Prof. Morrison of Wisconsin University in substituting this product for barley in the standard cattle ration. Harold Hibbert described the Oexmann process of treating straw with alkali under pressure for the production of a feed which is 75 per cent edible. An improvement over this process is the Beckmann method, by which 100,000 tons of feed was made in Germany in 1918. Chopped straw is treated for 3 hours at 100 deg. C. with a 1 per cent Na_2CO_3 solution. Since no pressure is required, this can be carried out by any farmer and yields a feed which is 75 per cent edible, whereas the original chopped straw was less than 20 per cent edible.

Division of Dye Chemistry

Of the twelve papers scheduled for the Dye Division, only six were read, as several of the authors were not present. R. N. Shreve, secretary of the Division, presided.

Herbert L. Haller's paper on the preparation of phenylglycine ortho carboxylic acid from anthranilic acid and monochloracetic acid was read by Max Phillips of the Color Laboratory, Bureau of Chemistry. The paper discussed the optimum conditions of concentration, time, temperature, ratio of reacting materials and condensing agent as determined by experiment. This process was said to be used commercially in France.

"The Preparation of 7-7′ Di (alpha-hydroxyisopropyl) Indigo" was the subject of a paper by Max Phillips. It described the preparation of a new indigo dye from paracymene obtained from sulphite turpentine. The new dye has a similar absorption spectrum to that of indigo and compares favorably in dyeing properties. It is soluble in most organic solvents. Thus far the yield obtained is only about 15 per cent theoretical.

"The Influence of Sulphur on Colors of Azo Dyes" was the subject of a paper by W. R. Waldron and E. Emmet Reid, read by the latter. Dr. Reid exhibited several series of wool samples in connection with his talk, showing the effect of sulphur in the sulphide and sulphone condition in comparison with the sulphur-free base. Thirty different bases containing sulphur in various positions and associated with various alkyl and aryl radicals were prepared, diazotized and coupled with dye intermediates. It was found that sulphide sulphur

deepens the color, but the sulphone group gives a color even lighter than that of the base.

"Uses of Paratoluenesulphonyl Chloride in the Manufacture of Dyes and Intermediates" was the title of a paper by Jules Bebie, Monsanto Chemical Co. This substance is a byproduct in the manufacture of saccharin. One of its derivatives, chloramine-T, is an excellent germicide. It can be used as a component or part of a component for the production of various classes of azo dyes and in combination with azo dyes containing hydroxyl groups to make the resulting dyes fast to alkali and soap.

"The Application of the Direct Dyes in Coloring Paper," by Walter C. Holmes, E. I. du Pont de Nemours & Co., was read by title by A. E. Houlehan. The paper discusses the ineffectiveness of customary trade practice for sized papers due to the formation of considerable proportions of aluminum lakes of undesirable characteristics. A large range of attractive shades of superior fastness are said to be possible by judicious employment of copper lakes of various individual dyes and combinations.

"The Analysis of Beta Naphthylamine," by Henry R. Lee and D. O. Jones, was read by the former. Four methods for this determination were discussed, with advantages and comparative results. Melting point curves for beta naphthylamine with each of its usual impurities were given.

Division of Organic Chemistry

A most ambitious program of thirty-odd papers was scheduled for the Division of Organic Chemistry and long sessions were held on both Wednesday and Thursday. The chairman, Dr. Hans T. Clarke, had not recovered sufficiently from his recent illness to attempt the long trip to Birmingham, and in his absence the meetings were conducted by Prof. Frank C. Whitmore, secretary of the Division. Unfortunately lack of space in this issue precludes the detailed mention of the many interesting and valuable papers which were presented before the organic chemists, but it is at least worth while to comment on an important innovation introduced by this Division. On March 25, well in advance of the Birmingham meeting, Dr. Whitmore sent a complete set of abstracts of all papers to each member enrolled in the Division. This action not only stimulated the interest of organic chemists in the work of the Division but afforded an opportunity for those unable to attend the meeting to follow its progress. It is the belief of the Division's officers that only a small proportion of the organic chemists of the country are now enrolled in the Division of Organic Chemistry, and it is suggested that those interested in receiving copies of abstracts communicate with Dr. Whitmore, of Northwestern University, at Evanston, Ill.

Division of Rubber Chemistry

It will be recalled that at the New York meeting the Division of Rubber Chemistry went on record as favoring the formation of a central research laboratory under the direction of the Rubber Association of America. After due deliberation the Rubber Association has decided that the time is inopportune for such an undertaking and is, therefore, taking no action at present.

The Geer age test was formally adopted as the standard age test of the Division. The feeling was expressed by Mr. Boggs and others that the present specifications containing limits on extracts, total and free sulphur, etc., are restricting development. Physical and life tests were considered much more reasonable. The Rubber Division methods of chemical analysis are now ready for publication and will be taken up for approval at the September meeting. The physical testing committee has prepared agenda and will report at the September meeting.

Internal Mixers

R. P. Dinsmore reported on an elaborate series of experiments on internal mixers performed at the Goodyear Tire & Rubber Co. One gathered from his paper that the results have not been entirely satisfactory. He met with least difficulty in low-grade compounds. He mentioned the interesting observation that rubber which is plasticized by heat at high temperature, such as is obtained in the internal mixers, has a greater recovery—that is, is stiffer—when cooled than stock broken down to the same apparent plasticity on the mill.

Thermal Properties of Rubber and Rubber Pigments

Extensive experiments to determine the specific heat and conductivity of rubber fabric and were summarized by Ira Williams in a paper on "Thermal Properties of Rubber and Rubber Pigments." This matter is of great importance. Mr. Williams' tables will be found below.

THERMAL CONSTANTS OF PIGMENTS

Pigment	Sp.Gr.	Sp.Ht.	Conductivity (C.G.S. Units)
ZnO	5.5	0.125	0.00166
Red oxide	4.7	0.160	0.00132
$MgCO_3$	3.0	0.303	0.00103
Lithopone	3.95	0.115	0.00094
Whiting	2.68	0.201	0.00084
Cord fabric*	1.5	0.324	0.00082
Blanc fixe	4.35	0.114	0.00078
Gas black	2.0	0.204	0.00067
Dixie clay	2.6	0.200	0.00058
Talc	2.70	0.209	0.00058
Litharge	9.25	0.052	0.00051
Rubber, smoked sheet crepe, etc., including cured	0.92	0.502	0.00032
Golden antimony	3.20	0.025	0.00021
Sulphur	2.00	0.175	0.00012

*Approximate

Physical Properties of Rubber Compounded With Light Magnesium Carbonate

H. W. Greider made a study of the physical properties of rubber compounded with light magnesium carbonate. The dolomite deposits of Pennsylvania furnish an adequate supply of raw materials. Best grades of precipitated carbonate approximate $11MgCO_3 . 3Mg(OH)_2 . 11H_2O$. The water is probably chemically combined. No decomposition below 265 deg. C. The light magnesium carbonate has a specific gravity of 2.18. Extensive compounding data show 9 volumes magnesium carbonate to 100 volumes rubber to be the optimum ratio. This corresponds to 21 parts by weight on rubber. Magnesium carbonate ranks as a filler between zinc oxide and carbon black. The high set imparted will restrict its use. Surface aging of stocks high in carbonate is bad, due probably to crystals of carbonate. Mixtures of carbon black and magnesium carbonate, 6 volumes and 3 volumes, respectively, to 100 of rubber, show greatest stiffening action. The combination of zinc oxide and magnesium carbonate is the best aging. Work is going forward on producing an amorphous magnesium carbonate which the author hopes will overcome the high set.

Stress-Strain Curves

W. B. Wiegand presented some excellent ideas on a standardized graph for stress-strain curves, etc., for the purpose of making the work of the various investigators more comparable. This matter was referred to the physical testing committee.

Relation Between Chemical and Physical State of Cure

The relation between chemical and physical state of cure of rubber vulcanized in the presence of certain organic accelerators was discussed by Norman A. Shepard and Stanley Krall. Their paper dealt with the old question of the relation between physical properties and coefficients of vulcanization. Experiments were performed with several common accelerators. The accelerator ratios were varied until the stress-strain curves at a definite cure—namely, 60 minutes at 141.7 deg. C.—passed through a definite point. In this manner they secured the same depolymerization from heat in all cases. It was found that equivalent stress-strain curves under these conditions were given with the following compound:

Base Stock:	
Rubber	48
Zinc oxide	48
Sulphur	3
Equivalent accelerator ratios:*	
Hexamethylenetetramine	0.5
Paranitrosodimethylaniline	0.25
Aldehyde ammonia	0.75
Thiocarbanilide	1.5

*The amounts of accelerator shown were added to four different mixes of the base stock.

The coefficient of vulcanization was obtained as follows:

Extraction 16 hours in an Underwriter's flask with acetone; 5 hours' extraction with alcoholic potash; 16 hours' extraction with alcohol followed by treatment with an ether hydrochloric mixture, as according to Stephens, followed by long extraction with water to remove all soluble sulphates. Sulphur was then determined by the Watters and Tuttle method. Coefficients of vulcanization were as follows: 0.87 with hexa-, 1.03 with paranitroso, 0.98 with aldehyde ammonia, and 1.38 with thiocarbanilide. The authors therefore conclude that vulcanization coefficient has no relation to physical properties and that the various accelerators have a specific action other than sulphur addition.

Recent Developments of the Chemistry of Rubber

Dr. Geer repeated his very interesting talk before the Rubber Division.

Approximately thirty-five members attended the meeting of the Division.

Division of Water, Sewage and Sanitation

Prof. Edward Bartow, of the State University of Iowa, read a paper prepared by himself and two of his associates, M. E. Flentje and W. U. Gallaher, discussing the effect of temperature on the rate of reaction in water softening by the lime-soda ash method. Although the reactions in this process are well known, the effect of heat has not been definitely established in the literature. Furthermore, the manufacturers of hot lime-soda water softeners have made public but little of their own data on this subject.

The experimental work described in this paper was conducted on the deep-well water of Iowa City, which has a mineral acid hardness around 95 p.p.m. A special apparatus was developed which could be heated electrically to a constancy of 0.5 deg. In addition to temperature variations, the amount of lime was varied to ascertain the effect of mass action on the process. It was used both in excess and in lesser quantity than that theoretically required for complete softening.

The principal conclusions of the authors were as follows:

1. The rate of reaction increases with lime provided sufficient sodium carbonate is added to neutralize the non-carbonate hardness.
2. The rate increases greatly with the rise in temperature; the greatest relative increase in rapidity probably occurs in the 18-20 deg. C. rise above normal.
3. Completeness of reaction also increases with temperature and the first 18-20 deg. is likewise most effective. The time of reaction is cut from 4 hours to 30 minutes. At a rise of 40 deg. the reaction is almost instantaneous—in fact there would appear to be no justification for heating above 65 deg. C.
4. With increasing temperature a small decrease was noted in the amount of lime required for softening.

Mechanism of Iron Removal

Prof. A. M. Buswell, chairman of the Division, gave an interesting discussion of the mechanism of iron removal. Our prior knowledge of iron in water has been very ably summarized in a long paper presented by Robert Spurr Weston[1] in 1909 and Dr. Buswell limited his comments to more recent developments. In connection with the two usual methods of removal—viz., filtration and aëration followed by filtration—it was pointed out that detention after aëration is not particularly effective, since even 6 hours fails to remove more than 25 per cent of the Fe. The probable explanation is that the iron is still in colloidal form. Gravel filters, probably by adsorption, will remove 25 per cent and thus lessen the load on slow sand filters.

The fact that lime will remove iron, while alum is not so effective, can be explained on the basis that the $CaCO_3$ resulting from the lime forms negatively charged particles which attach themselves to the colloidal suspension. Alum, on the other hand, forms positive colloids which do not exhibit the "attaching" power of the $CaCO_3$. This theory is confirmed by the fact that other negatively charged particles such as clay and diatomaceous earth act in a manner similar to lime.

Dr. W. W. Skinner, secretary of the Division, summarized two papers from his laboratory at the Bureau of Chemistry. The first, by J. W. Sale, discussed the determination of specific gravity of mineral waters by calculation. The second, by Dr. Skinner and Messrs. Badger and Sale, outlined a number of interesting reminiscences regarding the unusual compositions noted in certain bottled mineral waters.

The Value of the p_H Determination in Water Treatment

Chairman Buswell also summarized a paper by Dr. W. D. Hatfield on the application of p_H value to the operation of a filter plant. After reviewing the various methods for determining the hydrogen-ion concentration, the author concludes that the colorimetric methods

[1] "Purification of Ground Waters Containing Fe and Mn," *Trans.*, Am. Soc. C. E., vol. 64, pp. 112-207 (1909).

are more satisfactory than the electrometric. He has found the buffer solutions of Clark and Lubs to be the most useful. Among his principal conclusions are that the amount of alum used is dependent upon the buffer value of the water, which in turn is roughly dependent upon the methyl orange alkalinity. Coagulation begins at a p_H value of 7.8 and in the summer months is satisfactory at around 7.6. The most efficient results at the Highland Park (Detroit, Mich.) filter plant over several months demonstrated an optimum value of 7.3. In the discussion of this paper it was pointed out that these conclusions are of course applicable only to the single plant studied.

Dr. Buswell, in a lucid discussion of the chemical equilibria in the coagulating basin, drew a chart which showed the striking importance of the hydrogen-ion concentration. It was made very evident that all of the basic reactions in water treatment are more or less dependent upon this factor. Much of the work which has been done recently, especially by the engineers, to simplify water chemistry has been at the expense of neglecting many of the underlying fundamentals such as are considered in Dr. Buswell's paper.

The Smoker

On Tuesday evening the members of the Society were the guests of the Alabama Technical Association at a smoker given at the Southern Club of Birmingham. The hosts, who are the Alabama members of the leading national engineering societies, provided an interesting program of music, vaudeville and good fellowship. Perhaps the most popular as well as unusual feature of the program was the characteristic negro melodies sung by a chorus from the Colored People's Sixteenth Street Baptist Church.

Excursions to Plants

The Tennessee Coal & Iron Co.'s Special

Through the energetic efforts of the Alabama Section's committee on excursions, of which J. R. Harris was chairman, and through the courtesy of the Tennessee Coal, Iron & Railroad Co., about two hundred members were enabled to visit the numerous industrial plants clustered in the Birmingham Valley. A special train was furnished which left Birmingham at 9 a.m. on April 7 and carried the members to the iron, coke, steel and wire works and to the iron and coal mines, stopping at each point of interest long enough for a brief inspection trip through each plant.

Although any of the plants visited would have offered enough of interest to consume several days of inspection, the well-planned excursion served admirably to give the members a birdseye view of this industrial center of the South. In this richly endowed valley were seen iron and coal mines, limestone quarries, gravel beds and byproduct coke plants within a radius of a few miles. the longest rail haul required for any of the raw materials of the steel works being 14 miles. The morning of the trip included stops at the Ensley plant of the Tennessee Coal & Iron Co., where the blast furnaces and open hearths were seen in operation, a visit to the Bessemer rolling mills, which were rolling out steel rails, and stops at Ishkooda iron mine and the coal mine at Edgewater. Arrived at Bayview, the members were greeted by the strains of "Dixie," while on the slope above a beautiful lake were found tables loaded down with barbecued meat and Southern delicacies and even a mysterious tent which was rumored to contain a high explosive, manufactured from corn in the nearby hills of Shelby county.

After a hearty luncheon, the special train proceeded to the T.C.I. byproduct plant, which was thrown open for inspection; thence to the Fairfield blooming mill, where the plate and structural mills, tie plate department and car plant were seen. The final stop was made at the American Steel & Wire Co. and opportunity was afforded for seeing the drawing of wire, the weaving of wire fences and the manufacture of wire nails. Not one of the tired chemists that tumbled from the train at 6 o'clock in Birmingham but had conceived an admiring appreciation of the industrial activity of this section.

Additional opportunity was afforded on Saturday, April 8, for visits to the American Cast Iron Pipe Co. and the fertilizer and cement plants in the vicinity of Birmingham. Great credit is due to the local committees, not only for the well-planned trips but for the excellent arrangements for meeting places, entertainment and transportation. The executive committee was composed of J. F. Carle, chairman; Theodore Swann, C. N. Wiley, M. Kuniansky, J. T. MacKenzie, J. R. Harris, H. S. Geismer and A. K. Boor.

Visit to Muscle Shoals

A desire on the part of many to visit the Muscle Shoals nitrate plants and power site resulted in arrangements being made for special sleepers leaving Birmingham Friday night and arriving at Sheffield Saturday morning. About fifty made the trip, the delegation being divided at Sheffield into two parties, those who intended to spend the entire day there and those who wished to leave early in the afternoon. Members of the Sheffield Chamber of Commerce very kindly furnished automobiles and conducted the parties through plants 1 and 2, and the steam power plant on the Tennessee River, which were thrown open for the occasion. In the afternoon the visitors were afforded the privilege of a detailed and extremely interesting inspection of Wilson dam under the expert guidance of Colonel Weeks, officer in charge of construction.

The two crowded days of excursions and sightseeing brought a successful meeting to a fitting close. Each homeward-bound member carried away a jumble of pleasant impressions — the beauty and hospitality of Birmingham, her remarkable industrial activity, the magnitude of the Muscle Shoals project, the solid support which Henry Ford has in the South, the hospitality which was manifested everywhere and recollections of friendship renewed and made.

Au revoir, Dixie, and thank you!

E. H. H. C. P. Wik Kirk Buck Mack
"CHEM. & MET.'S" DELEGATION AT BIRMINGHAM

Chemical Schedule of the Senate Tariff Bill

A Study of the Changes Proposed in the Fordney Measure Which Will Most Affect the Chemical Industries—Provisions for Flexible Tariff and Temporary Extension of Dye Embargo—Tabular Comparison of Rates With House Bill and Existing Law

AFTER nearly 9 months of study and preparation the majority members of the Senate Finance Committee have reported their long-expected revision of the permanent tariff bill. Although many important changes have been made in the draft approved by the House, a long and bitter fight is in prospect before the bill is finally written on the statute books. A number of the crudities and rough spots in the Fordney measure have been smoothed over and notable improvement made in the elimination of certain provisions of questionable merit.

As in past tariff laws, ad valorem rates in the Senate bill are based on the foreign value of imported merchandise. The American valuation plan as embodied in the bill passed last July by the House was abandoned because of the limited number of exactly comparable domestic and foreign products and the difficulty and probable litigation involved in defining comparability to the satisfaction of importers, domestic manufacturers and customs officials.

As a substitute measure the committee has incorporated provisions for a flexible tariff and proclaimed American valuation such as had been recommended by President Harding. The elasticity in the tariff has been provided by giving the President authority to increase or decrease the rates not exceeding 50 per cent, if after investigation he finds such action is necessary. The President is also empowered to change the basis of valuation on certain items from the foreign value to the value of the domestic article; to impose penalty duties and prohibit the importation of particular goods; and to impose additional retaliatory duties against any country which discriminates against us.

Embargo on Dyes and Synthetic Organic Chemicals

So far as the chemical industries are concerned the outstanding feature of the tariff bill is the extension for 1 year of the dye and chemical control provisions of the emergency tariff act. A last-minute change before the bill was reported provided that the President could extend the embargo for an additional year if it should be found necessary. Chairman McCumber, in the report which accompanied the bill, gives the following explanation of the committee's attitude toward the domestic dye and synthetic organic chemical industries:

> It was found that the rates provided for dyes and coal-tar chemicals, after the limited embargo provisions covering these products had been eliminated on the floor of the House of Representatives, were wholly inadequate to protect the domestic industry.
>
> It is common knowledge that Germany had a monopoly of the world's trade in dyes prior to the war. Although our domestic industry has made great strides during and since the war, when these products have been admitted to the United States only under license, as provided by the emergency tariff act of May 27, 1921, and although our industry is capable of supplying between 85 and 90 per cent of the quantity required by domestic consumers, it has not attained a point of efficiency of manufacture where it can hope to compete with the well-organized industry which exists in Ger-

RATES OF DUTY ON IMPORTANT CHEMICALS IN SENATE BILL COMPARED WITH THOSE IN HOUSE BILL AND UNDERWOOD-SIMMONS ACT

Specific duties on per pound basis unless otherwise noted

Commodity	Underwood-Simmons Act of 1913	Fordney Bill of 1921	Fordney Bill of 1922
Acetic acid, 65% and less	Free	¾c.	¾c.
Acetic acid, over 65%	Free	2c.	2c.
Acetic anhydride	2½c.	8c.	5c.
Boric acid	¾c.	2c.	1½c.
Chloroacetic acid	15% n.s.p.f.	5c.	5c.
Citric acid	5c.	12c.	18c.
Lactic acid	1½c.	1½c.–3c.†	2c.–4c.†
Tannic acid and tannin	5c.	4c.–20c†	4c.–20c.†
Tartaric acid	3½c.	6c.	6c.
Arsenic and arsenious acids	Free	25%	3c. and 2c.
Formic acid	1½c.	25%	4c.
Gallic acid	6c.	25%	8c.
Oleic acid	15% n.s.p.f.	25%	1½c.
Oxalic acid	1½c.	25%	4c.
Phosphoric acid	Free	25%	2c.
Pyrogallic acid	12c.	25%	12c.
Stearic acid	15% n.s.p.f.	25%	1½c.
Acetaldehyde, etc	15% n.s.p.f.	6c.+30%	6c.+30%
Acetone	1c. per lb.	25%	25%
Alcohol, amyl	½c.	6c.	3c.
Alcohol, butyl and propyl	½c.	6c.	3c.
Fusel oil	½c.	6c.	2c.
Alcohol, methyl	Free	15c. per gal.	10c. per gal.
Alcohol, ethyl	$2.60 gal.	15c. per gal.	10c. per gal.
Aluminum hydroxide	15%	½c.	½c.
Alum	15%	1/10–¾c.†	1/10–¾c.†
Ammonium carbonate	¾c.	1½c.	1½c.
Ammonium chloride	¾c.	1½c.	1½c.
Ammonium sulphate	Free	½c.	½c.
Anhydrous ammonia	2½c.	2½c.	2½c.
Antimony oxide	25%	2c.	1½c.+25%
Tartar emetic	15% n.s.p.f.	5c.	6c.
Argols and wine lees	5%	5%	5%
Cream of tartar	2½c.	5c.	5c.
Rochelle salts	2½c.	5c.	5c.
Balsams, crude	10%	10%	10%
Balsams, refined	15%		
Barium carbonate	15%	1c.	1½c.
Barium chloride	½c.	1½c.	1½c.

Commodity	Underwood-Simmons Act of 1913	Fordney Bill of 1921	Senate Bill of 1922
Barium dioxide	1½c.	4c.	4c.
Barium hydroxide	15% n.s.p.f.	25% n.s.p.f.	1½c.
Barium nitrate	15% n.s.p.f.	2c.	2½c.
Bleaching powder	1/10c.	⅜c.	½c.
Caffeine	$1	$1.50	$1.50
Tea waste	1c.	1c.	1c.
Calcium carbide	Free	1c.	1c.
Calomel	15%	30%	45%
Carbon tetrachloride	1c.	2½c.	2½c.
Chloroform	2c.	8c.	6c.
Chalk, precipitated	25%	15%	35%
Chicle, crude	15c.	15c.	15c.
Chicle, refined	20c.	20c.	20c.
Chloral hydrate	25%	25%	35%
Terpin hydrate	25%	25%	35%
Thymol	25%	25%	35%
Urea	25%	25%	35%
Glycerophosphoric acid	25%	25%	35%
Coal-tar intermediates	10%	7c.+30%	7c.+50%
Coal-tar dyes medicinals, etc	30%	7c.+35%	7c.+60%
Cobalt oxide	10c.	20c.	20c.
Collodion	15%	35c.	35c.
Pyroxylin, unfinished	25%	40c.	40c.
Pyroxylin, finished	40%	65c.+25%	60%
Drugs, crude	Free	Free	Free
Drugs, advanced	10%	10%	10c.
Buchu leaves	10c.	10c.	10c.
Coca leaves	10c.	10c.	10c.
Gentian	½c.	½c.	½c.
Licorice root	½c.	½c.	½c.
Sarsaparilla root	1c.	1c.	1c.
Belladonna	10%	25%	3c.
Digitalis	10%	25%	3c.
Henbane	10%	25%	3c.
Stramonium	10%	25%	3c.
Cyanide: potassium cyanide, sodium cyanide, compound and mixtures	Free	Free	10%
Ergot	10c.	10c.	10c.
Diethyl sulphate	15% n.s.p.f.	25%	15c.

Commodity	Underwood-Simmons Act of 1913	Fordney Bill of 1921	Senate Bill of 1922
Dimethyl sulphate	15% n.s.p.f.	25%	15c.
Ethyl acetate	5c.	4c.	3c.
Ethyl chloride	20%	15c.	15c.
Ethyl ether	4c.	6c.	4c.
Extracts for dyeing and tanning	¾c.	11%	25%
Flavoring extracts, non-alcoholic	20%	25%	25%
Formaldehyde	1c.	25%	2c.
Hexamethylenetetramine	15% n.s.p.f.	25%	10c.
Glycerine, crude	1c.	1c	1c.
Glycerine, refined	2c.	3c.	2c.
Ink and ink powders	15%	20%	30%
Iodine, resublimed	Free	20c.	20c.
Bromine	Free	10c.	5c.
Bromine compounds	n.s.p.f. 15%	10c.	8c.
Lead acetate, white	1¼c.	3½c.	2½c.
Lead acetate, brown	1c.	2½c.	2c.
Lead nitrate	1½c.	2½c.	3c.
Lime, citrate of	1c.	7c.	6c.
Magnesium carbonate	1½c.	2½c.	2½c.
Magnesium chloride	15% n.s.p.f.	¾c.	½c.
Magnesium sulphate	1/10c.	½c.	½c.
Magnesium oxide	3½c.	7c.	7c.
Magnesia, calcined	Free	¾c.	¾c.
Manganese: borate, resinate, sulphate and all other manganese compounds and salts, n.s.p.f.	15% n.s.p.f.	25% n.s.p.f.	25%
Menthol	50c.	25%	50c.
Camphor, crude	1c.	1c.	1c.
Camphor, refined	5c.	6c.	6c.
Oils, animal, n.s.p.f.	15%	20%	20%
Oils, fish, n.s.p.f.	3c. per gal.	20%	5c. per gal.
Oils, expressed, n.s.p.f.	15%	20%	20%
Castor oil	12c. per gal.	4½c.	3c.
Cottonseed oil	Free	2c.	3c.
Coconut oil, crude	Free	2c.	4c.
Soya-bean oil	Free	2c.	3c.
Hempseed oil	3c. per gal.	1½c.	1½c.
Linseed oil	10c. per gal.	2½c.	3½c.
Olive oil, less than 5 gal.	30c. per gal.	7½c.	50c. per gal.
Olive oil, more than 5 gal.	20c. per gal.	6½c.	40c. per gal.
Peanut oil	6c. per gal.	2½c.	4c.
Poppyseed oil	6c. per gal.	2c.	2c.
Rapeseed oil	6c. per gal.	1½c.	6c. per gal.
Turkey-red oils	25%	25%	35%
Oils, essential, n.s.p.f.	20%	25%	25%
Orange and lemon oils	10%	20%	30%
Peppermint oil	25c.	25%	25%
Opium, crude	$3	$3	$3
Opium, manufactured	$4	$4	$4
Morphine	$3 per oz.	$3 per oz.	$3 per oz.
Cocaine	$2 per oz.	$2 per oz.	$2.60 per oz.
Perfume materials, synthetic	20%	35%	45%
Perfumery, alcoholic	40c.+60%	40c.+60%	40c.+60%
Perfumery, non-alcoholic	60%	60%	60%
Floral waters	20%	20%	20%
Bay rum	$1.75 per pr.	40c.+60%	40c.+60%
Paris green	Free gal.	15%	2c.
Phosphorus	Free	10c.	8c.
Paints, artists'	20%	25%	30%
Paints and pigments, n.s.p.f.	20%	25%	25%
Barytes, crude	15%	$4 per ton	$5 per ton
Barytes, ground	20%	$7.50 per ton	$10 per ton
Prussian blue	20%	12c.	8c.
Ultramarine	15%	3c.	4c.
Bone black	15%	20%	1c.
Chrome colors	20%	25%	30%
Gas black	15%	20%	30%
Litharge	25%	2½c.	2½c.
Orange mineral	25%	2½c.	3c.
Red lead	25%	2½c.	2½c.
White lead	25%	2½c.	2½c.
Ochers, siennas, umbers	5%	½–⅜c.	½–⅜c.
Satin white	20%	½c.	½c.
Spirit varnishes, denatured	10%	25%	35c. per gal +35%
Spirit varnishes, not denatured	$1.32 per gal.+35%	$2.20 per gal.+25%	$2.20 per gal.+35%
Vermilion reds	15%	33c.	28c.
Zinc oxides	10%	1½c.	1¾c.
Zinc oxides, in oil	15%	2c.	2¼c.
Lithopone	15%	1½c.	1¼c.
Potassium chromate	1c.	2½c.+15%	2½c.+15%
Potassium dichromate	1c.	2½c.+15%	2½c.+15%
Potassium chlorate	½c.	1c.+15%	1c.+15%
Potassium ferricyanide	2c.	7c.+15%	7c.+15%
Potassium ferrocyanide	1½c.	4c.+15%	4c.+15%
Potassium iodide	15c.	25c.+15%	25c.+15%
Potassium bicarbonate	½c.	40%	1½c.+15%
Potassium bromide	15% n.s.p.f.	10c.+15%	8c.+15%
Potassium carbonate	Free	40%	¾c.+15%
Potassium hydroxide	Free	40%	1c.+15%
Potassium nitrate	35c.	40%	½c.+15%
Potassium permanganate	1c.	40c.	4c.+15%
Santonin	Free	75c.	75c.
Soap, castile	10%	15%	15%
Soap, toilet	30%	30%	10-50%
Soap, all others	5%	20%	5%
Sodium arsenate	Free	1c.	1c.
Sodium bicarbonate	½c.	⅜c.	½c.
Sodium borate	½c.	½c.	½c.
Sodium bromide	15% n.s.p.f	10c.	8c.
Sodium carbonates	Free or ½c.	½c.	½c.
Sodium chlorate	½c.	1½c.	1½c.
Sodium chloride, bags	Free	0.11c.	0.2c.
Sodium chloride, bulk	Free	0.7c.	0.16c
Sodium chromates	½c.	1½c.	1½c.
Sodium formate	15% n.s.p.f.	25%	1c.
Sodium ferrocyanide	¾c.	2c.	2c.
Sodium hydroxide	½c.	½c.	½c.
Sodium nitrite	½c.	3c.	3c.
Sodium phosphate	½c.	½c.	½c.
Sodium sulphate, crystals	Free	5c.	5c.
Sodium sulphate, anhydrous	Free	10c.	10c.
Sodium sulphide	½c.	¾–¾c.†	¾–¾c.†
Sodium silicate	Free	¾c.	¾c.
Sodium sulphites	½c.	⅜c.	⅜c.
Sodium hydrosulphite	15% n.s.p.f.	35%	35%
Sulphoxylates	15% n.s.p.f	35%	35%
Starch, potato	1c.	1½c.	2c.
Starch, all other	½c.	1c.	1c.
Dextrine, potato	1¼c.	1½c.	1½c.
Dextrine, all other	¾c.	1½c.	1½c.
Strontium salts	15% n.s.p.f.	25%	50%
Strychnine	Free	15c. per oz.	15c. per oz.
Thorium nitrate	25%	25%	45%
Tin compounds	10%	20%	25%
Titanium compounds	15% n.s.p.f.	25%	5c.+25%
Vanilla beans	30c.	30c.	30c.
Tonka beans	25c.	25c.	25c.
Zinc chloride	½c.	1 7/10c.	1 7/10c.
Zinc sulphate	½c.	¾c.	¾c.
Zinc sulphide	15%	1½c.	1½c.
Petroleum, crude	Free	Free	Free
Fuel oil	Free	Free	Free
CHEMICALS ON THE FREE LIST			
Chromic acid	Free	Free	Free
Hydrofluoric acid	Free	Free	Free
Hydrochloric acid	Free	Free	Free
Nitric acid	Free	Free	Free
Sulphuric acid	Free	Free	Free
Cinchona bark	Free	Free	Free
Calcium acetate	Free	Free	Free
Calcium chloride	Free	Free	Free
Calcium nitrate	Free	Free	Free
Calcium cyanamide	Free	Free	Free
Coal-tar crudes	Free	Free	Free
Copper sulphate	Free	Free	Free
Copper acetate	Free	Free	Free
Crude drugs	Free	Free	Free
Enfluerage grease	20%	Free	Free
Floral essences	20%	Free	Free
Ferrous sulphate	Free	Free	Free
Iodine, crude	Free	Free	Free
Monazite sand	25%	Free	Free
Oils, essential	20%	Free	Free
Potash salts, crude	Free	2½c.††	2½c.††
Quinine	Free	Free	Free
Sodium nitrate	Free	Free	Free
Sodium sulphate, crude	Free	Free	Free
Sulphur	Free	Free	Free
Pyrites	Free	Free	Free

* Not specially provided for.
† Depending on strength.
†† For two years; 2c. for third, 1½c. for fourth, 1c. for fifth, thereafter free.

many. Your committee has reached the conclusion that no rates in American tariff history would be adequate to protect this industry.

Your committee therefore recommends that the provisions of the emergency tariff act relating to dyes and synthetic organic chemicals be extended for a period of 1 year after the tariff bill becomes a law. The President is also authorized, if upon investigation he ascertains that the rates specified upon coal-tar intermediates and dyes do not equalize the differences in competition here and abroad, or if he ascertains that an industry in the United States is being or is likely to be injured by reason of the importation of like intermediates or dyes into the United States, to issue a proclamation stating such fact and to continue the dye and chemical control act in force for a further period not to exceed 1 year. In addition, the following rates of duty on these products are proposed: 50 per cent plus 7 cents per pound on intermediates and 60 per cent plus 7 cents per pound on finished coal-tar products.

Under the administrative provisions previously referred to, the President is given authority to change the basis of these rates to the American values of similar or competitive articles and also to increase or decrease these rates as much as 50 per cent if such action is found to be necessary. The extension of the dye control provisions for 1 year, or 2 years if necessary, will give the President ample time to investigate conditions in the dye industry and to ascertain what changes in rates and methods of valuation are necessary in order that all branches of the organic chemical industry may become firmly established in the United States.

The inequalities between the rates on citrate of lime and citric acid were adjusted by increasing the duty on citric acid from 12 to 18 cents per pound and decreasing

the rate on citrate from 7 cents to 6 cents per pound. The duties on lactic acid and oxalic acid have been increased considerably over those in the House bill. The rates on butyl alcohol and competitive products were more than cut in half by the Senate Finance Committee. Both crude and ground barytes received substantial increases and additional compensatory duties were imposed on the various barium chemicals. In the case of mercurials, too, it was necessary to increase the duty in order to compensate for the increase in the rate on quicksilver, which had been changed on the floor of the House. The duty on chalk was radically increased—from 15 to 35 per cent—presumably to take care of the highly purified, chemically refined chalk.

Changes From Ad Valorem to Specific Duties

In a number of places throughout the chemical schedule it will be observed that specific duties were substituted for the ad valorem rates of the House bill. This was usually done in the case of definite chemical compounds in which there is but little variation in the grades or qualities ordinarily used in commerce. Another factor which no doubt prompted many of these changes was the relatively greater stability in prices at present than at the time the House bill was framed.

The duty on natural dyeing and tanning extracts has been more than doubled over that in the House draft. A new classification covering vulcanized or hard fiber has been inserted to provide for cellulose products made by treating cellulose with zinc chloride to hydrolize it and then after dehydration, molding the material by pressure. The glue and gelatin paragraph has been entirely rewritten and edible gelatin has been separated from other forms of glue and gelatin. In the case of the technical products the separation is on a price basis —the dividing line being at a value of 40 cents per lb.

Vegetable Oils

A heavy duty was placed on cottonseed, soya bean, coconut and peanut oils, but by means of an important proviso these oils can be imported duty free under bond for use in the manufacture of products unfit for food. This is practically equivalent (except in the case of peanut oil) to putting them on the free list. The duty on castor oil has been reduced and that on alizarin assistants increased from 25 to 35 per cent. One interesting and highly important change has been in the case of tapioca and sago, which were transferred from the free list and given substantial duties under the agricultural schedule.

The paragraph on soap was changed materially and the language of the old 1909 provision accepted. This provides somewhat higher duties but will also give the customs officials a chance to distinguish between "perfumed" and "unperfumed" toilet soap.

Potash and Cyanide Tariffs

Fertilizer materials remain dutiable, although the rate on ammonium sulphate was reduced from $\frac{3}{5}$ to $\frac{1}{4}$ cent per pound. Chilean nitrate, however, continues on the free list. The sliding scale of duties on crude potash salts—viz., 50 cents per unit for the first 2 years, 40 cents for the third, 30 for the fourth, 20 for the fifth, and thereafter duty-free—was continued in the Senate bill, although a number of slight reductions were made among the refined potassium salts.

The results of one of the most interesting of the tariff battles in the chemical schedule is found in the new paragraph 33a, which provides a 10 per cent duty on potassium and sodium cyanides. This may be said to represent a compromise between the demands of the domestic producers and those of the important consuming interests.

Paragraph 5, the important "catch-all" or "basket" clause of the chemical schedule, which includes "all chemical elements, salts and compounds" not elsewhere specially provided for, carries a duty of 25 per cent ad valorem. This is the same as in the Payne-Aldrich tariff of 1909 and is an increase of 5 per cent over the rate in the corresponding paragraph of the 1913 tariff.

Research Develops New Concept of Soils

Investigations by the Bureau of Soils of the Department of Agriculture have resulted in the announcement of an interesting new conception of the nature of soils. A colloidal material, quite different in nature from the mineral particles and organic matter which are generally believed to make up the whole of the soil, has been isolated from a number of different soils and has been dubbed "ultra clay." It seems to constitute a fundamental part of the soil. Studies of the behavior and properties of the colloidal particles that make up this ultra clay are giving a new concept of the soil, and it is predicted that these researches will throw fresh light on many soil problems.

Ultra clay is described as a gelatinous material which shrinks greatly on drying and has a high absorptive power for water, ammonia, salts and dyes. At the proper moisture content it may have a binding power far greater than portland cement. At other moisture contents it is highly plastic. In short, this material has in an exaggerated degree most of the properties characteristic of the soil as a whole.

Chemically, ultra clay appears to be chiefly a gelatinous silicate of aluminum with varying amounts of ferric hydroxide, silicic acid, aluminum hydroxide and organic matter, in a colloidal condition. These substances exist in such a fine, or colloidal, state of subdivision that when the material is shaken up with water a permanent, opalescent suspension is obtained and many of the individual particles appear under the ultramicroscope only as points of light in active motion. In the presence of certain salts the colloidal particles coagulate, forming large aggregates which readily settle out.

The Electric Resistance Furnace in an English Brass Foundry

A month's test was recently conducted to determine the utility of a Baily 1-ton nose-tilting type furnace in one of the oldest brass-rolling mills in England. The test charges consisted of cartridge shells and rolling mill scrap, pouring 60-40 brass into round billets, strip molds and condenser plates.

In the test on round billets, 3 in. to 6 in. in diameter, operating the furnace continuously for thirty-one heats, 50 hours was consumed in melting and a total of 48,608 lb. of brass was poured. The electrical energy consumed was 306 kw.-hr. per ton of metal melted.

With a similar charge of cartridge shells and rolling mill scrap pouring 60-40 brass into condenser plates weighing 1,700 lb. each eighteen heats required 31 hours and 49 minutes. The total metal melted was 30,744 lb. at an energy consumption of 276 kw.-hr. per ton of metal melted.

FIG. 19—PLATINUM MINING TOWN OF ANDAGOYA AT CONFLUENCE OF SAN JUAN AND CONDOTO RIVERS IN COLOMBIA

Minerals, Earths and Clays of Latin America—III

A Review of Some Latin-American Resources, Many of Which Await Commercial Development—Platinum in Colombia, Lead in Mexico, Bismuth in Bolivia, Monazite Sand in Brazil, Asphalt in Trinidad, Sulphur, Borax, Precious Stones and Other Important Mineral Products*

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In 1914, when the outbreak of the European war practically shut off the Russian exportation of platinum, the chemical industry and other platinum users of the world turned to the second most important source, the Republic of Colombia. These two countries have furnished practically the world's supply of platinum—Colombia before 1914 being a distant second to Russia, supplying only 6,000 to 15,000 oz. out of a total of 250,000 to 300,000 oz. With the Russian output greatly curtailed, Colombia's proportion, as well as the actual amount produced, increased rapidly. In 1917 the estimated production of Colombia was 32,000 oz. and that of Russia 50,000; in 1918 the figures were 35,000 oz. for Colombia and 25,000 for Russia; in 1919 Colombia produced about 35,000 oz. and Russia 30,000; and in 1920 the two countries were about equal with 35,000 oz. each. These figures, of course, especially as regards Russia, represent only broad estimates.[1] Our imports from Colombia in 1920 were 29,853 oz., and in 1921 31,840 oz. There is reason to believe that with more intensive mining operations the South American country may in time lead the world as a platinum producer, even with a normal Russian output.

Colombian platinum is derived entirely from placer operations in the sands and gravel of the rivers of the western part of the country, from the Ecuadorian border to the headwaters of the Atrato River. The principal stream, so far as known deposits are concerned, is the Condoto River, a tributary of the San Juan. Most of the platinum has heretofore been recovered by natives, but dredging operations, backed by extensive British and American capital, are now being carried on. The South American Gold & Platinum Co. has two dredges working on the Condoto River, and is preparing a third which will be larger than either. One of the dredges produced 6,349 oz. in 10 months in 1919, and in the first 8 months of 1920 worked at a still better rate. The British Platinum & Gold Corporation also has a dredge on the Opogodo River of the San Juan basin. Colombian platinum as it reaches the market consists of 80 to 85 per cent of platinum, a higher proportion than the average, the remainder comprising other metals of the platinum group, notably osmium and iridium.

The platinum deposits are said to extend over the border into Ecuador, but apparently the metal, which is found associated with gold, is not found in important quantities in that country. On the island of Chiloe, off the mainland of Chile, beach deposits of black sand are reported to contain some platinum, but in amounts too small to be profitable so far as present discoveries have disclosed.

Lead and zinc are scattered over many countries of South America, and are smelted in many of them, as also in Mexico. The output of lead (metric tons) in South America and Mexico in recent years has been:[2]

	1913	1914	1915	1916	1917	1918	1919	1920
South America..	2,729	3,145	4,667	4,267	4,571	5,268	7,234	5,510
Mexico.....	62,000	23,598	31,384	19,966	46,612	88,503	78,645	84,200

*For Parts I and II, which discuss other mineral resources of these countries, the reader is referred to Chem. & Met. Eng., vol. 26, Nos. 14 and 15, pp. 631 and 697, April 5 and 12, 1922.

[1]The U. S. Department of Commerce gives the following as a Russian estimate of production in recent years: 1914, 156,960 troy oz.; 1915, 108,489 oz.; 1916, 78,997 oz.; 1917, 98,483 oz.; 1918 (to July 1), 13,166 oz.

[2]Amer. Bur. Metal Statistics Year Book, 1920.

The chief South American lead exports come from Peru, where it is obtained as a byproduct in silver mining or from the ancient slag of the Cerro de Pasco copper mines, which formerly produced silver. The total represents scarcely a third of 1 per cent of the world's output. In the neighboring country of Bolivia there is also a small production, the exports running from 1,000 to 3,000 tons a year. The ore is galena and the only field worked is near the town of La Quiaca, on the Argentine border. This ore is generally exported through Buenos Aires. Argentina has numerous deposits of lead in the same districts in which copper is found; in fact, the sulphides of the two metals often occur together. Working heretofore has been for the purpose of obtaining silver, with which the lead is often associated. All deposits are lode deposits.

In the provinces of San Juan, Mendoza, Neuquen and Cordoba there has been more or less exploitation and development of the argentiferous galena veins, but in other provinces containing apparently abundant deposits, among which are Salta and Jujuy, there has been little production. Lead has been reported from several localities in Brazil; Chile has a small output from the silver mines; Colombian lead ores have been found in the departments of Caldas, Santander, Boyaca and Cundinamarca, and Venezuela has lead deposits in the states of Lara and Tachira. Galena deposits in the State of Minas, Uruguay, have been worked occasionally.

Zinc in the form of sphalerite is associated with lead and other ores in several countries and large deposits are said to exist in the Yauli district in the Province of Junín in Peru. The general lack of transportation facilities, however, has prevented development or active interest in most of these sources.

Mexico has extensive deposits of both lead and zinc. Lead smelting is an important industry, particularly in the Monterey district, and the annual pig-lead production of 50,000 to 125,000 tons makes Mexico one of the notable sources of the world's lead supply. The chief states producing lead are Chihuahua, Durango, Sonora, Nuevo Leon, Coahuila, San Luis Potosi and Zacatecas. There is apparently a large potential output of zinc in Mexico, and in the Piedras Negras district, when prices are favorable, production of calamine ore is carried on at the rate of 10,000 tons a month. The total Mexican production in recent years has been at the rate of 11,000 to 45,000 tons a year.

In Central America, Guatemala has deposits of lead, zinc and copper near Concepcion, and the International Railways has shipped several hundred tons of calamine ore and lead carbonates, together with concentrates.

Bauxite Deposits in the Guianas

While Brazil is said to have deposits of ferruginous bauxite among the surface iron ores of Minas Geraes, and occurrences are reported in Venezuela, Colombia and Ecuador, the only section of Latin America where the mineral is known to exist in large quantities is the Guianas. Because of lack of settlement and of transportation facilities the beds have not been fully mapped out, but they are said to be of great extent, and a former Governor of British Guiana has declared that the deposits of that colony are probably the largest in the world. The alumina content is very high, analyses showing over 60 per cent. The work of exploiting these deposits was begun in 1913, but during the war there was little activity. In 1917 shipments from British Guiana amounted to 2,070 tons, in 1918 to 4,266 tons, in 1919 to 1,967 tons, and in 1920 to 29,394 tons. Because of lack of a demand in the United States the company working the deposits stopped operations early in 1921. Shipments for the first 5 months of 1921, had, however, amounted to 10,545 tons, against 2,982 tons in the previous year.

Antimony From Mexico, Bolivia and Peru

Mexico, Bolivia and Peru have a place among the antimony-producing countries of the world, but only the first named ranks as an important source. Mining in South America was largely the result of war-time demands. The Mexican ores are mixed sulphides and oxides, containing 5 to 50 per cent antimony, and are found principally in the states of San Luis Potosi and Queretaro, although occurrence is spread widely over the country. Sonora, Guerrero, Durango and Lower California, among other states, have deposits of unknown extent. Production in 1917 is stated to have been 2,646 tons; in 1918, 3,278 tons; in 1919, 470 tons; and in 1920, 1,572 tons.

The Bolivian ore is of high grade, running over 50 per cent antimony, but the visible supply is said to be limited. The country is not an important prospect for the future, although war-time shipments were heavy, rising to 27,414 tons of ore in 1916, valued at $6,614,000. The chief producing district is in the southern part of the Department of Potosi. The Peruvian output has come mostly from the Department of Puno, although Cajamarca, Huanuco, Junín and other departments have deposits and Jeru is considered a source of possible future importance. The ore worked has averaged about 60 per cent antimony. Chile reports native antimony and stibnite in the states of Trujillo and Lara, but there has been no particular development in either country.

Bismuth and Quicksilver

The world's chief source of bismuth is Bolivia, where the ore, consisting of both native bismuth and the sulphide, is found associated especially with tin deposits and also with silver and copper. Production comes mainly from mines at Tasna, Chorolque and Huayna Potosi. Since 1914 exports of bismuth have ranged between 350 tons and 680 tons, valued at $850,000 to $1,600,000. Peru has a single mine, in the Department of Junín, whose reserve is said to be sufficient to supply the world for many years. The ore consists of oxidized bismuth compounds, averaging 3 per cent bismuth. In Chile bismuth has been reported from the Province of Atacama, as a sulphide. In Brazil it occurs

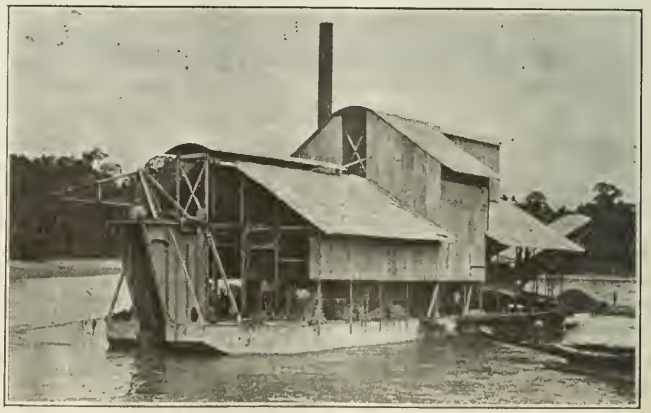


FIG. 20—DREDGE OPERATING IN THE CONDOTO

in the gold mines of Minas Geraes, both as native bismuth and the oxide, and is reported from the State of Rio Grande do Sul. The State of Lara, in Venezuela, has bismuth deposits.

Mercury has been found in several countries—Mexico, Peru, Bolivia, Argentina, Colombia, Chile, Brazil and Dutch Guiana—but in modern times only in the first two has much attention been given to production. The Peruvian mine at Huancavelica was opened about 1566 and the deposits have been worked, though not continuously, since that time. The ore is said to contain an average of 2 per cent mercury. In recent years mining has been suspended, but the owner, a Peruvian, is preparing to reopen the mine, and is driving a 4,000-ft. tunnel and has built two small furnaces. In Dutch Guiana floats of quicksilver are reported from near Marowyne River, and cinnabar is reported in place in one locality. The mines of Mexico, in San Luis Potosi, Guerrero and Durango are producing considerable amounts of quicksilver, the production for the whole country amounting to 163 tons in 1918, 118 tons in 1919, and 77 tons in 1920.

There is no mention of the existence of radium in any Latin-American country except in Brazil, where it is recently reported that the director of a museum in Fortaleza has discovered a deposit of radium-bearing minerals in the interior of the State of Ceara.

Important Non-Metallic Minerals

Mica.—Mica is becoming an important article of export in Brazil and Argentina, and has also been mined to some extent in Guatemala. The Brazilian mica is muscovite, of excellent quality, the masses taken out for export being mostly about 6 in. square, although much larger are often found. Production has so far been confined to four states, Bahia, São Paulo, Goyaz and Minas Geraes. São Paulo shipped 11,000 kilos in 1918. The Argentine mica is found in the Sierra de San Luis and the Sierra de Cordoba, and is said to be of good quality. The deposits are numerous and one Buenos Aires exporter has offered to furnish regular supplies up to 5 metric tons per month. The character and size of the quantities available are unknown, but shipments to Europe from Cordoba have consisted of small sizes of light brown muscovite. The Guatemalan mica is also muscovite, white, amber, green and other colors being found.

Monazite Sand.—In addition to its nitrates and other non-metallic minerals, Latin America has two rich fields, each of which is probably the most valuable of its kind in the world. These are the monazite sands of Brazil and the asphalt lakes of Trinidad and Venezuela. The invention of the gas mantle established the first commercial outlet for monazite, since this mineral is the chief source of thorium and cerium salts, on which the mantles are dependent for their incandescence. Mesothorium, the radioactive element which is coming into increasing importance as a substitute for radium in the manufacture of luminous paints, is also found in monazite. The monazite of Brazil is found both along the seacoast and in the inland river beds, where the action of the water has concentrated the sands formed by the disintegration of the crystalline rocks of the coastal mountains. The occurrence of the monazite in these rocks is too rare to permit profitable working. More concentrated deposits are found at various places along the Brazilian coast between Maranhao and Rio de Janeiro, but only in the states of Bahia and Espirito Santo are they of commercial value. The federal government claims the sands on a strip 33 m. wide, measuring from mean high tide, and these are now being worked under lease. The sands are high in thoria, averaging 4 to 6 per cent, and they can therefore be worked while deposits in our own country lie idle because of low prices. The beach reserves are estimated at 15,000 to 20,000 tons of concentrates. The inland streams apparently furnish the real reserve, the river beds of Minas Geraes, Espirito Santo and Rio de Janeiro having gravels that would probably yield 200,000 tons of monazite. In the last few years exports have gone wholly to the United States, shipments amounting to 1,136 tons in 1917, 500 tons in 1918, 146 tons in 1919, and 1,153 tons in 1920.

Asphalt.—Asphalt deposits, formed by the evaporation of the volatile parts of oil rising to the surface, are found in various parts of Venezuela and on the island of Trinidad. The two great sources of the asphalt of commerce are Trinidad Lake, on the island of that name, and Bermudez Lake, about 30 miles inland on the mainland across from Trinidad. The latter is much larger, covering about 2,000 acres, compared with about 120 acres for the former, but Trinidad has been the chief source of past exports, shipments amounting to 130,000 to 230,000 tons annually as compared with 25,000 to 95,000 tons from Venezuela. Trinidad Lake goes to an unknown depth, boring being difficult because of the fact that the asphalt is in constant slow motion. A depth of 150 ft. has been achieved. Venezuela has other deposits besides Lake Bermudez, several of which have been worked. One is located as far west as the Limon River, 50 miles west of Maracaibo. Cuba and Mexico in the past have also shipped varying amounts of bituminous substances.

Graphite.—Another form of carbon, graphite, is found in several countries, including Mexico, Brazil, Chile, Uruguay and Paraguay. Mexico is one of the chief producers of amorphous graphite for the manufacture of

FIG. 21—CARRYING ORE FROM MINE TO MILL IN MINING DISTRICT OF PERU

pencils, and some crystalline graphite is also reported. Normal production runs for 1,000 to 3,000 tons a year, that for 1917 being 420 tons; in 1918, 6,190 tons; 1919, 4,023 tons; and in 1920, 2,991 tons. The Santa Maria mine, near La Colorado, Cordoba, is the chief producer. Brazil apparently has deposits of an excellent grade of graphite in Minas Geraes and Rio de Janeiro, and also unsurveyed deposits of flake graphite. The former has been used locally for pencil manufacture. Exports amounted to 44 tons in 1918 and 2 tons in 1919. In 1920 there were no exports. In Chile some graphite has been mined at Chehueque, Atacama, but the production has been inconsiderable.

Sulphur.—Several countries have important deposits of sulphur, which are worked for local purposes. Perhaps the most important of these are in Chile in the craters and slopes of the old volcanoes. These deposits are near the nitrate fields and are convenient for the manufacture of the black blasting powder used in nitrate working. Deposits so far worked occur in provinces of Tacna, Tarapacá, Antofagasta, Atacama and Coquimbo, the chief producing district being that of Tocora in Tacna Province. The country's production has gone as high as 10,000 tons a year. Peru has many sulphur deposits, some of them with contents running 30 to 40 per cent sulphur. Venezuela has working deposits of sulphur.

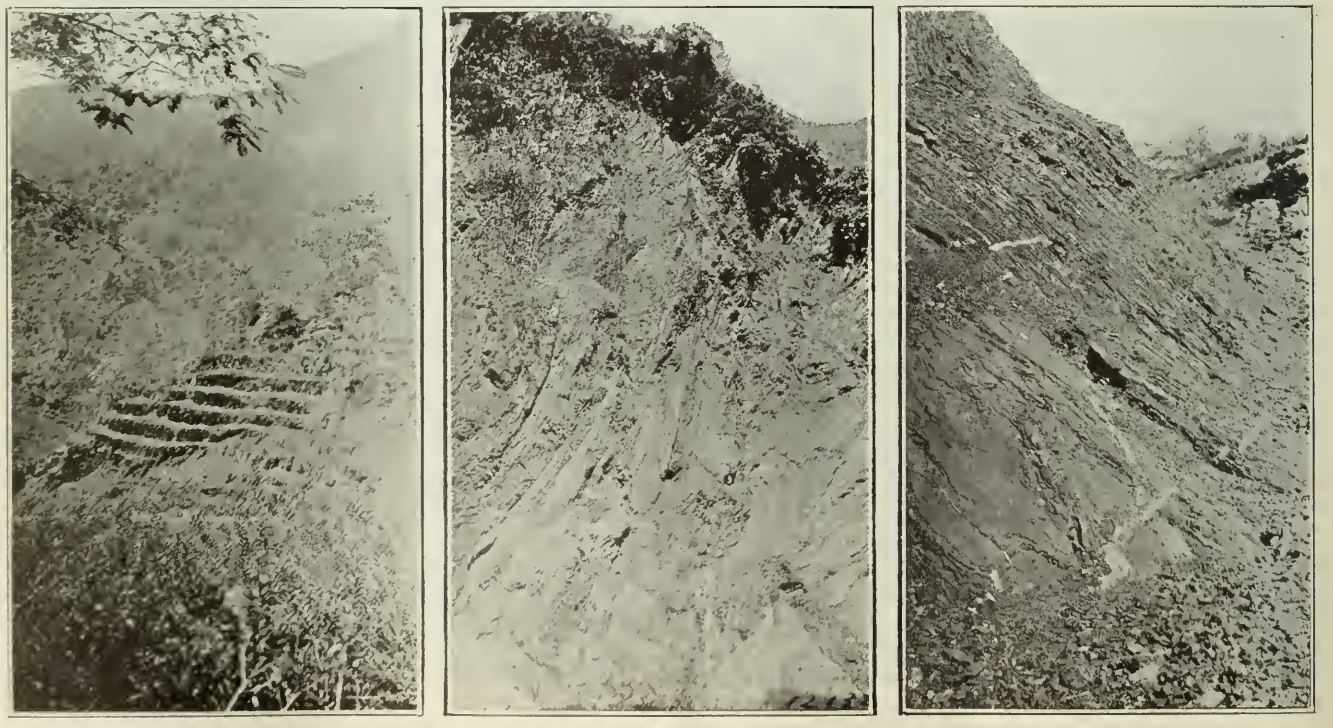
Several localities in Mexico produce sulphur, especially in the states of Durango, San Luis Potosi and Lower California. An interesting deposit worked off and on since the times of the early conquerors is that in the crater of Popocatapetl, where the supply is large, but the altitude makes exploitation expensive. Mexico also has important pyrite deposits, notably one in the State of Guerrero of several million tons, containing 48 per cent sulphur, but there is no production of importance. Cuba has a pyrite deposit near Cienfuegos, and the Andean countries and Brazil, in South America, report its presence in association with more important metals.

Borax.—Chile, Peru, Bolivia and Argentina are the borax countries of South America, the desert regions of northern Chile and one deposit near Arequipa, Peru, being the chief sources. The borates are found in the beds of dried-up lakes called *salares*, some of which contain millions of tons of crude borax. Because of transportation costs very few of these are worked, Chile's production of 40,000 tons annually coming almost entirely from the Saler de Ascotan in Antofagasta. Borax Consolidated, Ltd., a large British company, controls the industry in Chile, Bolivia and Peru, and it can increase its output to take care of any possible demand. The Argentine deposits are in the provinces of Los Andes, Jujuy, Salta and Catamarca. Those worked commercially contain 25 to 40 per cent of boric acid. The sun-dried product runs 38 to 50 per cent anhydrous boric acid. Several hundred tons is mined yearly for local and export purposes, but lack of fuel and transportation facilities makes more extended production unprofitable.

Rock Phosphate.—The chief Latin-American contribution to the world's supply of phosphate rock comes from the Dutch islands of Aruba and Curacao, off the coast of Venezuela. Normally there is a large exportation to Europe. Islands off the coast of French Guiana also export phosphates. Chile and Peru have worked deposits.

Potash.—Chile is the only country having potash deposits of importance, and the industry in that country has not been devoloped. The potash occurs in the *salares*, the two chief ones being the Salar de Pintados and the Salar de Bella Vista, in Tarapaca. Chilean chemists have estimated that these deposits contain over 2,000,000 tons of potash. They are of low grade, however, containing 10 to 15 per cent potassium sulphate (or chloride) and it is yet uncertain whether they can be worked profitably.

In addition to these separate deposits it has been found that some sodium nitrate deposits contain a certain amount of potassium nitrate, and the du Pont com-



FIGS. 22, 23 AND 24—VIEWS OF THE MUZO EMERALD MINES IN COLOMBIA

pany has recovered over 1,000 tons a year of potash in the form of the nitrate. It is claimed that if the du Pont process of separating the potassium from the sodium nitrate were followed at all the nitrate plants, over 100,000 tons of potash could be recovered annually.

Other Undeveloped Possibilities

Other non-metallic minerals are found scattered here and there and give evidence of what may be expected in the way of future development of Latin America's mineral wealth. Magnesite is produced in limited quantities on the island of Margarita, in Magdalena Bay, Lower California, where large quantities in canyon walls and stream beds are reported to be available without mining, and also in Margarita Island, Venezuela, where the ore is of the white amorphous type and occurs in very large deposits. Shipments from both these countries to the United States have been made regularly for several years. Fluorite has been found in many places in Mexico, but has been mined commercially in only one, a rich deposit located near Guadalcazar, in San Luis Potosi. Other deposits promise to become profitable; one of green fluorite in the town of Chalchihuites, in Zacatecas, has been worked to a certain extent. In Córdoba, Argentina, veins of fluorite occur in bands that are colorless, light green, yellow, violet, blue or almost black. Alum and soda are found in the old volcanos in Los Andes, Argentina. Large quantities of alum occur in two craters as clean white compact masses of mixtures of aluminum and magnesium sulphates containing about 20 per cent aluminum sulphate. Mexico is a considerable producer of white arsenic, the output being 2,246 tons in 1919 and 2,183 tons in 1920. The Mapini smelter owned by the American Metal Co. (Ltd.), has a plant with a normal annual capacity of 5,000 tons.

Chile is, of course, the world's largest producer of iodine, which is obtained as a byproduct of the nitrate industry. The largest year's output in recent times was 1,500 tons in 1916, an amount which could if necessary be greatly increased. Asbestos has been reported from Brazil and Uruguay, but apparently the deposits are of no commercial value.

Building stone is plentiful throughout Latin-American countries, but that of Uruguay is perhaps most ornate and best known. The quarries yield both marble and granite, the former ranging through many colors, white, red, pink, gray, black and banded, and providing excellent material for either building or statuary. A number of granite quarries are active, much of the granite being of high grade. Slates of a beautiful color and toughness, very suitable for roofing, are quarried in Uruguay for local purposes. Another notable product of that country found near Conchillas, in Colonia, is a very fine grade of talc which is of such purity that it is used for pharmaceutical purposes as well as in various industries.

Precious Stones

In precious and semi-precious stones Latin-American countries exhibit a wide range. Brazil and the Guianas are well known for their diamonds. Colombia is one of the chief emerald producers of the world. Pearl fishing has for centuries been an important industry of the Caribbean waters off the coast of Venezuela, and in the Pacific along the coast of Mexico, Nicaragua, Costa Rica and Panama. Mexico is famous for its opals. Uruguay has amethysts, agates and other semi-precious stones, and Venezuela has opals, amethysts and garnets.

Distribution of Petroleum Refineries in U. S.

Petroleum refineries in the United States on January 1, 1922, numbered 479 completed plants, with 30 additional plants in process of construction, according to a statistical summary prepared by H. J. Lowe, petroleum economist of the Federal Bureau of Mines. The indicated daily refining capacity of these plants is 2,164,050 barrels of crude oil.

The tremendous increase in the extent of the petroleum refining industry of the country is shown by the fact that in 1914 but 176 petroleum refineries had been completed. Within eight years the number of refineries has been increased by 172 per cent.

Texas at present leads all other states in the volume of oil refining business, with 63 operating plants, with a daily capacity of 345,150 barrels; in addition, the state had on January 1, 46 refineries in shut-down condition, while 9 other plants were being built. Oklahoma is the second state in number of refineries, with 54 operating and 43 shut down; operating plants in this state had a daily capacity of 234,650 barrels. California, with 34 operating plants, was refining 314,360 barrels daily. Pennsylvania had in operation 48 plants, with a daily refining capacity of 114,930 barrels. New Jersey, with but 5 refineries, treats 224,000 barrels of oil daily.

The importance recently attained by the State of Louisiana in this country is indicated by the fact that 14 refineries were treating 114,350 barrels daily, while 11 plants were in shut-down condition. Kansas, with 19 operating plants, was refining 57,650 barrels daily; Illinois, with 12 plants, was handling 62,050 barrels; Wyoming, with 11 plants, was refining 89,900 barrels; and Indiana, with 5 plants operating, was handling 54,300 barrels daily.

Of the 479 completed refineries in the United States, 154 were in shut-down condition at the first of the year. The daily refining capacity of these non-operative plants was 254,610 barrels, or approximately one-eighth of the entire refining capacity of the country. The 30 new plants in process of construction will, it is estimated, add 59,950 barrels to the country's daily refining capacity.

Need for Standardization of Mineral Fillers and Paving Blocks

The broad field of mineral fillers is sadly lacking standardization, according to Oliver Bowles, mineral technologist of the Bureau of Mines. Many users of mineral materials have very indefinite knowledge of their requirements either in color, grain size, grain shape or chemical composition. The standardization of fillers is practically an untouched field, and such standardization accomplished through a comprehensive study of the subject would not only promote better manufacturing processes but would be of material benefit to producers. It is claimed by one producer that the cost of purchasing special screens to satisfy the requirements for odd sizes for one customer destroys most of the profit obtained from grinding roofing grade talc.

Granite paving blocks are manufactured in a great variety of sizes, says Mr. Bowles. Eleven varieties, sold under trade names, were reported in 1917, and many other varieties were sold by sizes only. The State of Maine reported seven different sizes, New York seven, Massachusetts ten and other states a varying number. Undoubtedly some latitude should be permitted in paving block dimensions, particularly in length, but too great complexity is involved when every state or city writes its own specifications.

Aluminum-Silicon Alloys

Aluminum-Silicon Alloys Long Known Are Coming Into Use Because of Superior Casting Qualities—Unique Structural Change Brought About by Treatment of Molten Alloy Improves Physical Properties of Castings—Technical Properties of Alloys Described

By ZAY JEFFRIES
Research Bureau, Aluminum Co. of America

IN VIEW of the fact that aluminum-silicon alloys are now being used to some extent commercially, it is believed that a brief account of their history and characteristics will be of interest to aluminum founders and users of aluminum alloy castings.

Earliest Records

In *Comptes rendus*, vol. 42, p. 49 (1856), is found an account of what appear to be the first alloys of aluminum and silicon, prepared by H. St. Claire Deville and independently by Wöhler. Aluminum-silicon alloys can be prepared in a number of ways. One method described by Wöhler is to fuse a mixture of aluminum and an excess of the double fluoride of potassium and silicon at a temperature above 950 deg. C. in an ordinary crucible. After cooling, there is found in the midst of the fused salt an alloy of aluminum and silicon which contains varying amounts of silicon, depending upon the duration of the heating. Alloys of this nature were used for the purpose of producing pure silicon. This was accomplished by dissolving the aluminum with hydrochloric acid, nearly pure silicon remaining as a residue. In a book "Aluminum and the Alkali Metals" by Charles and Alexander Tessier (1858) the authors state, "As Deville has correctly observed, silicon does not destroy the malleability of aluminum as iron and copper would do." The authors state that the alloy they experimented with contained at least 10 per cent Si.

A rather extensive investigation of aluminum-silicon alloys was made by Adolphe Minet in the early '90s. In a note published in *Comptes rendus*, 1891, p. 1215, he gives the analyses and tensile properties of several aluminum-silicon alloys and aluminum-silicon-iron alloys, in both the cast and forged condition. The alloys were prepared by electrolysis, using a bath composed of sodium chloride (60 parts) and double fluoride of sodium and aluminum (30 parts), to which was added at the moment of fusion alumina (5 parts) and silica (5 parts). He makes the following comment on the tensile results: "The alloys rich in silicon, such as those which contain 8.9 per cent of this metalloid, possess tensile properties superior to those of pure aluminum."

In vol. 1, p. 10, of the *Journal de l'Electrolyse* (1895) results of tests on a large number of Minet's aluminum-silicon alloys are given. One alloy containing 89.8 per cent Al, 1.57 per cent Fe, 8.9 per cent Si, had a tensile strength of 24.300 lb. per sq.in. and elongation of 2.85 per cent as cast. The same alloy in the rolled condition showed a tensile strength of 27,950 lb. per sq.in. and elongation of 9.18 per cent. In this article the following comment is found: "The presence of silicon in aluminum, contrary to the ideas generally spread since Henry St. Claire Deville, does not injure the mechanical properties of aluminum; on the contrary, it gives to it greater hardness and strength without destroying its malleability, and this up to a content of about 10 per cent. Iron, on the contrary, is a harmful element; however, up to a content of 1.25 per cent it increases the strength of aluminum."

The following is quoted from Prof. J. W. Richards' book on "Aluminum," third edition (1896), p. 518: "A small amount of silicon does not appear to be very injurious to the malleability of aluminum, which bears it much as iron and copper do, but over 1 or 2 per cent commences to change its color, makes it harder and especially crystalline so that its malleability is rapidly impaired. The silicon, however, may be present up to even 5 per cent without preventing the use of the metal for castings and articles not to be worked.

"Minet has proved that aluminum may contain even 8 per cent Si and yet be quite strong if the amount of iron present is small; but as the iron increases over 1 per cent the metal becomes worthless."

Studies on the Constitutional Diagram

The first work of consequence on the constitution of the aluminum-silicon alloys is reported by Vigoroux and Arrivaut in "Procès-verbaux de la Société des sciences physiques du Bordeaux," Nov. 21, 1901. Micographs of samples containing 45.5, 25.35, 14.82 (Fig. 1 herewith) and 4.81 per cent Si are given. The authors would place the eutectic composition between 14.82 and 25.35 per cent Si, since their micrographs clearly show excess aluminum in the former and excess silicon in the latter. However, they did not attempt to construct a constitutional diagram.

"Mechanical alloys" of aluminum and silicon are described by Guillet, "Etude Industrielle des Alliages Metalliques," (1906), vol. 1, p. 965, and also in Kent's Mechanical Engineers' Hand Book, 9th edition, p. 398. The following is taken from Guillet: "Among the alloys of aluminum, the ones such as ferro-alumium, ferrosilicon-aluminum and silicon-aluminum, where the silicon is above 10 per cent, are employed in metallurgy. The others, in which the silicon is below 10 per cent, can be employed for mechanical purposes in place of steel on account of their high strength and their lightness." Types are described as follows:

Types	Al	Fe	Si
1	92	1.25	6.75
2	90	0.75	9.25
3	90	trace	10.0

"The highest strength has been obtained with the alloys in which the proportion of iron is quite low and that of silicon about 10 per cent. Above that amount the alloys are crystalline and not of much use. The density of the alloys of silicon is about that of aluminum."

In *Zeitschrift für anorganische Chemie*, vol. 58, p. 154 (1908), W. Fraenkel gives the first constitutional

diagram of the aluminum-silicon alloys. He reports that the alloys form a eutectiferous system with no chemical compounds. The eutectic alloy contains about 90 per cent Al and 10 per cent Si and freezes at a temperature of about 576 deg. C. The alloys were prepared by melting together commercially pure aluminum and Kahlbaum silicon. In *Revue de Métallurgie*, vol. 8, p. 457 (1911), Frilley describes the results of experiments on aluminum-silicon alloys. He calls attention to the harmful effect of high iron on the aluminum-silicon alloys, both as regards the effect on tensile properties and corrosion. He describes an alloy containing 89.18 Al, 10.07 Si and 0.75 Fe as "brilliant crystalline, fusible; can be forged cold." Frilley made aluminum-silicon alloys both by melting mixtures of the two metals and by reducing the oxides of the two metals simultaneously in the electrolytic cell. He states: "All of these [above] alloys were prepared, as we have said, by fusion of aluminum and silicon. It is entirely rational to assume that the results found might be entirely different, if we were able, under other conditions, to bring together some silicon and aluminum for instance in the nascent state, to use an obsolete expression. Now this is precisely what takes place in an electric furnace producing aluminum by electrolysis, and it has been proved that the silicon-aluminum alloy thus obtained has very different properties from those of the metal obtained by melting together the two substances."

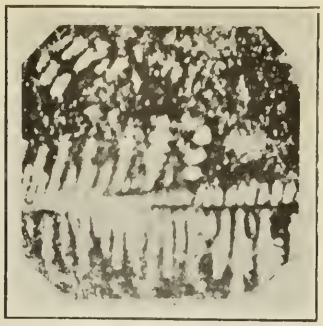


FIG. 1

Aluminum-silicon alloy containing 14.82 per cent Si; fine grained eutectic and excess Al. (Vigoroux). × 35.

Frilley thought that the simultaneous electrolytic production of aluminum and silicon in the form of an alloy might produce a definite compound of aluminum and silicon, not producible except by electrolytic means. He concludes his paper as follows: "In the actual state of our knowledge, we are no better able to produce it than we are able to produce electrolytic silicon, but, as we said above, the problem is the same and everything predicts that on the day when such alloys are realized industry will be in the possession of metal endowed with the most interesting properties."

In 1914 Roberts (*Journal of the Chemical Society*, vol. 105, p. 1383) confirms Fraenkel's constitutional diagram. The eutectic composition was about 90 per cent Al and 10 per cent Si and the freezing point of the eutectic was about 578 deg. C. Alloys used by Roberts were made by the direct fusion of aluminum and silicon.

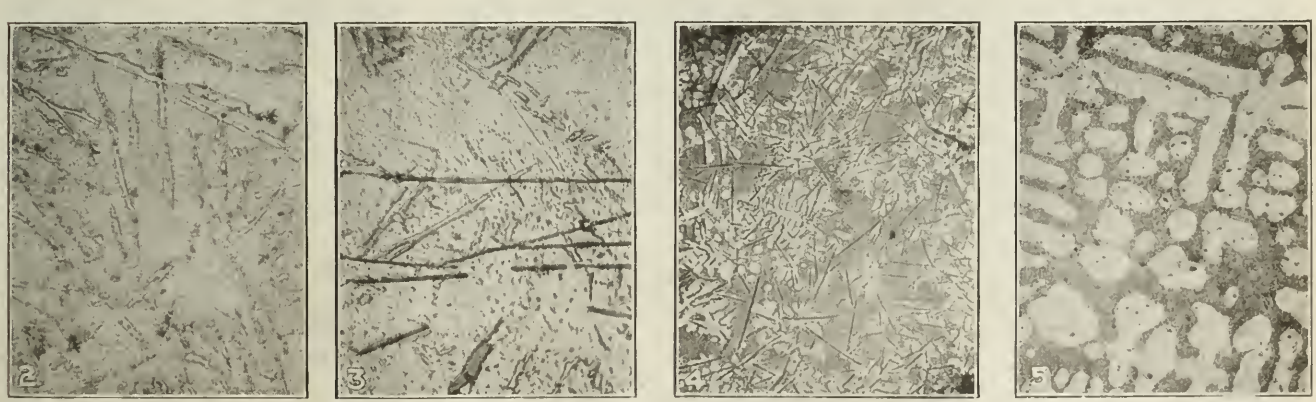
In 1915, in *Stahl und Eisen*, vol. 35, p. 875, Schirmeister describes experiments on aluminum-silicon alloys to determine the mechanical properties and resistance to corrosion. From his experiments he draws the following conclusion: "Accordingly, aluminum is in general favorably influenced by the addition of silicon, and at the same time the specific gravity is unchanged. The alloys with 5 to 7 per cent Si are best suited to rolling and with 10 to 12 per cent Si to casting." With reference to casting he states: "Contraction and piping decrease with increasing silicon content; at about 11 per cent Si the alloys scarcely pipe at all and above this amount they begin to swell upon solidification."

A general review of the literature on silicon alloys is given by Escard in a book entitled "Aluminum in Industry," published by H. Dunod and E. Pinat, Paris, 1918.

Various Appearances of Silicon

A review of the literature on aluminum-silicon alloys reveals certain discrepancies. Fraenkel and, independently, Roberts report that the eutectic alloy contains about 90 per cent Al. Both these investigators prepared their alloys by the direct addition of elemental silicon to commercial aluminum. Vigoroux and Arrivaut, on the other hand, show by micrograph (Fig. 1) and also mention in the text of their article that in an aluminum-silicon alloy containing 14.82 per cent Si, dendrites of aluminum freeze out first—that is, the aluminum is in excess of the eutectic composition. The silicon in this sample is very finely dispersed. According to Fraenkel and Roberts, such an alloy should contain excess silicon and all the aluminum should be in the eutectic. It will also be recalled that Frilley specifically states that aluminum-silicon alloys prepared by electrolysis of a bath containing both alumina and silica have different characteristics, both physically and chemically, from alloys prepared by the melting together of aluminum and silicon.

These observations have since been confirmed experimentally. When an aluminum-silicon alloy is prepared by direct electrolytic reduction, poured into a containing vessel and permitted to solidify, the silicon is found in the resulting alloy in a finely dispersed state. On the



FIGS. 2 TO 5—ALUMINUM-SILICON ALLOYS WITH 10 PER CENT SILICON

Fig. 2—Normal aluminum-silicon eutectic. 90 per cent aluminum and 10 per cent silicon. × 200.

Fig. 3—Normal aluminum-silicon alloy containing 10 per cent silicon and 1 per cent iron. × 200.

Fig. 4—Aluminum-silicon alloy containing 10 per cent silicon and 1 per cent iron made by direct electrolytic reduction. × 40.

Fig. 5—Electrolytically prepared aluminum-silicon alloy containing less iron than the one shown in Fig. 4. × 40.

other hand, in the alloys containing less than 10 to 11 per cent Si prepared by melting together the two elements, the silicon is present in the form of relatively large thin plates. In alloys containing more silicon, the eutectic portion of the silicon is present in the form of relatively large thin plates, whereas the excess silicon appears as more or less equiaxed polyhedral particles, as shown in Figs. 7 and 10.

Fig. 2 shows the normal structure of a sand-cast alloy

FIG. 6—SAME AS FIG. 4, BUT × 250

containing 10 per cent Si, made by the direct melting together of aluminum and silicon. Fig. 3 shows the structure of a sand-cast aluminum alloy containing 10 per cent Si and about 1 per cent Fe, prepared by direct melting. Iron forms a silicide reported to be $FeSi_2$; some of the needles or plates in Fig. 3 are silicide and some are silicon. Figs. 4 and 6 show the structure of an alloy of approximately the same chemical composition—namely, Si 10 per cent, Fe about 1 per cent—prepared by direct electrolytic reduction of silica and alumina. The iron silicide plates are about the same size as in Fig. 3, but the silicon is present in very small particles and the aluminum in dendrites. Fig. 5 shows another electrolytically prepared alloy containing less iron, which has better properties.

Influence of Method of Manufacture

Not only does this process of manufacture greatly affect the condition of the silicon as regards dispersion, but strangely enough it actually changes the composition of the eutectic alloy from 10 to 11 per cent Si in the alloys prepared by direct fusion to 15 per cent Si in the alloys prepared by electrolytic reduction. The amount of excess material of course changes as the eutectic composition changes. The freezing point of the eutectic may be lowered from 576 deg. in the alloys prepared by fusion to about 564 deg. C. in the alloys prepared by direct electrolytic reduction.

Micrographs of the 14.82 and 4.81 per cent Si samples of Vigoroux and Arrivaut show a structure identical with the typical structure produced by direct electrolytic reduction. As previously noted, their alloys were prepared in small porcelain crucibles by melting together commercially pure aluminum and an aluminum-silicon alloy containing about 50 per cent Si, "the immediate product of the reduction of potassium fluosilicate by aluminum." It is evident that their method of preparation produced an alloy having the same structure and therefore the same properties as the alloys obtained electrolytically, a structure evidently caused by the action of the potassium fluosilicate at the elevated temperatures. The correctness of this latter statement is substantiated by the recent work of Pacz, who produced the same structure by the use of compounds of alkali metals with fluorine.

If we refer to the aluminum-silicon alloys made by melting together the two elements as the "normal" alloys and those prepared by the simultaneous electrolytic reduction of alumina and silica as the "modified" alloys, then the alloys prepared by Minet and Vigoroux in 1856 were "modified." A modified alloy may be melted and if it is quickly resolidified it still has the modified structure and characteristics. If permitted to remain in the molten state it gradually passes over to the "normal" condition.

The earlier aluminum-silicon alloys were prepared in different ways, so that some were "normal" and others "modified." Vigoroux and Arrivaut prepared modified alloys; at least the 4.81 and 14.82 per cent Si samples were "modified," whereas Fraenkel and Roberts prepared "normal" alloys. To the best of my knowledge Frilley was the first investigator to differentiate between the two varieties of aluminum-silicon alloy.

Investigations made by the staff of the Aluminum Co. of America accord nicely with those of Fraenkel and Roberts on the "normal" alloys and with Vigoroux and Arrivaut on the "modified" alloys. We find no chemical compound of aluminum and silicon. The modified

FIGS. 7 TO 9—NORMAL ALLOY MODIFIED BY PACZ METHOD

Fig. 7—Normal aluminum-silicon alloy containing 12.58 per cent silicon. Eutectic plus excess silicon. × 250.

Fig. 8—Same alloy shown in Fig. 7, modified by Pacz process. Eutectic plus excess aluminum. × 50.

Fig. 9—Same as Fig. 8, but × 250.

FIGS. 10 AND 11

"Silumin"; normal and modified structure respectively. × 175. (Metallbank).

alloys and normal alloys show the same type of crystalline silicon by X-ray crystal analysis.

Quite recently A. Pacz of Cleveland (U. S. Patent 1,387,900, Aug. 16, 1921) devised a method of "modifying" the "normal" aluminum-silicon alloys. His process consists briefly in the preparation of the aluminum-silicon alloy by the direct mixture of the two metals, and after the alloy is molten an alkali fluoride—such as NaF, KF, LiF or some other compound containing fluorine and an alkali—is placed on top of the molten alloy. He preferably employs NaF as a base and stirs the pulverized compounds into the molten metal with a carbon rod. After skimming, the alloy is poured and then possesses the properties similar to those obtained by the direct electrolytic reduction of aluminum and silicon. Fig. 7, for example, shows the structure of an alloy containing 12.58 per cent Si made by the direct melting together of aluminum and silicon and cast without any further treatment. Figs. 8 and 9 show another portion of the same alloy after modification in the manner described by Pacz. In the first case, it will be noted that the alloy contains excess silicon plus eutectic in which the eutectic silicon is present in the form of relatively large plates, whereas in Figs. 8 and 9 it will be noted that the alloy contains excess aluminum and the silicon is entirely present in the eutectic in a finely dispersed state.

"Silumin"

Apparently aluminum-silicon alloys treated by a similar process are called "Silumin" in Germany. Figs. 10 and 11 show the structure as published by the Metallbank and Metallurgische Ges.; Fig. 10 is the alloy poured without any treatment and Fig. 11 the alloy poured after the treatment. It will be noted that there is a considerable quantity of excess silicon in the former figure, whereas the latter shows eutectic composition.

Figs. 12 and 13 show the structure of modified aluminum-silicon alloys containing 11.9 per cent Si prepared by Mr. Pacz. The silicon is finely dispersed and there is excess aluminum in the sample. A normal alloy containing 11.9 per cent Si shows excess of silicon.

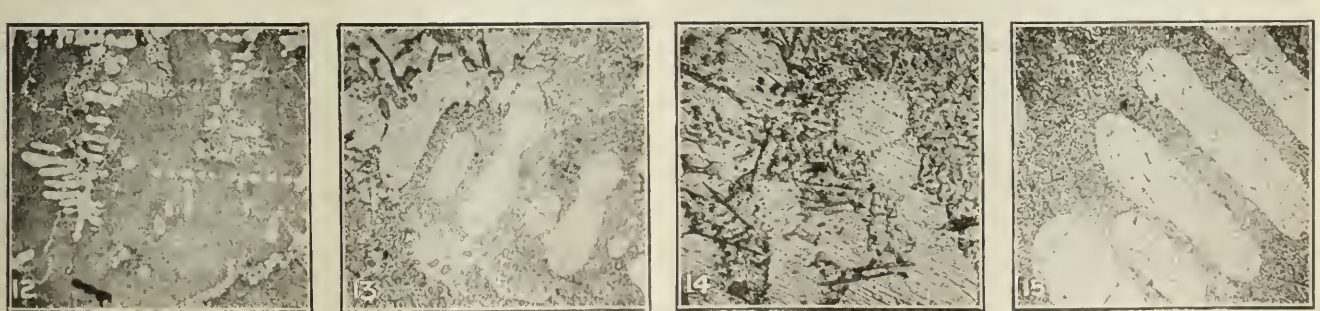
The improvement in physical properties by modification is slight in 5 per cent alloys, but quite marked in aluminum alloys containing between 8 and 15 per cent silicon. Thus the improvement as compared to the normal alloys is more marked the higher the silicon content. With a silicon content of 13 per cent the tensile strength of a sand-cast normal alloy is about 20,000 lb. per sq.in. and the elongation about 2 per cent in 2 in. However, this alloy, modified by the Pacz method and cast in sand, may have a tensile strength of 27,000 lb. per sq.in. with an elongation of 6 or 7 per cent in 2 in. The degree of improvement depends, among other things, on the quantity of flux used. Fig. 14 shows the effect of a small quantity of flux on an aluminum alloy containing 10 per cent Si. It will be noted that the silicon is somewhat refined as compared to Fig. 2. Fig. 15 shows the effect of a greater quantity of flux on the same alloy. Remelting of an alloy modified by the Pacz process, in such a manner as to permit the metal to remain in the molten state for any considerable time causes a reversion to the "normal" condition. The ordinary melting of large batches (10 lb. or more) causes the modified alloy to revert to the normal or nearly normal state.

Physical Properties

The aluminum-silicon alloys are in general resistant to corrosion if the iron content is not excessive. They can be machined, but not as readily as the aluminum alloys customarily used for castings. The density of aluminum-silicon alloys is about 2.65, as compared with about 2.85 for the aluminum-copper alloys.

One of the chief advantages of aluminum-silicon alloys is their good casting properties—a sound "leak-proof" piece may be obtained either in the normal or modified condition.

It will be noted in Fig. 6 that the alloys prepared by direct electrolytic reduction do not show any considerable refinement of the iron silicide plates. This is also true of alloys treated with the Pacz flux. Inasmuch as any considerable quantity of these iron silicide plates will weaken and embrittle the metal, it is essential to keep the iron content low either in the normal or modified alloys. In general it may be said that the lower the silicon content the greater will be the amount of iron permissible in the alloy. With 5 per cent Si, for example, a tensile strength of 18,000 lb. per sq.in. and elongation of 4 to 6 per cent in 2 in. is obtained in the normal state, even with an iron content as high as 0.75



FIGS. 12 TO 15—ALUMINUM-SILICON ALLOYS, MODIFIED BY PACZ METHOD

Fig. 12—Modified aluminum-silicon alloy containing 11.9 per cent silicon. × 40.
Fig. 13—Same as Fig. 12, but × 200.
Fig. 14—Aluminum-silicon alloy containing 10 per cent silicon, partly modified. × 200.
Fig. 15—Same alloy as Fig. 14. Completely modified. × 200.

per cent. This alloy is also machinable, but it does not machine as well as the ordinary aluminum alloys.

Although the tensile strength and elongation of the modified aluminum-silicon alloys are very satisfactory, the yield point is quite low. At a stress of 12,000 lb. per sq.in. the extension is about 2½ times that of No. 12 alloy, which contains about 92 per cent Al and 8 per cent Cu (Metallbank).

Only small quantities of aluminum-silicon alloys are used commercially at present. It seems, however, that they will be found suitable for thin-walled castings and watertight parts. In some places the alloys should be used because of their resistance to corrosion. The modified and normal alloys have about the same advantages with the exception of tensile strength. Many uses will not require high tensile strength, so it is probably safe to predict that the alloys will be used in both the normal and modified conditions according to requirements. When the sand-cast alloys are used in the normal state the silicon content should, in general, be lower than in the modified alloys. In the latter the silicon may be from approximately 8 to 15 per cent and in the former from about 4 to 10 per cent.

Summary

1. Aluminum-silicon alloys were first prepared as early as 1856 by Deville.
2. As early as 1856 Wöhler had prepared aluminum-silicon alloys by fusing together metallic aluminum and an excess of double fluoride of potassium and silicon in an ordinary crucible.
3. As early as 1858 an aluminum-silicon alloy containing approximately 10 per cent Si had been mechanically worked.
4. An extensive study of aluminum-silicon alloys was made in the early '90s by Minet and others, who describe physical properties of a number of electrolytically prepared alloys both in the cast and forged conditions.
5. In 1901 Vigoroux and Arrivaut described the structure of aluminum-silicon alloys containing 4.81, 14.82, 25.35 and 45.5 per cent Si. The 14.82 per cent alloy shows excess aluminum dendrites plus eutectic. The eutectic structure shows a very fine dispersion of the silicon.
6. In 1908 Fraenkel gave the first constitutional diagram of aluminum and silicon, showing that normally the composition of the eutectic alloy is 90 per cent Al and 10 per cent Si and its freezing point is 576 deg. C.
7. In 1911 Frilley discovered that aluminum-silicon alloy prepared by direct electrolytic reduction "has very different properties from those of the metal obtained by melting together the two substances."
8. In the "modified" alloys produced electrolytically the silicon is much more finely dispersed, the eutectic contains a greater quantity of silicon, and the freezing point of the eutectic is lower than in the "normal" alloys prepared by the melting together of aluminum and silicon. The tensile strength becomes greater and the elongation greater as the dispersion of the silicon becomes finer.
9. In 1920 A. Pacz of Cleveland worked out a process of "modifying" the "normal" aluminum-silicon alloys.
10. The modified aluminum-silicon alloys prepared by Frilley's electrolytic reduction method, by Vigoroux and Arrivaut's potassium ferrosilicate method and by the Pacz sodium fluoride method revert to the normal types if permitted to stand in the molten state for any considerable time. Remelting such alloys in large batches and recasting are sufficient to cause the alloys to revert to the normal structure and normal properties.
11. Aluminum-silicon alloys in general are quite resistant to corrosion, if the iron content is low.
12. Aluminum-silicon alloys are machinable, but they do not machine as well as the standard aluminum-copper alloys.
13. The use of processes to modify or disperse the silicon is advantageous chiefly when quantities of silicon above about 8 per cent are used.
14. The chief advantage of aluminum-silicon alloys is in their casting qualities, which advantage is present both in the normal and modified alloys.
15. Iron makes the aluminum-silicon alloys more corrodible and in general weakens and embrittles them.
16. The greater the amount of silicon used the less is permissible iron.
17. It is safe to predict that both normal and modified aluminum-silicon alloy castings will become commercially important.
18. In the modified alloy castings silicon should be from 8 to 15 per cent.
19. In the normal sand castings silicon should be from 4 to 10 per cent according to requirements.

Carbon Black From Natural Gas in 1921

The carbon-black industry showed marked progress in 1921, according to a report of the United States Geological Survey. The estimated total output was 14 per cent greater than in 1920. The following table, which shows the output by states, is based on reports from nearly all the operators:

ESTIMATED PRODUCTION OF CARBON BLACK FROM NATURAL GAS IN THE UNITED STATES IN 1921, BY STATES

State	No. of Plants	Carbon Black Produced — Lb.	Value	Average Price Per Lb. (Cents)	Average Yield of Carbon Black Per 1,000 Cu.Ft. Lb.	Gas Used (Thousands of Cu.Ft.)
Kentucky	2	2,697,075	$215,822	8.0	1.8	1,518,763
Wyoming	2	419,400	37,521	8.9	0.5	869,000
Oklahoma, Pennsylvania, Montana	3	573,225	38,707	6.8	0.9	629,492
West Virginia	21	23,909,000	2,088,000	8.7	1.7	14,312,800
Louisiana	13	31,034,000	2,967,000	9.6	1.0	32,101,800
Total for 1921	41	58,632,700	5,347,050	9.1	1.2	49,431,855
Total for 1920	35	51,321,892	4,032,286	7.9	1.3	40,598,978
Total for 1919	36	52,056,941	3,816,040	7.3	1.0	49,896,235

The average yield of carbon black per thousand cubic feet of gas consumed was slightly lower in 1921 than in 1920, although the efficiency of some of the plants had been materially increased. The yield in 1921 ranged from 0.2 to 3.5 lb., and the maximum was 1.5 lb. higher than the maximum in 1920.

The manufacture of printer's ink consumes approximately from 20 to 25 per cent of the total output of carbon black. About 30 to 35 per cent is used in the rubber industry, where it serves chiefly as a reinforcing agent. A considerable quantity of carbon black is exported to be used for similar purposes abroad but more especially for printer's ink.

The carbon-black industry is an economic factor in the development of new gas fields. This industry can easily be successful in new areas that are sparsely populated and at long distances from markets and that present other unfavorable conditions. Its one requirement is a sufficient supply of natural gas, and in fact an isolated area where there is a sufficient supply of natural gas is an ideal location for carbon-black plants, because there is no domestic demand for the gas. The best illustration of the carbon-black industry as an aid in the development of new and remote natural-gas fields is furnished by the Monroe field in Louisiana. About 5 years ago only a few wells had been drilled in that field in an unsuccessful search for oil. Owing to its remoteness from large cities and communities there is little demand for the gas for domestic use, and this field has therefore been a fertile one for the carbon-black industry, as shown by the quantity produced there.

In the interest of conservation the Department of Conservation of Louisiana has formulated rules requiring the extraction of gasoline from the gas before the gas is burned in the carbon-black plants. As a result most of the carbon-black plants are operated in conjunction with the gasoline plants.

T.A.P.P.I. BANQUET AT THE ASTOR, NEW YORK, APRIL 11, 1922

Seventh Annual Meeting of T.A.P.P.I. Held in New York

Technical Association of the Pulp and Paper Industry Holds Enthusiastic Convention at the Waldorf-Astoria, Pervaded by a Spirit of Optimism for the Immediate Future of the Business, Which Is Emerging From the Period of Depression

FROM the first day of the convention week, April 10, when the technical personnel of the American pulp and paper industry began congregating at the Waldorf-Astoria in New York, a general feeling of optimism was evident.

"The trade is optimistic today, where a year ago it was just the reverse," said W. J. Raybold, president of the American Pulp and Paper Association. "The paper and pulp men have been taking heavy losses, but business is improving and the outlook is more hopeful than in many months."

The convention of the Technical Association was held in connection with the forty-fifth annual meeting of the American Pulp and Paper Association together with other affiliated associations. Sessions of all the sections were held in the Waldorf-Astoria through the week up to Thursday evening.

T.A.P.P.I. re-elected all the present officers—namely: G. E. Williamson, Strathmore Paper Co., president; F. C. Clark, Pejepscot Paper Co., vice-president, and W. G. MacNaughton, secretary.

The high spots in the convention proceedings were the interest displayed in the subject of vocational education and the practical consideration of the technical study of the drying of paper. Prof. David Snedden of Columbia University and J. C. Wright, director of the Federal Board of Education, were the principal speakers on the subject of vocational education, a subject in which the association has been actively interested for some time. In connection with the publication of the third volume of the series of textbooks on "The Manufacture of Pulp and Paper" by the society, the discussion was of especially timely interest.

The problem of the drying of paper is being taken up by the association as a systematic engineering investigation. Besides the paper read by M. B. Littlefield, which is briefly discussed below, F. C. Clark, of the Pejepscot Paper Co., contributed to the symposium on this subject, which was one of the most important which came before the convention. Representatives of a number of paper mills entered the discussion and will continue the study of the problems along the basic lines prescribed.

Sectional Meeting on Soda Pulp and Sulphate Pulp

"Some Factors Influencing the Yield and Strength of Pulp Cooked by the Soda Process" were discussed by Martin L. Griffin. The parallel between the process in cotton textile finishing and reducing wood to finished pulp by the soda process was pointed out. The low yield of the soda process compared with the sulphite and sulphate processes is attributed to the fact that the latter are deoxidizing and therefore act to preserve the strength and increase the yield. Experiments have shown that the addition of small quantities of sulphur increases the yield by its deoxidizing action. A posi-

tive pump to circulate the liquor in either direction and to prevent the direct exposure of part of the chips and pulp to high pressure steam was also recommended as a step to improve yields.

"Recovery and Its Control," by George K. Spence, took up methods of determining the percentage of the original soda used that is recovered and returned to the system. Mr. Spence described the system instituted at Johnsonburg by which the actual recovery for any one period can be calculated and losses located.

Sectional Meeting on Heat, Light and Power

"Modern Lighting for Paper and Pulp Mills," by J. H. Kurlander of the Edison Lamp Works, was illustrated by stereopticon views contrasting the average unsatisfactory lighting practice with up-to-date installations where the proper lamps and reflectors are intelligently used. Mr. Kurlander described a number of typical installations in machine rooms, beater and finishing rooms, and presented curves showing the methods used for correctly spacing and hanging lights for proper illumination.

"The Power Plant of the Paper Industry," by A. G. Darling and H. W. Rogers, pointed out the economies that may be effected by intelligent co-ordination of steam and electric power. The mechanical power requirements of the plant and the process steam requirements were summarized, and upon this basis suggestions were made as to the most efficient machinery for each purpose. Economies that may be effected by the installation of modern hydraulic equipment, electric boilers where hydro-electric power is available and automatic hydro-electric generators were outlined.

Additional emphasis was laid on the use of the last-mentioned apparatus by Horace Drever and Frank Hodson of the Electric Furnace Construction Co. in a paper entitled "The Electric Steam Generator." It is claimed that the use of electricity will save the cost of installation in a little over a year. The generator provides a means of utilizing idle power and thus improving the load factor and occupies small ground space, being simple, reliable and easily controlled.

Sectional Meeting on Mechanical Pulp

"The Efficient Production of Mechanical Pulp," by Adolph F. Meyer of Minneapolis, Minn., discussed the widely different methods of producing mechanical pulp for newsprint and the power consumption in different mills. Mr. Meyer presented curves emphasizing the importance of the proper grinder speed as influencing power consumption and described various installations of governors for this speed control. The shortcomings of the centrifugal pump as a pulp-grinder governor were emphasized and performance records in which the Meyer governor was used were presented in contrast.

"Relative Efficiency of the Automatic Magazine Grinder as Compared With the Pocket Type Grinder" was the title of J. J. Case's paper, which compared the two types of grinders with regard to labor costs, power and maintenance charges. The economical advantages of the automatic magazine type were clearly demonstrated.

The Drying of Paper

"The Drying of Paper," by M. B. Littlefield, took up the problems of drying under the subjects of the properties of paper under heat, proper drying conditions, heat supply and removal of water vapor. Studies of the effects of variations in thickness, furnish, entering and final moisture content and critical moisture content have been made on various grades. The amount of drying accomplished by suction, presses and driers has been determined. Careful studies have also been made of the quantity of heat supplied to the driers and the factors which influence its efficient utilization. Under the topic of the removal of water vapor, the most efficient methods of air circulation were discussed. Drying curves were given to show the rate of removal of water under certain drying conditions, and the effect of steam pressure on rate of drying and consequently on production. Drying ovens, speedometers, pressure gages and accurate records were recommended for efficient drying.

Cotton Linter Pulp

"Stamso-Cotton Linter Pulp," by Stewart E. Seaman of the Stamsocott Co., described the manufacture of this new product, the various grades and qualities and the application of the product in the high-grade paper trade. This pulp may be used in place of rags with a very material saving.

Report of the Sulphite Pulp Committee

The sulphite pulp committee called attention in its report to the need for the development of a more complete knowledge of the constitution of lignin and announced the publication of a translation of the fundamental research of Peter Klason on the constitution of lignin and of Rudolf Sieber's work on the analysis of raw sulphite acid. The report also suggested work on the development of a rapid method for the determination of residual lignin in unbleached sulphite pulp and for the direct determination of combined SO_2 in sulphite acid.

The committee presented its recommendations for specifications for limestone and lime in the manufacture of sulphite pulp.

G. P. Gensberg presented a paper on the "Analysis of Reclaimed Cooking Acid for Sulphite Mills."

The Chemistry of the Sulphite Process

"The Chemistry of the Sulphite Process," by R. N. Miller and W. H. Swanson of the Forest Products Laboratory, presented work of the laboratory in investigating the fundamentals of this process and showed their application in a series of experimental cooks. In this investigation, the total SO_2 content was determined at intervals through the cooks by blowing the cooks prematurely and examining. The apparatus and methods of analysis used were described. It was found that the marked change in chemical composition of the liquor ceased at about the same time that the pulp of superior quality was produced—namely, about the eleventh hour. The rate of removal of lignin was also studied. The importance of the content of free sulphurous acid at the end of the cook was pointed out.

Banquet

Tuesday evening was set aside for the annual feast at the Astor. A large attendance enjoyed an excellent program of speakers, the principal speech being given by Otis W. Caldwell, director of the Lincoln School, New York, on "The Scientific Mind." Judge Charles F. Moore acted as toastmaster.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Discussion of Disposal of Muscle Shoals Features Joint Meeting of Engineering Societies

Dream cities built up around limitless power resources, fertilizer cheap as dirt and the adaptation of the government nitrate plants for the production of peace-time products were reduced to absurdities by an array of distinguished speakers in a symposium on the Muscle Shoals problem before a joint meeting of the four founder societies in the Engineering Societies Building, New York, on April 14. The discussion was divided into its two logical phases—namely, the project as a power producer and as a nitrate producer. Brigadier-General Harry Taylor, Assistant Chief of Engineers, U. S. A., took up the first topic, and W. S. Landis, of the American Cyanamid Co., discussed the commercial aspect of the second phase, while Major-General C. C. Williams, Chief of Ordnance, U. S. A., spoke on the munitions aspect.

Theodore Nagel, consulting engineer, gave a concise description of the cyanamide process as used in Plant No. 2 which served to make clearer the actual operation of the plant as shown in several reels of motion pictures. The pictures showed the construction and operation of Plant No. 2 and views of the steam power plant on the Tennessee River.

General Taylor presented a history of attempts that were made since 1828 to develop the Tennessee River at Muscle Shoals for navigation and as a power site and gave numerous statistics on construction features of the Wilson dam, with stereopticon views showing details.

W. S. Landis told of the organization of the Air Nitrates Corporation, a subsidiary of the American Cyanamid Co., for the erection of Plant No. 2, one of the largest war operations ever undertaken. The calcium carbide capacity of the plant greatly exceeds the demand of the entire country. The cyanamide produced there is not suitable for fertilizer, said Mr. Landis, and should not be confused with the fertilizer material known under the trade name of "Cyanamid."

The country's maximum peace requirements of ammonium nitrate is 20,000 tons per year. Plant No. 2 has a capacity of 110,000 tons annually. The ammonium nitrate used in industrial explosives is made from the waste acid of the explosive industry and it is doubtful if Muscle Shoals nitrate could be produced as cheaply. The production of "Cyanamid" fertilizer or mixed salts has been suggested. Such plans would mean that the oxidation and absorption plants would be useless and would require the erection of sulphuric acid plants and large bagging and shipping facilities. Only 150,000 tons of ammonium sulphate per year is used in fertilizer and the increase in the production from byproduct plants would seem to indicate that competition in this field would be a losing proposition. Altogether the prospects for the commercial utilization of the plant seem discouraging to Mr. Landis.

Major-General Williams discussed the necessity of munitions for military preparedness in general. The Ordnance Department is not concerned over the process used for the fixation of nitrogen, he said, but it does hope for the development of a commercially practical process as a preparedness measure. He described the serious shortage of nitrate that existed in the Civil War and pointed out that in the World War America depended upon Chile for 75 per cent of the nitrate used and that these fields are being exhausted at the rate of 2,500,000 tons per year. Plant No. 1 at Muscle Shoals, which cost $13,000,000, was stamped as a "failure," but Plant No. 2 operated long enough to prove that it was capable of its full rated production. This plant cost about $70,000,000, but it would have paid for itself in 3 years, had the war continued.

A banker's view of the situation was presented by Francis E. Frothingham, of Coffin & Burr, bankers. This firm has distributed $20,000,000 of Alabama Power Co. bonds and Mr. Frothingham therefore felt qualified to compare the offer of that company with Henry Ford's. While acknowledging Mr. Ford's ability as a manufacturer, the speaker expressed the belief that the same offer from any other source would have been instantly repudiated. He emphasized the necessity for observing the provisions of the federal water-power act and declared that all bids should be submitted on this specification. He characterized as unfair Mr. Ford's failure to denounce the glittering real estate promotion schemes built around the "75-mile city" and the absurd propaganda to the effect that he saved Muscle Shoals from the junk-heap and from exploitation by foreign capital. He compared the details of the two offers, pointing out that the power company would accept the law, spend its own money for the completion of the dam and be bound to serve the public without discrimination and for only a fair return.

Mr. Frothingham emphasized the desirability of utilizing the Muscle Shoals power for public utility so that it might fit in its logical place in superpower development. The Alabama Power Co., with its experience and good record as a public utility as well as by its prior interest in the development, should receive first consideration.

E. A. Yates, of the Wood, Hulse & Yates Co., engineer, went into the details of the power situation in the South. He argued for the distribution of the Muscle Shoals power as against concentrating the consumption there. Mr. Yates estimates the available power at Muscle Shoals at 2,100,000 kw.-hr. annually at 80 per cent efficiency and 100 per cent load factor. The absolute prime power, based on the average river flow for 22 years, is only 400,000,000 kw.-hr. yearly. As far as power is concerned, he concluded, the greatest benefit will be derived by distribution. The greater the system to which the dam is connected the greater will be the utilization of secondary power.

Little Interest in Dye Inquiry—End of Testimony in Sight

Completely overshadowed by the completion of the tariff schedule, the dye investigation dragged half-heartedly through another week without new developments. It is expected that hearings will be concluded within the next few days.

C. J. Thatcher, vice-president of the Thatcher Process Co. of Syracuse, N. Y., advanced the conclusion that industry can be developed to meet the needs of the country only by the selective embargo system. This conclusion is unescapable after a study of the tariff history and statistics of the United States for the past 40 years, he said.

The "concrete result of previous attempts to build up an American industry by ad valorem tariff protection was to give the German dye monopoly control of the American market," the witness declared.

Ward Thoron, treasurer of the Merrimac Manufacturing Co., of Lowell, Mass., and Huntsville, Ala., attacked the present system of licensing imports and asserted that it caused annoying and intolerable delays to the dye users. Mr. Thoron argued that a tariff would give the American dye and organic industry all the protection it needs; the selective embargo system would place dye users at a disadvantage in competing with foreign manufacturers on certain textile products, he declared, because of the delay entailed in obtaining necessary foreign dyes.

Connecticut Valley Engineering Societies Hold Annual Joint Meeting

Over three hundred members of the chemical engineering societies represented in the Connecticut Valley met at Hotel Bond in Hartford April 11 for the annual joint meeting.

The principal speaker was Dexter S. Kimball of the Engineering School of Cornell University and president of the American Society of Mechanical Engineers. The subject of his address was "Engineering Civilization." Dr. Kimball said that the only distinction between our civilization and the civilizations that preceded it consisted in a greatly increased production made possible by engineering methods. In no other respects do we differ from the nations of antiquity. Dr. Kimball believes that the science of engineering will provide a solution for the problems which have overwhelmed the nations in the past.

The second speaker on the program was Hiram Percy Maxim, who gave a very interesting talk on thee "Development of the Wireless Telephone." He sketched briefly the various contributions made by the men who have been the leading figures in wireless communication. Prof. Bristol gave an exhibit of his sound reproducer which has just been developed at his laboratories. Numerous tests showed the exact reproduction of both voice and musical instruments.

Chicago Chemists Club Elects Officers

Annual meeting and election of officers of the Chicago Chemists Club occurred at the quarters, 315 Plymouth Court, on the evening of April 7. The retiring president, Otto Eisenschiml, gave an exceptionally well received talk on the things for which the club stands. His kindly and genial good-fellowship is ever a source of warmth to the members, and the chief regret was that he could not remain the permanent president. The retiring secretary, Paul Van Clief, made an excellent speech. His faithful service over two régimes brought a vote of thanks from the membership.

The principal feature of the evening was an illustrated talk on crystalline forms of water by ex-President William Hoskins. Snow flakes are his hobbies and he wove a fairy tale in the telling, to the delight of the old and young alike.

Officers elected for the coming year were: Chester H. Jones, president; G. A. Menge, first vice-president; Otto Stanger, second vice-president; A. E. Schaar, secretary; Oscar H. Wurster, treasurer; William Hoskins and L. M. Tolman, trustees.

Government Kelp Plant to Be Enlarged and Operated as Private Enterprise

The kelp potash plant of the Bureau of Soils, U. S. Department of Agriculture, at Summerland, Cal., was sold and transferred on April 1 to Rodney Benson of Santa Barbara. This plant was constructed in 1917 and operated for 4 years as an experimental and demonstrational plant with a view to the development of processes for extracting potash and byproducts from the giant kelps of the Pacific. It was closed through Congressional action in 1921. The plant will be enlarged and put back into operation at once for the manufacture of "Kelpchar," a decolorizing carbon of very high activity, potash salts, and iodine. Dr. J. W. Turrentine, who was in charge of the plant throughout the period of the experimentation, after turning over to the government's successors the manufacturing data established there, will return to Washington, D. C.

Historic Powder Plant to Be Scrapped

E. I. du Pont de Nemours & Co., Wilmington, Del., have permanently closed their historic powder mills at Brandywine, near Wilmington, and the plant will be dismantled. The mills were founded 120 years ago, in 1802, by Eleuthere I. du Pont, and have been used continuously for the manufacture of powder and explosives up to a recent date. The plant site has been transferred to a realty company and the property will be disposed of to private interests, representing heirs of the original owners. The Brandywine mill was the first of its kind in this country and furnished munitions for the War of 1812 and the Civil War.

Exhibit of Industrial and Technical Photography to Be Included in Chemical Exposition

At a meeting held in the Waldorf-Astoria, New York, April 10, plans were discussed for the organization of an exhibit of commercial and technical photography. John H. Graff, of the Brown Co., acted as temporary chairman and presented a summary of the circumstances which seem to warrant an exhibition of this nature.

"During the last few years," said Mr. Graff, "photography has more and more developed to be an important factor in industry, commerce and science, and a number of large concerns have established permanent photographic departments of their own, as an aid to better efficiency in administration, engineering, research, buying, selling, advertising, education, co-operation and for many special purposes peculiar to the individual needs of the concerns."

Industrial photography can be divided roughly into three classes—work done with the ordinary camera, photomicrographic work and work requiring specially constructed equipment. The first class includes photographic records of accidents and control boards, photographs demonstrating evidence of waste and salvage, safety ideas and construction reports. The second class includes metallography, studies of concrete, powder, gelatin, bacteria, tanning, paint making and pulp and paper. In the special equipment class may be mentioned the "slow-motion" motion picture studies of physical tests and movements, aërial photography for topographic work and commercial photostat work.

Besides the valuable knowledge gained by such a conference and exhibition in regard to application, technique, equipment and material, it would demonstrate if it would be beneficial to form a permanent association for the development of industrial and technical photography and the necessary qualifications for the men selected to do this work. Such a convention would not only be of value to those who have already entered this field, or those who by an exhibition of this kind would be made familiar with the practicability of adopting it for their own use, but also to the manufacturers of photographic equipment and material and optical and other scientific instruments related to the same.

Among those attending the meeting were representatives of the U. S. Testing Co., Cooper-Hewitt Co., Ansco Co., Eastman Co., U. S. Rubber Co., Sharp & Hamilton, U. S. Bureau of Standards and Bausch & Lomb. It was agreed that the idea behind the movement is commendable and it was decided to arrange to hold the exhibit in connection with the Chemical Exposition in New York next September. Charles Roth, manager of the National Exposition of Chemical Industries, was elected chairman of a committee to consider further means of securing co-operation of the industries.

A second meeting will be held at the Chemists' Club, New York, on May 10, at which time it is hoped that those industries interested in the undertaking will have accredited representatives present.

South Urges Acceptance of Ford Shoals Offer

In consideration of the various lease offers for the Muscle Shoals, Ala., nitrate plants, the Senate Agricultural Committee last week heard Senator Underwood of Alabama and Colonel W. J. Borden of the Corps of Engineers, U. S. A. Senator Underwood urged acceptance of the Ford proposal. Colonel Borden said it would take 6 years to complete the nitrate project.

The Senate Committee on Appropriations in reporting the agricultural appropriation bill to the Senate adds $5,000 for investigations concerning the application of chemistry to agriculture.

Government to Sell Saltpeter

The War Department has called for bids for 40,000 tons of sodium nitrate. Opportunity will be offered for purchases of the material in quantities as small as 100 tons.

Government Exhibit on Dust Prevention Methods Planned at Fire Protection Convention

Numerous serious dust explosions and fires in the United States and Canada have led engineers in the Bureau of Chemistry of the United States Department of Agriculture to arrange an exhibit showing the need for preventive measures and the results of work that has been done. The exhibit, which will be shown first at the annual convention of the National Fire Protection Association at Atlantic City, May 8 to 12, will include three phases of dust explosion and fire prevention.

One panel of the booth will be devoted to the problem in its relation to industries where grain is milled or handled or where food products are made. It will include such plants as grain elevators, sugar refineries, flour mills, starch factories, and cocoa and spice mills. Another panel will show the danger of dust explosions in threshing machines and methods of prevention. This danger is always present where threshing is being done, but is more to be feared during dry weather and when there is much smut in the grain. The third danger emphasized in the exhibit is that of cotton gin fires. In this case there is technically no dust explosion, but the fine fibers of cotton, once a fire has started, burn with almost explosive violence. Such fires are often started by electric sparks generated by the rubbing of the cotton on metal pipes through which it is passing. Drawings and photographs will be displayed showing methods for reducing the danger.

Accompanying this three-panel booth will be a stereomotorgraph which will be used to show views of industrial plants, threshing machines and gins that have been wrecked or damaged by explosions or fires. The entire exhibit will be available for the use of associations or similar organizations interested in the prevention of dust explosions or fires. Application should be made to the United States Department of Agriculture.

Uncertainty as to Freight Rates Holds Up Raw Materials Orders

Decided differences of opinion exist among the members of the Interstate Commerce Commission in the matter of the proposed reduction in rates. Rumor has it that certain members believe that the railroads can afford no reductions at this time. Some believe rates can be reduced on basic commodities, while others believe there should be a general reduction on all commodities. With such a situation existing, it is obvious that a considerable delay may ensue. So far as coal is concerned, the psychological moment was passed when the decision did not come down on April 1. Had it not been for the strike, the delay in handing down this opinion would have had a very serious effect on the coal industry. The delay is discouraging buying of many commodities.

It may be that the Interstate Commerce Commission will await the action of the Railroad Labor Board, since the decision in regard to wages has such an important bearing on rates.

Very few contracts for coal are being made at this time, but in most of those that are being made the buyer is insisting on a clause which provides that he is to have the benefit of any reduction which may be made in freight rates.

New Government Bulletin on Edible Corn Oil

The result of its investigations into the preparation of an edible oil from crude corn oil has just been published by the United States Department of Agriculture as Department Bulletin 1010, a professional paper. A detailed account of the various processes in use is given, together with a discussion of experiments on the refining of corn oil under various modifications of the usual methods. A comparison is made of the economics of the methods proposed, and detailed plans of a commercial refining plant are presented. The bulletin is entitled "The Preparation of an Edible Oil From Crude Corn Oil." Copies may be obtained of the United States Department of Agriculture, Washington, D. C.

Proposed Working Clause in Patent Laws Modified as Result of Protests

Such sentiment against compulsory working of patents was evidenced at the initial hearing on that subject that Senator Stanley determined to redraft his bill. He expects to eliminate the 5- and 2-year limitations and change his bill so as to prescribe that patents shall be worked within a reasonable time, to be determined by the Commissioner of Patents.

Thomas E. Robertson, the Commissioner of Patents, declared his unalterable opposition to a working clause, because he believes it is imperative that the patentee have a monopoly. It is necessary, he said, to encourage invention and also is necessary to make the patent readily salable. A working clause, he declared, would discriminate greatly against the small inventor. He pointed out that the term of patents was changed from 14 to 17 years because it was shown that profits accrued mainly in the latter part of the term.

It was pointed out at the hearing that a large number of patents are taken out for protective purposes only during the research period. For that reason it was held that compulsory production would have the effect of giving a body blow to all research.

Frederick P. Fish, widely known patent attorney of Boston, and A. C. Oliphant, of the Federated American Engineering Societies, were among those who appeared against the bill.

The position of the Secretary of War and of the Ordnance Department was that the national defense is involved in the matter of patents, particularly when foreigners are not required to manufacture in this country.

Up-to-Date Powdered Coal Installation for T. C., I. & R.R. Co. Power Plant

The Tennessee Coal, Iron & Railroad Co., after thoroughly investigating the economies made possible by the use of pulverized coal as a fuel for steam generation, has decided to use it for its new boiler installation at Ensley, Ala. A contract has just been closed with the Fuller Engineering Co., Allentown, Pa., for the installation of the complete coal-driving, pulverizing and conveying systems to serve this plant and for burners and feeders for five 834-hp. Stirling boilers designed to operate at 200 per cent of rating.

The boilers will be situated approximately 600 ft. from the pulverizing plant and the fuel will be conveyed directly to the boiler bins by means of the Fuller-Kinyon transport system. The fuel will be diverted from the main line to the individual service bins through distributing valves and branch lines. The bins will be equipped with automatic bin recorders, which will keep the operator advised at all times as to the fuel conditions in the service bins.

New Sulphur Mining Plant for Freeport Co.

The Freeport Sulphur Co., New York and Freeport, Tex., awarded contract on March 24 to Dwight P. Robinson & Co. for the design and construction of a complete sulphur-mining plant at Hoskins Mound, Tex. Cloyd M. Chapman has been retained by the Freeport Sulphur Co. as consulting engineer.

The company now operates a large sulphur-mining plant at Freeport, Tex., consisting of four units which were built in the period from 1913 to 1918 by Westinghouse, Church, Kerr & Co., which has since been merged into Dwight P. Robinson & Co. This plant contains one of the largest installations of oil-burning boilers in the world.

Canadian Rolling Mill Destroyed by Fire

The east wing of the plant of the Vancouver Rolling Mills at Richmond, B. C., was destroyed by fire on the evening of March 31, with an estimated loss of between $50,000 and $60,000, about half of which is covered by insurance. Already plans are being made for the rebuilding of the plant.

Exposition of Power and Mechanical Engineering Planned for New York in December

Announcement has been made of the National Exposition of Power and Mechanical Engineering to be held at the Grand Central Palace, New York, from Dec. 7 to 13, 1922, by the managers of the exposition.

The exposition was decided upon by a group of engineers and manufacturers who had felt the need for such a means of having men get together, exchange ideas, see the latest development in equipment and lay problems before the manufacturer. It will be the foremost exposition of this kind and the first distinctly power exposition ever held. A number of progressive manufacturers have already engaged space for their exhibits.

The exposition will immediately follow the annual meeting of the American Society of Mechanical Engineers, and it is expected that the exhibits will supplement the programs and discussions at the professional meetings of the society. The professional divisions of the society will hold sessions relating to fuels, stokers, steam power plants, railroads, steam utilization in the paper industry, textile and gas power, and it is expected that the exhibits at the exposition will throw interesting light on the papers presented at these sessions of the A.S.M.E. meeting.

That the exposition will be comprehensive may be inferred from the plans, which are to include exhibits of every type of machine, apparatus, equipment, instrument, device and the various materials and supplies necessary in the operation of the complete power plant. The committee decided that its keynote should be "an exposition of apparatus employed in the generation, distribution and utilization of power."

The advisory committee for the exposition is under the chairmanship of I. E. Moultrop of the Edison Electric Illuminating Co. of Boston, and includes a number of prominent engineers.

Chemists of Thirteen Countries Meet to Promote International Good Will

An international meeting of chemists is to be held in Utrecht, Holland, June 21 and 23. Invitations have been sent to 100 chemists residing in thirteen different countries. These include men from the United States, Great Britain, France, Germany, Italy, Holland, Russia, Austria, Czechoslovakia, Denmark, Norway, Switzerland and Sweden. The purpose of the meeting is primarily scientific and social. A number of addresses will be presented by chemists in attendance at the meeting, but it is not the intention to undertake legislation with regard to chemical matters or other functions which are at present performed by the International Union of Pure and Applied Chemistry. The latter meeting is to be held at Lyons, France, June 28, and has not thus far included German or Austrian chemists.

Will Honor Pasteur on Centenary of Birth

The centenary of Pasteur's birth is to be celebrated at Strassburg next year and plans are under way for erecting a monument to his memory. Anyone desiring to make a contribution for the Pasteur centenary may do so through a committee which has been organized at Stanford University, consisting of Carl Alsberg, R. E. Swain and E. G. Martin. Prof. E. G. Martin, the chairman, may be addressed at the Department of Physiology, Stanford University, California.

Obituary

JOHN BALLOT, president of the Minerals Separation North American Corporation, died on Saturday, April 1.

KNOX TAYLOR, president of the Taylor-Wharton Iron & Steel Co., died on April 4 at his home at High Bridge, N. J. Mr. Taylor was the fifth generation of his family to manage the company, which was found in 1742. He was born at High Bridge, Oct. 19, 1873, son of the late William Johnston Taylor and of Mary Alward Taylor. He began his education at Chester, N. J., where for a time his father operated an iron blast furnace. Later he attended the Hill School at Pottstown, Pa., the Model School at Trenton, and was graduated from Princeton University with the degree of Bachelor of Science in 1895. In college he was a member of the track, athletic and football teams, and was selected as all-American guard. Mr. Taylor's love of outdoor life led him to engage in mining engineering work in the Rocky Mountains for 7 years after leaving college. He was a member of several clubs and associations, among them being the Engineers' Rocky Mountain and University clubs, American Society for Testing Materials, American Institute of Mining and Metallurgical Engineers, American Chemical Society, American Society of Mechanical Engineers, Society for Promotion of Engineering Education and Iron and Steel Institute (England).

Personal

A. E. BONN has resigned as general sales manager of the American Cyanamid Co. and as vice-president of the Air Nitrates Corporation and is now president of Bonn & Co., New York.

J. R. FRITZE has resigned as assistant metallurgist of the Keystone Steel & Wire Co., Peoria, Ill., to accept the position of chief metallurgist for the Avery Co. of the same city.

L. F. FROST, formerly with the Lisk Manufacturing Company, Ltd., Canandaigua, N. Y., the Enamel Products Co., Cleveland, and the Phillips-Clark Stone Co., Geneva, N. Y., has become chemist in charge of research and production with the Vitreous Enameling Co.

R. E. HALL has been appointed to take charge of the physical laboratory of the Pittsburgh station of the Bureau of Mines, where he will be engaged on solubility investigations. Mr. Hall was formerly with the Koppers Co., Pittsburgh, and with the Geophysical Laboratory, Washington.

J. K. HAYWOOD, chairman of the insecticide and fungicide board of the Bureau of Chemistry, completed 25 years' service with the bureau recently and was the recipient of a gold watch tendered him by his associates in the bureau and by former members of the Bureau of Chemistry staff.

G. A. HENDRIE, formerly assistant to the vice-president of the American Cyanamid Co., is now vice-president of Bonn & Co., New York.

ROBERT D. LANDRUM, chemical engineer for the Harshaw, Fuller & Goodwin Co., Cleveland, Ohio, has become vice-president in charge of development and sales for the Vitreous Enameling Co. and the Vitreous Steel Products Co., both of Cleveland.

M. LARUE has resigned his position as chief metallurgist of the Avery Co., Peoria, Ill., to accept a position with the Sherwin Williams Co. to do special sales promotion work in its St. Louis district.

JOHN MCCONNELL, formerly of the Interstate Iron & Steel Co., is now vice-president in charge of operation of the United Alloy Steel Corporation, Canton, Ohio.

J. W. REA, assistant engineer of the Eastern Clay Products Co., Pittsburgh, Pa., gave an interesting illustrated lecture on "The History and Manufacture of Vitrified Clay Pipe" before a meeting of the Allentown (Pa.) branch of the American Association of Engineers, on April 6.

HERBERT V. STEINER, New York, has been elected president of the Coplay Cement Manufacturing Co., Coplay, Pa., to succeed Ferdinand Loeb. GEORGE A. CHRIST, of Allentown, Pa., has been re-elected secretary and treasurer of the company.

BIRGER H. STROM is now research chemist in the Boston & Montana Department of the Anaconda Copper Mining Co., Great Falls, Mont.

DEAN E. WINCHESTER, for many years on geological work on coal, petroleum and oil shale for the U. S. Geological Survey and the Standard Oil Co. of N. J., has recently opened an office in Denver for geological practice, with special attention to petroleum and oil shale.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Statistics on Paper Production

A summary of production, shipments and stocks in the paper mills of the United States during the month of February, 1922, has recently been compiled by the Federal Trade Commission. From these statistics it will be observed that the total production for all grades of paper was 501,817 net tons in February, 1922, as compared with 407,966 tons in the corresponding month of the preceding year and 463,841 tons as the average for the years 1917-21 inclusive. Shipments during February, 1922, exceeded 490,000 tons, and in the same month of 1921 amounted to 383,679 tons.

Likewise stocks on hands at the different paper mills at the beginning and end of the month were slightly larger than on corresponding dates in the previous year.

The principal increases in production were in the case of paperboard and boxboard, wrapping and bag paper, fine writing and book paper, and felt and building paper. The output of standard and special grades of newsprint showed marked decreases both in quantity and number of mills in operation. Only 65 were in active production in February, 1922, as compared with 88 in the preceding year.

Under the caption "Loss of Production" the report points out that in February, 1922, 934 paper machines were idle, as compared with 1,065 in February, 1921. The total number of idle hours in the later month was 128,842 and in February, 1921, over 202,000. Of the total number of machines not in operation during the second month of the current year, 580 were idle because of lack of orders, 124 for repairs and 230 because of lack of material, power or for other reasons.

Comparing the stocks on hand at the domestic mills on Feb. 28 with their average daily production, based upon the combined production for 1918-21, the figures show that:

Newsprint paper mill stocks equal 6 days' average output.

Book paper mill stock equals 13 days' average output.

Paperboard mill stocks equal 10 days' average output.

Wrapping paper mill stocks equal about 25 days' average output.

Fine paper mill stocks equal about 34 days' average. output.

Total paper mill stocks of all grades equal about 14 days' average output.

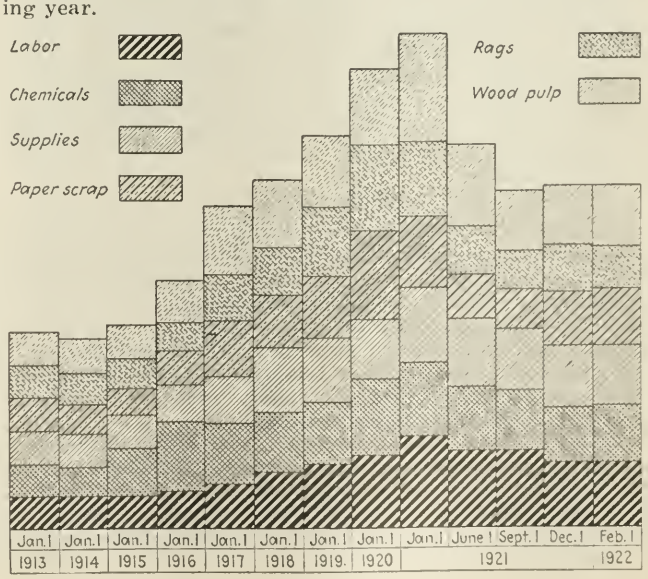
INDEX NUMBERS FOR FACTORS ENTERING INTO PAPER PRODUCTION COSTS

	1922	1921				1920	1919	1918	1917	1916	1915	1914	1913
	FEB. 1	DEC. 1	SEPT. 1	JUNE 1	JAN. 1	JAN. 1	JAN. 1	JAN. 1	JAN. 1	JAN. 1	JAN. 1	JAN. 1	JAN. 1
Wood Pulp	190	188	169	243	327	226	218	206	205	124	101	103	100
Rags	126	135	115	139	227	253	211	140	136	91	93	96	100
Paper Scrap	175	160	122	131	214	271	190	150	166	105	84	95	100
Supplies	183	185	190	210	225	181	178	178	138	118	105	102	100
Chemicals	173	170	181	196	220	223	191	179	188	216	143	90	100
All Mat'rials	171	171	157	202	271	230	207	180	175	122	103	99	100
Labor	204	204	234	234	276	225	197	168	130	111	100	100	100
Material & Labor	178	178	173	208	272	229	205	178	166	120	102	100	100

Paper Production Costs

An interesting study of the factors entering into the cost of producing paper is afforded by the accompanying table and chart prepared from data issued by the American Writing Paper Co., of Holyoke, Mass. The figures used are index numbers each based on a value of 100 for Jan. 1, 1913.

It will be noted that labor and wood pulp, which were the two most important elements in paper production costs in the peak month of January, 1921, still continue at comparatively high levels. Chemicals used in paper making were selling for 73 per cent above the 1913 figure on Feb. 1, 1922, having increased 3 per cent since Dec. 1 of the preceding year.



CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	158.81
Last week	158.36
April, 1917	207
April, 1918 (high)	286
April, 1920	261
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

The New York Market

NEW YORK, April 16, 1922.

The chemical market during the past week showed signs of irregularity in some directions, while in others a moderate volume of new orders gave an encouraging light to the general situation. The advancing tendency of the foreign exchange market was fully reflected in prices for shipment of chemicals from abroad. European inquiries for solid caustic soda continued to reach the market and prices are holding very firm. Soda ash is holding its own without any important feature. Prussiate of soda still remains in an easy state under an absence of any buying interest. Copper sulphate is moving moderately for export and domestic consumption. Glaubers salt and cyanide of soda dealers are finding extreme difficulty in selling goods even at material price concessions. Domestic producers of cyanide still quote the market at 26c. per lb. Chlorate of soda is finding a better outlet and the market seemed more active during the latter part of the week. Nitrate of soda is decidedly firmer and sulphate of ammonia is still lacking in the spot market, with shipment goods held at a premium for limited quantities. Higher prices for citric acid in Italy and the proposed tariff of 18c. per lb. have created a firmer market here, although the present domestic market is not very active. With the active season directly ahead, dealers are looking forward to a very strong condition in the citrate market.

General Chemicals

Acetic Anhydride—Producers report moderate trading on the basis of 38c. per lb., with a possibility of some shading on round lot business. The general quotation ranges from 38@40c. per lb., according to quantity.

Carbon Bisulphide—Sales were recorded at 6c. per lb. by first hands, f.o.b. works. Spot prices range from 6¼@7c. per lb., depending on the seller and quantity. The movement is rather quiet at present.

Cyanide of Soda—Domestic material is being sold in a regular way to consuming quarters, but importers are finding great difficulty in moving supplies. Imported material ranges from 22@24c. per lb., depending on the strength.

Caustic Soda—Inquiry for export remains quite active and several fair-sized orders were reported at $3.60@$3.65 per lb. f.a.s. Producers can offer only June-July shipment at $3.60. Leading jobbers offer small lots at $3.80@$3.90 per 100 lb. Producers offer contracts at 2½c. per lb., basis 60 per cent, f.o.b. works.

Calcium Chloride—Manufacturers report a steady market for the ground and solid grades. Carload lots of solid are offered at $24 per ton New York, and $21 per ton f.o.b. works. Granular is held at 1½c. per lb. New York and $27 per ton f.o.b. works. The demand from the roads and refrigerating industry is fully up to expectations.

Carbon Tetrachloride—Leading dealers offer car lots at 9½c. per lb. Smaller quantities command a premium up to 12c. per lb. The market is reported steady.

Sal Ammoniac—Imported, white is quoted at 7@7½c. per lb., depending on the quantity. The gray is higher at 7½c. per lb. with offerings rather scarce. The domestic is held at 7½@8c. per lb. The general outlook seems rather bright for this chemical.

Vegetable Oils

Linseed Oil—The market at the end of last week was very strong and prices named by leading domestic crushers ranged from 81@83c. per gal. Several crushers advanced quotations to 83c. per gal. and it was thought that all sellers would soon come up to this level, provided the seed market holds. There was a much better demand for nearby oil, and with foreign oil much higher, the general tone of the market was very firm. Imported oil was advanced to 76c. per gal., April shipment, duty paid, New York.

Chinawood Oil—Buyers' offers were a shade under those of the sellers during the week and actual business was not up to expectations, considering the active inquiry. Spot oil was offered at 13¾c. per lb., in less than carload lots.

Coconut Oil—A good inquiry was noted for this material for shipment over the latter part of the year and several carlot orders have already been recorded for this shipment. Domestic Ceylon type oil for Aug.-Sept.-Oct. shipment went through at 7¼c. per lb. The New York market was quoted at 7⅜c. per lb., sellers' tanks, immediate shipment.

Corn Oil—The latest figures on actual sales were recorded around 9¾c. per lb., sellers' tanks, f.o.b. Chicago, indicating an easier market. The demand for refined oil was quiet and prices around 12½c. per lb. were heard.

Peanut Oil—Offerings of crude domestic oil were heard at 10c. per lb., tank cars, f.o.b. mills, Southeast. Oriental crude, in bond, was quoted at 8½@8¾c. per lb. Pacific coast. Local dealers of refined oil were asking 12½@12¾c. per lb., carlots. The demand was moderate.

Annual Reports

Celluloid Co. Shows Deficit.—The report of the Celluloid Co. for the year ended Dec. 31, 1921, shows a deficit of $1,146,239 after depreciation, inventory reduction, taxes and other charges. This is to be compared with a net income of $1,072,413 for 1920. The total income prior to deductions was $36,752, as against $2,055,532 for the previous year. Depreciation of $300,000, an inventory reduction of $428,352 and other charges amounting to $454,639 were deducted from the 1921 income.

American Smelting & Refining Co. Shows Smaller Income.—The net operating income from this company's smelting and refining plants before providing for bond interest, depreciation, obsolescence, ore depletion, etc., was $8,180,970.13, a decrease of $5,108,649.44 as compared to 1920. After making all deductions the net income from the year was $1,591,908.92 in comparison with $6,674,778.70 in 1920.

"The main factors in the year's poor showing," says the report, "was the extremely small production of copper, zinc and tin." The company's output of its principal products in 1920 and 1921 are compared with the pre-war year 1914 in the following table:

	1921	1920	1914
Gold (oz.)	1,780,205	1,849,048	2,540,911
Silver (oz.)	75,354,443	77,732,911	77,604,483
Platinum and palladium (oz.)	863	936	1,664
Lead (tons)	207,612	205,249	316,591
Copper (lb.)	348,888,000	590,850,000	529,686,000
Spelter (lb.)	14,628,614	44,106,253	15,748,000
Nickel (lb.)	120,080	375,167	356,187
Tin (lb.)	11,915,954	18,511,160	.....
Sulphuric acid (lb.)	9,952,000	51,688,000	24,296,000
Arsenic (lb.)	5,155,522	17,695,266	6,184,000
Copper sulphate (lb.)	2,237,471	3,618,172	6,798,000
Byproduct metals (lb.)	3,232,488	1,549,426	1,678,228
Sulphur dioxide (lb.)	154,794	8,154,734	.....

The report also includes the following operating statistics, which are of interest in connection with the decreased earnings and lower volume of production:

	1921	1920	1914
Number of men employed	7,605	13,330	12,179
Total wages and salaries	$11,440,480	$20,164,508	$10,212,591
Average wage per 8-hr. day	$4.17	$5.04	$2.33
Tons charge smelted	2,583,142	4,050,751	4,171,258
Tons bullion refined	357,062	505,535	588,718
Tons coal used	302,924	499,713	544,619
Tons coke used	263,384	394,014	447,761
Barrels fuel oil used	1,432,085	1,294,299	976,528
Cubic feet gas used	837,012,321	2,674,177,277	7,430,300
Tons ore mined	2,205,537	2,311,946	1,266,702
Tons coal mined	360,952	509,424	257,942
Tons coke produced	100,860	181,664	129,650

National Leather Co. Has Small Profit.—The annual report of this company and its subsidiaries for the year 1921 shows total sales amounting to over $23,500,000 and a surplus from earnings of nearly $200,000. Inventories had been reduced to the extent of about $1,000,000.

President George H. Swift, in his letter to stockholders, stated that considerable improvement had been noted during the last months, although the volume of sales had not expanded to the extent expected last October.

"It is apparent that at the present time," according to Mr. Swift, "the biggest problem facing the tanning business is the lack of satisfactory demand from the users of leather. It is exceptional to find a buyer who will anticipate his requirements more than a short time ahead. In other words, practically all buyers are buying in a hand-to-mouth manner, which, however, is a natural sequence after a period of declining prices such as we have gone through in the past two years."

The St. Louis Market

ST. LOUIS, April 14, 1922.

An active market in this locality may still be reported, although there was a temporary lull of a few days shortly after the beginning of the month. A complete recovery has been made, however, and at the present time the volume of business transacted is as good as—in fact, better than—any previous month. There are no important price changes to report at this time, and in general prices are firming up considerably.

ALKALIS

The alkali market has declined somewhat, although *caustic* and *soda ash* maintain a normal basis both in price and demand. *Bicarbonate of soda* has declined quite a bit of late and can now be obtained as much as 35c. per 100 lb. cheaper than 2 weeks ago. Whether this price is as yet reflected in the consumer's purchase remains to be seen but the jobbers have already taken advantage of it.

GENERAL AND SPECIAL CHEMICALS

The heavy *mineral acid* market remains the same, with a good demand and firm prices. *Citric acid* is now coming to life, with a very good demand, and this should continue with the approach of the summer season. There has been no change in the *white arsenic* situation. *Bromides* continue to be in good demand. A brisk demand for *carbon bisulphide* has been reported, with no change in price. The demand for *carbon tetrachloride* is routine. *Copperas* demand is still beyond production, with prices remaining the same; however, one manufacturer has temporarily withdrawn from the market. The previously anticipated slump in *glycerine* has finally made its appearance, and the price has accordingly declined 1c. per lb. Drums are now selling for 15c. per lb. *Sulphur* is holding firm at the same price level of 2 weeks ago, and with an increasing demand. An advance in price might be expected in the near future. The demand for *zinc sulphate technical* is routine, and prices prevailing 2 weeks ago are still in force; however, an advance may be expected at any time.

VEGETABLE OILS AND NAVAL STORES

Castor oil is holding its own with ease, though some spot goods can be had at less than the market price. The *linseed oil* market is showing the effects of heavy importations and American producers are at quite a disadvantage. Our prices have slightly recuperated from the low price of 84c. reached a few days ago and are now being maintained at 86c. Whether the home producers can control the market further is doubtful, and consumers are generally holding back for lower prices. *Turpentine* fluctuates daily, but the variation in price has been rather limited since reaching the low figure of 85c. last week.

PAINT MATERIALS

Paint manufacturers are experiencing a very serious slump just now that has decreased their anticipated demands greatly. *Barytes, lithopone* and *zinc* are not moving as would ordinarily be expected at this season, but manage to maintain their price level of a month ago.

The Iron and Steel Market

PITTSBURGH, April 14, 1922.

An unexpected development has occurred in connection with the coal strike inaugurated April 1, as a part of the Connellsville region and by far the major part of the Lower Connellsville region have gone on strike. A few strikes had been expected in the coke region, chiefly or wholly at works that have lately been paying less than the Frick or Steel Corporation wage scale, but there have been many strikes at Frick plants also. The United Mine Workers claim that most of the men are "organized," but the organization is no doubt of more or less makeshift character. On account of the disposition of Connellsville region workers to celebrate the Easter holidays very extensively the operators have taken no steps toward resumption, but next week strenuous efforts will probably be made to operate. Meanwhile the Frick company has moved many willing workmen from the Lower Connellsville to the Connellsville or old basin, putting idle ovens in operation.

No coal or coke, of course, had been stored in the Connellsville region, and little coke was stored at the blast furnaces tributary to Connellsville ovens, the result being that half a dozen or more blast furnaces have been banked or blown out, while orders pending to blow in about the same number have been suspended. The Connellsville and Lower Connellsville regions had been supplying coke for 20 or 25 per cent of the total blast-furnace operations of the country, and the coal shipments were also of some importance to the iron and steel industry.

The results of the Connellsville development must be distinguished from results that would follow exhaustion of the large stocks of coal that exist in the country. It is conceivable, though improbable, that the Connellsville labor troubles might last long enough to produce such a decrease in pig iron and steel production that finishing mills, now well stocked with coal, might be unable to use all the coal, on account of shortage of steel.

The effect of the Connellsville labor troubles upon the iron and steel market has been to cause merchant blast furnaces in several districts to withdraw prices entirely or to make advances of, say, $1 a ton. An extreme case is that of basic pig iron at valley furnaces, which a week ago was quotable at $18 furnace, but has just sold at $20 for 1,000 tons of standard grade and at $19 for 4,000 tons of off grade.

With pig iron stiffening and with coal supplies for the future more or less menaced, steel works have been disposed to become reserved in selling steel products. The Jones & Laughlin Steel Co., whose coal mines are union, has withdrawn entirely from the steel market, as it already had large steel commitments, with a moderate stock of coal. All the independent wire mills have advanced nails, staples and barb wire $2 a ton, making nails $2.50 a keg, but the Steel Corporation wire subsidiary has not followed up to this time. The recently advanced prices in sheets are reported to be fully effective, 2.40c. for blue annealed, 3.15c. for black, 4.15c. for galvanized and 4.50c. for automobile sheets, but as buyers had ample opportunity to cover at the old prices the market is now very quiet. Bars, shapes and plates remain quotable at 1.50c. as the general market.

SELLERS' ATTITUDE STIFFENED

The coal strike, with the ramifications developed, is a new factor, operating to curtail iron and steel production somewhat and to stiffen the attitude of sellers. Steel production had been mounting rapidly. There is an interesting question whether steel production would have continued to increase after April 1 if there had been no coal strike, also a question whether there would have been nearly as much increase in production to April 1 if no coal strike had been on the program. Estimating the rate of steel ingot production month by month on the basis of the monthly reports of the production of thirty producers, and plotting the average rates in the months December to March inclusive, the graph is almost a straight line. The rate in December was about 19,750,000 tons per annum and the rate in March about 32,500,000 tons. Continuing the line to April 1, as seems justified by the news in March, the rate on that date was about 36,000,000 tons. Obviously no such climb could continue for even a few months. Common observation is sufficient to show that actual consumption of steel has not so greatly increased. Presumably consumers in general have fortified themselves against a curtailment of supplies due to the coal strike which the coal strike may not produce even though in its first fortnight it has been more formidable than coal and furnace interests expected.

Limited quantities of Westmoreland County, Pan Handle and Connellsville coal have been in the market in the past week, but asking prices have been mounting and buyers have largely lost interest. Connellsville furnace coke has become unquotable. Occasional odd lots have been offered at fancy prices, while the average furnace will not pay over $3.50 for a supply, preferring to bank. Foundry coke has been available at $4.75@$5 25, against $4.25@$4.75 ruling as the market for several weeks, during which time most foundries were stocking.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 38 – $0.40
Acetone	lb.	$0.09 – $0 09½	.09¾ – .11
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5.00 – 5 25	5.30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.00 – 9 50	9.75 – 10 00
Boric, crystals	lb.	.11 – .11½	.11½ – .12
Boric, powder	lb.	.11½ – .11⅔	.11¾ – .12½
Citric	lb.	..... –	.45½ – .46
Hydrochloric	100 lb.	1.10 – 1.20	1.25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11¾ – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04¼	.04½ – 05
Molybdic, c.p.	lb.	3.00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)	....	..... –	..... – .....
Nitric, 40 deg.	lb.	.06 – .06½	.06¾ – .07
Nitric, 42 deg.	lb.	.06½ – .06¾	.07 – .07¼
Oxalic, crystals	lb.	.11½ – .12	.12½ – .13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08¾ – .09½
Picric	lb.	.25 – .27	.28 – .32
Pyrogallic, resublimed	lb.	..... –	1.65 – 1 75
Sulphuric, 60 deg., tank cars	ton	11 00 – 12 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	..... – .....
Sulphuric, 66 deg., drums	ton	20.00 – 20.50	21.00 – 22.00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22.50	23.00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34 00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.26½ – .28
Tartaric acid, imported, powdered	lb.	..... –	.27½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 5.50
Alcohol, methyl (see methanol)	....	..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03½ – .04	.04½ – .05
Alum, chrome lump	lb.	.07½ – .08	.08½ – .08½
Aluminum sulphate, commercial	100 lb.	1.65 – 1.85	1.90 – 2 40
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium nitrate	lb.	.06 – .06½	.06¾ – .07½
Amylacetate tech	gal.	..... –	2.00 – 2.40
Arsenic, white, powdered	lb.	.06¾ – .07½	.07¾ – .08
Arsenic, red, powdered	lb.	.12 – .12½	12½ – 13
Barium chloride	ton	87.00 – 90.00	91 00 – 95 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07½ – .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .04	.04½ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	1.60 – 1.75	1.80 – 2 75
Blue vitriol (see copper sulphate)	.....	..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)	.....	..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24.75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium peroxide	lb.	..... –	1.40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.89 – .91
Carbon bisulphide	lb.	.06 – .06½	.06¾ – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)	.....	..... –	..... – ....
Caustic soda (see sodium hydroxide)	.....	..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .06½	.06¾ – .07
Chloroform	lb.	..... –	.37 – .40
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	15.00 – 16.00	16.50 – 30.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	58 – .60
Copper sulphate, crystals	100 lb.	5.50 – 5 60	5 65 – 6 15
Cream of tartar	lb.	..... –	23½ – .25
Epsom salt (see magnesium sulphate)	.....	..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.93 – 1 00
Formaldehyde, 40 per cent	lb.	.08½ – .09	.09¼ – .10
Fullers earth, f.o.b. mines	net ton	16.00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32.00	..... – .....
Fusel oil, ref.	gal.	..... –	2 15 – 2 50
Fusel oil, crude	gal.	..... –	1.25 – 1 50
Glauber's salt (see sodium sulphate)	.....	..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.15 – 15½
Iodine, resublimed	lb.	..... –	4 05 – 4 15
Iron oxide, red	lb.	..... –	.12 – 18
Lead acetate	lb.	..... –	.09⅝ – 12
Lead arsenate, powd.	lb.	.14 – .14½	.14¾ – .15½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .07½	.08 – .08½
Magnesium carbonate, technical	lb.	.06 – .06½	.06¾ – .08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2.60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1 80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbonyl chloride)	.....	..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	.... –	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	.10½ – .10¾	.10¾ – .10¾
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – .05½	.05½ – .06
Potassium chlorate, crystals	lb.	.06 – .06¼	.06½ – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6.10 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07⅜ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.25½ – .26	.26½ – .27
Rochelle salts (see sodium potas. tartrate)	....	..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .07¾	.08 – .08¼
Salsoda	100 lb.	1.45 – 1.55	1.60 – 1.85
Salt cake (bulk)	ton	18.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04½ – .04½	.04½ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07¾	.08 – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .27
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.65 – 3.70	3.75 – 4.20
Sodium hyposulphite	lb.	.03 – .03¼	.03¼ – .03¾
Sodium nitrite	lb.	.08½ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¾ – .04	.04½ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.16½ – .16½	.17 – .17½
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.85 – 1.00	1.10 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04½ – .04⅝	.04¾ – .05⅛
Sodium sulphite, crystals	lb.	.03½ – .03¾	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09¼ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06½ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08½ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16 — .16½
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.26 — .28
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.95 — 1.00
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — 25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.20 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06¾ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.75 — 2.80
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — 18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.70 — .75
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.10 — 1.15
Phthalic anhydride	lb.	.35 — .38

Phenol, U. S. P., drums	lb.	.12 —	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls	lb.	.24 —	.24½
Salicylic acid, U. S. P.	lb.	.25 —	.26
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	.25 —	.27
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.26 —	.28
Beeswax, refined, light	lb.	.30 —	.32
Beeswax, white pure	lb.	.35 —	.40
Candellila, wax	lb.	.25 —	.26
Carnauba, No. 1	lb.	.45 —	.46
Carnauba No. 2, North Country	lb.	.25 —	.25½
Carnauba, No. 3, North Country	lb.	.16 —	.16½
Japan	lb.	.17 —	.18
Montan, crude	lb.	.04¼ —	.04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02¾ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03¼
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05¼
Stearic acid, single pressed	lb.	.08¾ —	.09
Stearic acid, double pressed	lb.	.09¼ —	.09½
Stearic acid, triple pressed	lb.	.10¼ —	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.30 —	5.35
Rosin E-I	280 lb.	5.40 —	5.45
Rosin K-N	280 lb.	5.50 —	6.60
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.88 —	....
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y	100 lb.	3.75	
Blood, dried, f.o.b., N. Y	unit	4.00	
Bone, 3 and 50, ground, raw	ton	30.00 —	32.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.90 —	3.00
Tankage, high grade, f.o.b. Chicago	unit	3.25 —	3.40
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0.17½ —	.17¾
Upriver coarse	lb.	.12 —	.13
Upriver caucho ball	lb.	.12½ —	.13
Plantation—First latex crepe	lb.	.14¾ —	.15
Ribbed smoked sheets	lb.	.14½ —	.15
Brown crepe, thin, clean	lb.	.13 —	....
Amber crepe No. 1	lb.	.15 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls	lb.	.13 —	.13¼
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.09½ —	.09¾
Corn oil, crude, in bbls	lb.	.11 —	.11¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.10 —	.10¼
Cottonseed oil, summer yellow	lb.	.12 —	.12¼
Cottonseed oil, winter yellow	lb.	.13¼ —	.13
Linseed oil, raw, car lots (domestic)	gal.	.82 —	.83
Linseed oil, raw, tank cars (domestic)	gal.	.78 —	.79
Linseed oil, in 5-bbl lots (domestic)	gal.	.85 —	.86
Olive oil, denatured	gal.	1.12 —	1.15½
Palm, Lagos	lb.	.07¾ —	.08
Palm, Niger	lb.	.06 —	.06¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09½ —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.86 —	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.10¾ —	..
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¼ —	....

FISH

Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

Prices remain quotably unchanged.

Refractories

All quotations same as April 5th report.

Ferro-Alloys

Ferromanganese 76-80% Mn, domestic $67 per ton.
All other prices remain unchanged.

Ores and Semi-finished Products

Quotation same as previous report.

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	4.50-5.00
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Nickel, electrolytic, resale	32.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	30.25
Lead, New York, spot	5.00-5.15
Lead, E. St. Louis, spot	4.85-4.90
Zinc, spot, New York	5.40
Zinc, spot, E. St. Louis	4.90

OTHER METALS

Silver (commercial)	oz.	$0.65¼
Cadmium	lb.	1.00-1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	160.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	50.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.48	$2.38
Soft steel bars	2.38	2.28
Soft steel bar shapes	2.38	2.28
Soft steel bands	2.98	2.88
Plates, ¼ to 1 in. thick	2.48	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Dixie Chemical Products Co., is planning for the erection of a new addition to its plant. D. H. Markstein is president.

TUSCALOOSA—J. H. Thress has construction nearing completion on a new brick-manufacturing plant and will install equipment and start operation at an early date. The site is on the outskirts of the city. The plant will cost about $22,000.

EUFAULA—The City Council is planning for the installation of a new filtration plant and system at the waterworks.

Arkansas

EL DORADO—The El Dorado Oil & Pipe Line Co. is planning for the rebuilding of the portion of its oil plant, recently destroyed by fire.

California

RICHMOND—The Luning Mineral Products Co., 21st St. and Chanslor Ave., manufacturer of mineral pigments used for paint production, has plans under way for the construction of an addition to its plant to more than double the present output.

Colorado

DENVER—The Continental Rubber Corp., recently organized under state laws, has negotiations in progress for the purchase of a local site to be used for the construction of a new plant for the manufacture of automobile tires and other rubber goods. A. E. Sidnell is president and treasurer.

Connecticut

VERSAILLES—The Inland Paper Board Co., Inc. recently organized, has taken over the local plant of the Federal Paper Board Co., comprising a number of buildings and over 600 acres of land, and in the future will operate at this location for the manufacture of composition paper-board specialties. A number of improvements will be made in the mill, including the erection of a 1-story power house. The new company is headed by William G. Shortess and Frank Mousley.

Delaware

YORKLYN—The National Fibre & Insulation Co. is arranging for the discontinuance of the plant of the American Vulcanized Fibre Co., at Newark, Del., recently acquired, devoted to paper manufacture and kindred production, and will combine the mill with its main plant at Yorklyn.

Florida

ORLANDO—The Orlando Pottery, operated by the Yowell-Drew Co., is having plans drawn for the erection of an addition, to include a new kiln. The equipment installation is estimated to cost close to $13,000. Bids will be asked early in May. Gamble & Bryan, East Liverpool, O., are engineers. N. P. Yowell is president.

HOMESTEAD—Fire, April 2, destroyed a portion of the local building of the Independent Fertilizer Co., with loss estimated at about $13,000.

Georgia

COLUMBUS—The Bradley Fertilizer Co., 8th St. and Tenth Ave., is reported to be planning for the immediate rebuilding of the portion of its plant destroyed by fire, March 24, with loss estimated at $90,000, including equipment.

Illinois

CHICAGO—The Byproducts & Coke Corp., 112th St. and Torrance Ave., has commenced the construction of a new 1-story coke-oven plant, 20 x 550 ft. Charles Stewart, 53 West Jackson Blvd., is engineer.

Indiana

MISHAWAKA—The Rubber Regeneration Co. is planning for the rebuilding of the section of its plant destroyed by fire, March 28. The loss has not been announced.

Iowa

DAVENPORT—The recent reference to the fire loss sustained at the plant of the Mammoth Glucose Co., March 30, reported at $300,000, occurred at the works Nichols Wire & Sheet Co., occupying a portion of the glucose plant under lease, and in a section owned by Charles Brady, who purchased the entire plant from the Corn Products Refining Co., the previous owner.

Kentucky

RUSSELL — The Kentucky Refractories Corp., Covington, Ky., has acquired property at Russell, totaling about 15 acres of land, and plans for the erection of a branch plant for the manufacture of firebrick, furnace linings and other refractory products. The works will be equipped for an output of about 75,000 bricks and other refractory units daily, giving employment to approximately 175 men. The cost is estimated at about $350,000, including machinery. A. J. Ivey is secretary and treasurer.

Louisiana

HOMER—The local refinery and oil plant of the Homer Oil & Refining Co. has been acquired by H. C. Leete and A. C. Lea, both of Shreveport, La., who will organize a company and operate the plant. The refinery will be remodeled and improved.

HOUMA—The City Council is planning for the construction of a new purification plant at the municipal waterworks. A bond issue of $200,000 has been voted for this and other municipal improvements.

Michigan

GRAND RAPIDS—The Valley City Milling Co., 217 Michigan St., has completed plans and will soon call for bids for the erection of a new flour mill to cost about $600,000, including equipment. The A. E. Baxter Engineering Co., Ellicott Square, Buffalo, N. Y., is engineer. William S. Rowe is president.

MONROE—Fire, April 2, destroyed the plant of the Weis Fibre Container Co., with loss estimated at about $1,000,000. The plant has been giving employment to about 300 men. It is planned to rebuild at an early date.

Missouri

ANNAPOLIS—The Annapolis Lead Co. will soon break ground for the erection of a new concentrating plant, to be equipped for a daily production of about 1,000 tons. A power house will also be constructed. The work is estimated to cost in excess of $400,000. M. C. Rhodes is president.

PHENIX—The Phenix Marble Co. is pushing construction on its new local plant and plans for early occupancy. It will be equipped for the manufacture of lime products, whiting and kindred specialties, and is estimated to cost $60,000.

JEFFERSON CITY—The Strawboard Mfg. Co. has preliminary plans under way for the erection of an addition to its plant.

New Jersey

PASSAIC—The Paterson Parchment Paper Co., 35 8th St., has awarded a contract to William Hassan, 625 Main St., for the erection of a 2-story addition, to cost about $50,000. The Solomon-Abbott Co., 175 5th Ave., New York, N. Y., is engineer.

EAST RUTHERFORD—Fire, April 10, destroyed two buildings at the plant of the Flintkote Co., Madison and Central Aves., manufacturer of asphalt shingles, waterproofing products, etc., with loss estimated at close to $100,000. Headquarters of the company are at 88 Pearl St., Boston, Mass.

KEYPORT—The County Gas Co., formerly the Standard Gas Co., is planning for extensions and improvements in its local water gas plant, to cost about $150,000. William J. Clothier is vice-president.

New York

FREEVILLE—The United Fertilizer & Lime Co., Merchants' Bank Bldg., Syracuse, N. Y., will build a new 1-story fertilizer manufacturing plant at Freeville, 45 x 75 ft.

OAKFIELD—The United States Gypsum Co., 1170 Broadway, New York, will build a new addition to its plant at Oakfield, used for the manufacture of panel boards and other gypsum products.

Pennsylvania

PHILADELPHIA—The Belmont Packing & Rubber Co., Butler and Sepviva Sts., manufacturer of mechanical rubber products, will break ground at once for the erection of a 2-story addition, 35 x 75 ft. The building contract has been let to George W. Crossley, 2264 Bridge St.

HAZLETON—The Thomas Leather Co. has been organized to take over and operate the plant of William Olewine, 9 East Broad St. Possession will be taken at once, and a number of improvements are contemplated. The new company is headed by Herbert F. and T. Frank Thomas.

South Carolina

CHARLESTON—The Consolidated Gas Co. is planning for extensions and improvements in its plant to cost about $40,000. A new purifier department to cost $25,000 will be installed.

Tennessee

KNOXVILLE—The Kinney Chemical Co., 727 Broadway, is planning for the erection of a 2-story plant, 25 x 150 ft. About 6,500 sq.ft. will be given over to chemical manufacture. F. L. Kinney is head.

Texas

DALLAS—John J. Simmons has awarded a contract to Lawrence Miller, Dallas, for the erection of a 3-story and basement plant for the manufacture of chemicals and chemical byproducts, estimated to cost about $50,000. Barglebaugh & Whitman, Dallas, are architects.

DALLAS—The Trinity Paper Mills Co., 3010 Williams St., is arranging a list of equipment for installation at its plant to provide for a capacity of about 4 tons of waxed and other papers per day. The machinery will include waxing equipment, slitters, winders, etc. J. Y. Webb is president, and R. G. Smythe, manager.

FREEPORT—The Freeport Sulphur Co. has commissioned Dwight P. Robinson & Co., engineers and contractors, 125 East 46th St., New York, N. Y., to prepare plans for its proposed new plant at Hoskins Mound, near Brazaria, Tex., on property recently leased from the Texas Co. It will cost approximately $500,000, with machinery.

CAMERON—The Cameron Water, Power & Light Co. is planning for the installation of a new water treatment and purification plant at its local waterworks, estimated to cost about $40,000.

HOUSTON—The Model Brick Co., recently organized, has plans under way for the erection of a new plant for the manufacture of brick and other burned clay products, and will take bids for the buildings and equipment during May. The initial output will approximate 12,000 bricks per day. W. J. Carter and J. F. Meyer, both of Houston, head the company.

THREE RIVERS—The Three Rivers Glass Co., 520 Bedell Bldg., San Antonio, Tex., recently organized, is having plans prepared for the erection of its proposed new plant at Three Rivers, consisting of a main building, 50 x 150 ft., and auxiliary structures. The company will specialize in the manufacture of bottles, and will develop an output of about 100 gross per day. Automatic glass-blowing machinery and other equipment will be installed. James Kepp is president, and H. L. Warrick, general manager.

West Virginia

WHEELING—The City Council has called a special election on April 24, to vote bonds for $2,000,000 for water-works extensions and improvements, including a new filtration plant. The Board of Water Commissioners is in charge.

Wisconsin

PARK FALLS—The Flambeau Paper Co. is perfecting plans for the rebuilding of its 2-story pulp and paper mill, estimated to cost about $100,000. Work will be commenced at an early date. Thomas W. Orbison, 812 College Ave., Appleton, Wis., is engineer. Guy Waldo is general manager.

New Companies

THE FLORIDA GLASS & NOVELTY WORKS, INC., Jacksonville, Fla., has been incorporated with a capital of $20,000, to manufacture glass specialties. C. E. Harris is president; Charles A. Powers, vice-president; and Harry W. Herwig, secretary and treasurer, all of Jacksonville.

THE K-B MFG. CO., Trenton, N. J., has been incorporated with a capital of $125,000, to manufacture alkalis and kindred products. The incorporators are Abraham S. Lewis and Harry Chalt. The company is represented by Alexander Budson, 901 American Mechanic Bank Bldg., Trenton.

THE AMERICAN BRICK CO., INC., Berlin, Conn., has been incorporated with a capital of $75,000, to manufacture brick and other burned clay products. The incorporators are E. M., M. F. and George A. Pickett, all of Berlin.

BARCAN & ZIEGLER, INC., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture chemicals, chemical byproducts, dyes, etc. The incorporators are E. D. Ziegler, M. Reiber and I. Barcan. The company is represented by Louis Levy, 277 Broadway, New York.

THE HARLEM RUBBER CO., 1652 North Kostner Ave., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture rubber products. The incorporators are George C. Siebert and Joseph A. Netzel.

THE VERTOXEL PRODUCTS CO., Newark, N. J., has been incorporated with a capital of 500 shares of stock, no par value, to manufacture bleaching powders and kindred products. The incorporators are Walter Marvin, 13 Margaretta St., Newark; Henry I. Tanner and Otto Eckert.

THE ORIENTAL LABORATORIES, INC., Memphis, Tenn., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are C. L. Gibbes, W. H. Steadman and W. H. Daniel, all of Memphis.

THE VELLEY CHEMICAL CO., Wilmington, Del., has been incorporated under state laws with capital of $3,000,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Service Co., Wilmington.

THE APUL TOWNSEND LABORATORIES, INC., New York, N. Y., has been incorporated with a capital of $275,000, to manufacture lubricants and affiliated products. The incorporators are W. E. Townsend, A. J. Paluszek and E. H. Paul. The company is represented by R. J. Mullen, 192 State St., Brooklyn, N. Y.

THE CONSUMERS' SERVICE CO., Pittsburgh, Pa., is being organized by W. J. Woolums, C. C. Bowker and L. W. Bowker, to manufacture refined petroleum products. Application for a state charter will be made on April 24. The company is represented by W. G. Heiner, 602 Frick Bldg., Pittsburgh.

THE MAGNESITE PRODUCTS CO., 31st and Cicero Sts., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture magnesite, lime, cement, etc. The incorporators are A. J. Petit, Frederick W. Snider and Edmund S. Cummings.

THE WONDER MINERAL & CHEMICAL CO., 3127 Park Blvd., Detroit, Mich., has been chartered under state laws to manufacture chemicals, chemical byproducts, etc. The incorporators are Warren W. Alger, James F. Williams and John Blenk.

THE DAMASCUS REFINING & MFG. CO., New York, N. Y., has been incorporated under Delaware laws with capital of $5,000,000, to manufacture refined petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE ELWOOD BRASS & ALUMINUM MFG. CO., Elwood, Ind., has been incorporated with a capital of $20,000, to manufacture brass, bronze and aluminum products. The incorporators are C. P. Rush, Henry Nauman, R. T. Boston and O. D. Hinshaw, all of Elwood.

THE FARMERS' & GINNERS' OIL MILL, INC., Austin, Tex., has been incorporated with a capital of $200,000, to manufacture cotton oil products. The incorporators are Leigh Ellis, H. Wunderlich and G. C. Quinn, all of Austin.

THE BRADLEY OIL CO., Wilmington, Del., has been incorporated under state laws with a capital of $4,000,000, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE TEXTILE CHEMICAL CO., INC., Providence, R. I., has been incorporated with a capital of $50,000, to manufacture chemicals, dyes and kindred products. The incorporators are Frank S. Shapiro, Mark Weisberg and Philip W. Lown, 5 Mt. Vernon St., Providence.

THE GRIFFITH-CUSTER STEEL CO., Johnstown, Pa., has been incorporated with a capital of $60,000, to manufacture steel products. Benjamin F. Custer, Johnstown, is treasurer.

THE ELDORADO DEVELOPMENT CO., Eldorado Springs, Mo., has been incorporated with a capital of $300,000, to construct and operate a lead and zinc mill and smelter. A. B. Stricklett is president, and L. T. Dunaway, secretary, both of Eldorado Springs.

THE QUALITOL LABORATORIES, INC., Buffalo, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals and affiliated products. The incorporators are O. C. McFarland and M. E. Buie. The company is represented by Coatsworth & Diebold, 438 Main St., Buffalo.

THE A. W. LEE OIL CO., Oklahoma City, Okla., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are A. W. and R. G. Lee, both of Oklahoma City.

THE FOURLOCK TILE CORP., Tuckahoe, N. Y., has been incorporated with a capital of $10,000, to manufacture tile and other burned clay products. The incorporators are J. Goldberg and C. F. Bailey. The company is represented by A. S. Mortimer, 111 Broadway, New York.

THE ACME COLOR CO., Boston, Mass., has filed notice of organization to manufacture chemicals, colors, etc. The company is headed by William W. Schofield, 97 High St., Boston.

THE OHIO VALLEY ROCK ASPHALT CO., Summit, Ky., has been incorporated with a capital of $500,000, to operate an asphalt mining and refining plant. The incorporators are R. G. Price, Joseph S. Laurent and Dover Williams, Fountain City, Tenn.

THE J. C. O'CONNOR CO., INC., Pittsburgh, Pa., has been incorporated with a capital of $100,000, to manufacture sheet steel products. H. E. Askin, 1825 Webster Ave., Pittsburgh, is treasurer.

THE GULF PHOSPHATE CORP., Dover, Del., has been incorporated under state laws with capital of $18,750,000, to operate a phosphate mining plant, manufacture fertilizer products, etc. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE LOTZ ASBESTOS CO., Hartford, Conn., has been incorporated with a capital of $100,000, to manufacture asbestos products. The incorporators are A. V. Nyquist, C. A. Jordan, Jr., and John Lotz, Jr., 94 Beacon St., Hartford.

THE DIXIE CO., Fairmont, W. Va., has been incorporated with a capital of $10,000, to manufacture lubricating oils. C. H. Neill is president; G. G. Smith, vice-president; and J. D. Alexander, secretary, all of Fairmont.

THE VENEZUELAN PETROLEUM CO., Pearl River, N. Y., has been incorporated under Delaware laws with capital of $5,000,000, to manufacture petroleum products. The company is represented by the Registrar & Transfer Co., 900 Market St., Wilmington, Del.

THE MCGREGOR OIL & MFG. CO., McGregor, Tex., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are H. E. Hackney, J. D. Naler and C. P. Shaffer, all of McGregor.

THE HOOSIER PAPER CO., Marion, Ind., has been incorporated with a capital of $25,000, to manufacture paper products. The incorporators are P. W. Slevin, Andrew Scheerer and C. C. Nelson, all of Marion.

THE JEWELL OIL CO., Lexington, Ky., has been incorporated under Delaware laws with capital of $100,000, to manufacture petroleum products. The incorporators are John B. and M. H. W. Jewell, and Harry M. Rowe, Lexington. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE CRANE CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incoprorators are J. W. Crane and J. E. Glen. The company is represented by G. L. Robinson, 31 Nassau St., New York.

THE COLUMBIANA FOUNDRY CO., McKeesport, Pa., has been incorporated with a capital of $5,000, to manufacture iron, steel and other metal castings. F. B. McConnell, McKeesport, is treasurer.

THE KENLATEX OIL CO., Wilmington, Del., has been incorporated under state laws with capital of $500,000, to manufacture petroleum products. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

THE UNITED STATES PRODUCTS CORP., Wilmington, Del., has been incorporated with a capital of $125,000, to manufacture chemicals and chemical byproducts. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

Capital Increases, Etc.

THE PENNSYLVANIA POTASH ACID FERTILIZER CO., Westfield, Pa., has filed notice of increase in capital from $350,000 to $1,000,000.

THE GEORGIA FULLERS EARTH CO., 26 Cortlandt St., New York, N. Y., has filed notice of increase in capital from $400,000 to $1,000,000.

THE WHITAKER-GLESSNER CO., Wheeling, W. Va., manufacturer of steel products, has disposed of a bond issue of $4,500,000, the proceeds to be used for general financing, operations and expansion.

THE GENERAL PETROLEUM PRODUCTS CO., 94th and Tinicum Sts., Philadelphia, Pa., has filed notice of increase in capital from $150,000 to $750,000.

THE RECTOR CHEMICAL CO., INC., 2 Rector St., New York, N. Y., has filed notice of dissolution under state laws.

THE LA BELLE IRON WORKS, Steubenville, O., manufacturer of steel slabs, billets, sheets, etc., has disposed of a bond issue of $4,000,000, the proceeds to be used for general financing and operations.

THE MOODY OIL & REFINING CO., Wichita Falls, Tex., has filed notice of increase in capital from $5,000,000 to $21,500,000.

THE POCOT OIL CO., Tonawanda, N. Y., has filed notice of increase in capital from $10,000 to $100,000.

Industrial Developments

PAPER—The Hinde & Dauch Paper Co., Sandusky, O., has resumed operations at its mill at Muncie, Ind., which has been closed for about a year past. The working force will be increased as rapidly as the plant can be placed in condition for operation.

Practically all of the paper mills in the New England district are increasing operations and adding to the working forces.

The Spanish River Pulp & Paper Mills, Ltd., Montreal, Que., is advancing its working schedule and is now operating at close to capacity.

The International Paper Co., New York, N. Y., has commenced the manufacture of paper at its new mill at Three Rivers, Que., which previously has been operating in part for the production of sulphite pulp. The plant has a rated capacity of 96 tons of paper daily, and it is expected to develop this maximum in the near future.

All of the paper mills at Escanaba, Mich., have resumed operations both in the pulp and paper divisions, following an idleness of a number of months. About 400 men have been added to the working forces.

RUBBER—The Firestone Tire & Rubber Co., Akron, O., has advanced its production schedule to a basis of 20,000 tires a day, as compared with an output of 17,000 tires daily in recent weeks.

The Seiberling Tire & Rubber Co., with plants at Barberton, O., and New Castle, Pa., has increased operations to a point of 1,600 tires and 2,000 tubes per day. Additional workers will be employed in the near future.

GLASS—The Pittsburgh Plate Glass Co., Pittsburgh, Pa., has increased production at its different plants to approximately 90 per cent of normal capacity.

The Ball Bros. Glass Mfg. Co., Muncie, Ind., is giving employment to about 1,500 operatives at its plant, and plans for increased operations, with additional workers, at an early date.

CERAMIC—The Enduro Porcelain Enameling Co. Middletown, Pa., a subsidiary of the Wincroft Stove Works, is maintaining full capacity operations at its plant, and has adopted a day and night working schedule.

The National Fireproofing Co., Perth Amboy, N. J., is increasing production at its local plant and adding to the working force. The present schedule is close to capacity output, with 10-hour working day.

METALS—The Anaconda Copper Mining Co., Butte, Mont., is increasing production at its local plants, with employment of an increased working force. The Washoe smelter at Anaconda, Mont., and the Great Falls, Mont., plants are in active operation.

The Utah-Apex Mining Co., Bingham, Utah, has resumed operations at its local properties, following a suspension for more than a year past. Employment will be given to about 250 men, with output of about 450 tons of lead ore per day.

Practically all of the metal-refining plants at Perth Amboy, N. J., have increased the April production schedule, as compared with the February and March outputs, and a large number of additional men are be-

ing employed. The different plants include the American Smelting & Renning Co., the United Lead Co. and the Raritan Copper Works.

A number of copper compaines in the vicinity of Ray, Ariz., have resumed operations at their properties, following a shutdown for about a year past. The principal companies, under one management, include the Utah Copper Co., the Ray Consolidated Copper Co., and Chino Copper Co. and the Nevada Copper Co. The present basis of production will be increased gradually.

The Calumet & Hecla Copper Co., Calumet, Mich., has resumed operations at its plant. Other copper companies in this same section are re-opening, including the Isle Royale Copper Co., and the Ahmeek Copper Co., giving employment to a total of about 2,000 men.

IRON AND STEEL—The Monongahela Tube Co., Clairton, Pa., is arranging for the immediate operation of its No. 2 furnace on day and night shifts, giving employment to about 175 men. The plant has been idle since late last year.

The Canton Sheet Steel Co., Canton, O., has resumed operations at its plant, effective April 17, following a shut-down for some time past.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., is operating its Ensley steel works at full capacity, and broke all previous production records during March, with the ingot mill manufacturing 96,000 tons, and the blooming mill 75,000 tons. One of the blast furnaces at the plant is being repaired and will be placed in service at an early date.

The Otis Steel Co., Cleveland, O., has opened its new sheet mill, and will soon bring the plant up to capacity. Present production is on a 75 per cent basis.

The Republic Iron & Steel Co., Youngstown, O., has blown in another blast furnace at its Hazleton plant, making the third unit in operation.

The Central Steel Co., Massillon, O., is increasing production at its mills, and six of the nine furnaces are now in operation. Further increase will be made at an early date.

The Sharon Steel Hoop Co., Sharon, Pa., is making ready to blow in its blast furnace at Lowellville, Ohio.

Manufacturers' Catalogs

THE L. R. CHRISTIE Co., Pittsburgh, Pa., has recently issued a new catalog showing various types of driers and containing two interesting articles by L. R. Christie, one on "Dryer Engineering" and the other on "Dryer Efficiency," which are illustrated by curves of some value to the engineer.

CHARLES ENGELHARD, INC., New York, is issuing Bull. A-23 on "Impervite Hard Porcelain and Impervite Refractory Porcelain."

THE SHEPARD ART METAL Co., Detroit, Mich., announces the publication of a booklet on "Shepard Die Castings." In it there is a chapter about die castings, illustrations and description of closed body hardware, polished nickel finish; die castings in zinc base alloys; die castings in aluminum; die castings in tin base metals, and die castings in lead alloys.

THE GRISCOM-RUSSELL Co., New York, in Bull. 360 describes "Griscom-Russell Evaporator Systems for the Economical Production of Distilled Boiler Feed Water." The application of evaporators to the purification of boiler feed water by distillation is covered in a general and non-technical way. The booklet is written so that the application of Reilly evaporators can readily be understood by the non-technical executive as well as the engineer.

THE ESTERLINE-ANGUS Co., Indianapolis, Ind., in Bull. 322 illustrates and describes various types of its graphic meter.

THE ATLAS VALVE Co., Newark, N. J., has issued a booklet on "Reducing Valves," giving tables and rules for determining the capacity of reducing valves and pipe connections; also for determining the capacity and flow of steam in pipes of different diameters and different losses in pressure. Copies will be sent upon request.

THE UEHLING INSTRUMENT Co., Paterson, N. J., calls attention to Bull. 112, covering Uehling CO_2 recording equipment for guiding the engineer and fireman in reducing the waste of fuel up the chimney. Particular attention is called to the recently developed "Pyro-porus" filter, shown on page 10, an exclusive Uehling feature, which is claimed to be very efficient in keeping the gas sampling lines clean. Other noteworthy features are the separate recorder for the engineer's office and indicator for the boiler front continuous (not intermittent) chart record and dry method of absorption.

W. S. ROCKWELL Co., 50 Church St., New York, has issued Bulletin 240, on "The Heat-Treatment of Springs With Stationary and Continuous Furnaces." This is one of a series of well-written pamphlets outlining the many factors controlling the methods of applying and utilizing heat and handling material in the modern metallurgical plant.

MERCK & Co., New York, are distributing a new edition of their booklet "Blue Label Reagents and Other Laboratory Chemicals." Copies will be sent to anyone interested on request.

THE DENVER FIRE CLAY Co., Denver, Col., has published an attractive bulletin on Oil Burners. This company is endeavoring to carry out an educational campaign in all its bulletins, making them useful for something besides the selling of its products, and in this bulletin the first twenty-one pages are devoted exclusively to the general discussion on various methods of using oil as fuel, while the last twelve pages are devoted to illustrations and descriptions of low-pressure burners, high-pressure burners, the combination burner, the high-low burner, the motorblower, blast valve, tuyere, refractories and illustrations for furnaces using DFC burners.

THE COMBUSTION ENGINEERING CORP., Broad St., New York, calls attention to a folder on Type K automatic stoker for small plants, and a booklet on the application of pulverized coal to locomotives. This latter booklet entitled "Lopulco Pulverized Fuel System for Locomotives," tells of the interesting phases of this company's pioneer work and contains a number of informative test reports.

WALLACE & TIERNAN Co., INC., of Newark, N. J., has just issued a new technical publication, No. 30, describing its bacteriological testing outfit and other chemical testing outfits useful in the control of water purification.

THE PYROLECTRIC INSTRUMENT Co., Trenton N. J., announces the publication of Catalog 19. It contains this company's complete line, including apparatus for low-resistance measurements, electro-dynamometer, electrometers, furnaces, galvanometers, hydrogen-ion apparatus and chemicals, inductances, keys and switches, laboratory accessories, meters for d.c. measurements, pyrometers and thermocouples, pyrovolter type instruments, resistances and resistance thermometers. Illustrations are given.

THE HOYT METAL Co., St. Louis, Mo., has issued a booklet on Products of Rolling Mill and Pipe Departments.

THE NATIONAL CARBON Co., INC., New York City, has just issued "The Carbon Electrode," an 80-page booklet containing many scientific and engineering data relating to the manufacture and use of electrodes in electric furnaces. The booklet contains also some useful hints on the handling, joining and storage of electrodes, as well as some useful electrode "don'ts."

THE SURFACE COMBUSTION Co., New York, N. Y., has ready for distribution Bulletin 3D on Surface Combustion Low-Pressure Air-Gas Inspirators. These inspirators are designed so as to be readily applicable to any make of gas furnace.

THE STANDARD CALORIMETER Co., East Moline, Ill., calls attention to Booklet 102, on "Directions for Using the Parr Sulphur Bombs and the Parr Sulphur Photometer."

SCHUTTE & KOERTING, Philadelphia, Pa., has just issued a new bulletin on "Air Jet Lift Equipment." This booklet is well illustrated, showing the action of the air jet lift, also several applications. Formulas and tables are given showing capacities under various conditions of air pressure handling different liquids.

THE HARDINGE Co., New York, N. Y., calls attention to a new bulletin on Quigley Fuel Systems, comprising methods of preparing, transporting and burning of pulverized fuels. This bulletin is known as No. 12 and treats the subject of pulverized fuels. Emphasis is laid upon the methods employed properly to prepare and burn the powdered coal, rather than occupying most of the space discussing the pulverizer. Aside from complete plant layouts, what it terms as a "Unit Milling Plant" is described. The system comprises a method of pulverizing and transporting the coal to one or more furnaces in the same locality, at the same time obtaining positive regulation and continuous operation over extended periods. A partial list of users is given.

THE PHILADELPHIA COPPERSMITHING Co., Philadelphia, Pa., has issued Catalog "S," descriptive of its sugar equipment. It announces that its research laboratories are in charge of Dr. Henry Arnstein and that it is equipped to handle problems dealing with chemicals (organic or inorganic), dyes, pharmaceuticals, food and food substitutes, sugar, motor fuel from vegetable and residual sources, vegetable oil, soap, glycerine, etc., plants.

THE CENTURY WOOD PRESERVING Co., Pittsburgh, Pa., in Bulletin 20 describes the storing and seasoning of cross-ties.

Coming Meetings and Events

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at Atlanta, Ga., May 8-11.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

AMERICAN WELDING SOCIETY will hold its annual meeting April 26-29 at the Engineering Societies Building, New York City.

ANNUAL SAFETY CONGRESS of the NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its national convention in Detroit, Mich., April 26-28.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

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To Regulate Trade Associations

THE dilemma in which trade associations find themselves as the result of the Hardwood decision continues to be the subject of much discussion. The most recent developments include the Hoover conference at Washington and the introduction, in Congress, of a bill by Senator EDGE placing such associations under the Federal Trade Commission and of a joint resolution, fathered by Senator EDGE and Representative MCARTHUR, providing for a Congressional investigation.

"Business is entitled to know in definite terms what it may and may not do," declares the preamble of the proposed joint resolution. This declaration will strike a sympathetic chord in many a weary heart. For 50 years American business has been struggling to attain certainty of its legal status. Successively under the old common law doctrines, under the state anti-trust laws and under the federal Sherman act, business has been operating under the handicap of indefinite and negative restrictions. The process has been one in which business, denied definite positive guidance, has tentatively adopted in its tendency toward combination one legal form after another—the pool, the trust, the holding company, the merger—only to be checked and turned back by the Supreme Court, which has finally evolved that marvel of indefiniteness, the "rule of reason." The latest decisions have made it clear that combinations in restraint of trade cannot be erected under the guise of open-price associations. One more experiment tried and the check once more applied! Business now asks for a statement of what it can do.

The uncertainty which has been present has been costly in the past—much more costly than is ordinarily realized. If one were to attempt to devise a plan for dampening business enterprise, it would be difficult to evolve a more efficient implement than a threat of illegality.

It is not meant to infer that business should be left free to do anything it chooses. So long as competition is the force relied upon to protect consumers from high prices, it will be necessary to prevent by law combinations in restraint of trade. We merely point out that certainty as to what is legal and what is illegal would greatly simplify the problem of the business man. How can one proceed confidently so long as the rules of the game are undetermined and constantly shifting?

In this particular case, moreover, uncertainty is likely to be particularly costly. Unless positive guidance is given, the trade association movement will receive a blow which will prevent in large measure the performance of many functions which are highly useful in the economic process and quite free from objection on the grounds of restraint of trade. For the fact-finding function of the trade association is really a risk-elimination function. If a business man can make his plans and decisions on the basis of fact and knowledge rather than guess and speculation, he can price more closely, eliminating the reserves and insurance premiums which inevitably accompany the conduct of business when surrounded by uncertainties. Trade associations now supply many valuable data and can be so developed as to supply more. Such data are essential to wise business decisions and will result in fewer losses to business men and lower prices to consumers.

The Edge bill may not be perfect. Senator EDGE does not pretend that it is. But certainly his proposals are steps in the right direction. It is possible to define fairly precisely the things which trade associations "may and may not do" and Congress owes it to the business community and to the country to make this clear.

Completing the Picture of Industry

IN FRESHMAN CHEMISTRY DAYS we learned that sulphuric acid was the great barometer of industry—in fact, of civilization itself. At that time, to be sure, our ideas on this subject were quite hazy, but since then we have come to realize that literally hundreds of industries are dependent on this important chemical. Fundamental materials such as copper, steel sheets, gasolene and fertilizers cannot be produced in needed quantities without sulphuric acid. This product lies at the very foundation of all our chemical industries. But all these things are well known even to the average layman and would not be worth the repeating here were it not for their bearing on a problem which is now confronting our industries.

When Mr. HOOVER became Secretary of Commerce one of his first ambitions was to organize a statistical service which would give the business men of the country a ready and accurate picture of industry. Such a picture meant current figures on the production and consumption of all the basic commodities of commerce. In a large measure Mr. HOOVER'S plans have been successful. Manufacturers, consumers, trade associations and statistical bureaus have given fully of their information. But there has been one conspicuous and outstanding failure. The picture of industry has been complete except for one important element. Monthly figures are now published for iron and steel, coal, cotton and wool, corn and wheat, copper, petroleum—all these. But the great barometer of industry is lacking. The chemical industry, or rather one of its principal components, alone has refused to co-operate with the Commerce Department. We of the industry are entitled to know the reason for this refusal. We have been told that it is because the manufacturers fear that the consumers will use the information to the disadvantage of the producer. We suspect, however, that the reason

is this: The big fellow already has his own informational service and doesn't want to share it with the little fellow who can't afford such costly facilities.

There is another thing which any manufacturer who is refusing to give these figures should keep in mind. If enough of the other industries of the country insist that they have a real need for this information, the department is going to get it for them. A sympathetic Congress which has already shown its willingness to back up Mr. HOOVER'S work with increased appropriations will not hesitate to enact legislation that will compel the giving of this information.

The acid makers whose selfish motives have already done damage to the good name of the chemical industries may yet be made to realize their short-sightedness.

How Much Petroleum Shall We Need in 1930?

STATISTICIANS have often projected the curve of petroleum consumption during late years to estimate the needs of the future. But J. E. POGUE has recently pointed out the fallacy of using such a trend curve alone for estimating the future demands for crude petroleum. He shows that any really sound basis of estimate must take into account the changes in industrial practice and allow for the modification of refinery yields in accordance with the indicated tendency of recent years.

In 1920 we used 531 million barrels of crude petroleum in the United States. This figure had been reached by increases of 10 per cent per year in the consumption during the previous decade. If such rates of compounding of demand should follow for another 10 years, the 1930 requirement for crude petroleum would be 1,260 million barrels, quite properly characterized as "a staggering volume."

But during recent years there has been a decreasing rate of addition to the number of motor vehicles, for we are approaching somewhere near a point of saturation for this equipment. Moreover the yield of gasoline per barrel of crude oil has been greatly increased, particularly during the past 5 years. In 1916 the ratio of gasoline produced to crude oil consumed was 0.154. In 1918 the ratio had reached 0.206, and in 1919, 0.214. The 1920 figure showed a slight falling off, no doubt due to peculiar business conditions, but in 1921 the ratio was back again to 0.233.

On these assumptions POGUE projects the curve of crude petroleum requirements through the coming 10-year period and reaches very interesting conclusions. He demonstrates that the combined efforts of these factors is such that 585 million barrels of crude petroleum for 1925 and 580 million barrels for 1930 probably will be adequate to meet the demand for gasoline. These quantities are not much greater than the 1920 consumption. In other words, if the present tendencies of industry continue, we have already reached somewhere near the maximum demand for crude petroleum. The increased quantity of gasoline which is needed will be supplied, during the next few years at least, largely by increasing the yield of gasoline per barrel of crude refined. Thus improved technology will again help to meet and care for the changing economic conditions of the country.

Meanwhile, look out for benzene, alcohol, and the chap who some day soon will build up from lower hydrocarbons and end with "gasoline"!

The Shortest Distance Between Two Points

DID it never occur to you, especially when contemplating the layout and arrangement, or, better, lack of arrangement, in evidence in many manufacturing plants, that the meaning of the old axiom about a straight line had never really been accepted by most of us? Mankind seems to have a special fondness for devious ways and we never deviate more noticeably than in some of these same plants.

Should the inquiring mind attempt to ascertain the cause for this wavering path in industry, the reason most frequently given is that, in the hurry and stress of expansion, it has been impossible to arrange extensions of building and equipment in such a way that the process continues to flow in a straight line. This is undoubtedly true in a majority of cases; but there are also cases where the plant started off with a poor layout and has had it ever since.

Now the answer to this is: If you are stuck in the mud, take measures to get out. If the product of a plant is restricted and the cost of production is too high, if the workers are compelled to wait for materials and partly finished goods pile up in the open spaces and block the passages, if an undue proportion of the force is employed in just carting materials back and forth through the plant, then the owners of the plant, the managers and the technical staff should take immediate counsel among themselves to the end that these conditions may be relieved. The relief will undoubtedly lie in correcting the routing and may also, and in fact generally does, necessitate a change in the methods by which the materials are handled between various steps in the process.

One example of the results which can be obtained by merely straightening the flow of the goods through a plant has come to our notice recently and serves to show the results that follow correct routing alone, there having been no additional equipment utilized in this operation.

In this particular factory the manufacturing was all done in one building and the raw material used was light in weight. The process was rerouted so that the raw material—stored in the basement—was started in the course of manufacture on the top floor and one operation succeeded another until the finished goods were delivered at the shipping point on the ground floor without the line once crossing itself. The space and equipment were the same as had been utilized formerly, but the production increased about a fifth and the force of over 200 men was reduced by 20 who had formerly been employed in keeping the aisles clear and the machines supplied with material. A further advantage was that the inventory of goods in process was reduced to one-quarter of the amount formerly carried.

Another example: A pulp mill found it advantageous to relocate the chip house at a cost of over a hundred thousand dollars in order to make the flow of material straight enough to permit the use of conveyors through the plant and thereby cut down the man-handling of material to a minimum.

Many examples such as these could be cited; but they really form a small proportion of the industrial plants of the country and by far the greater number are still in a position to profit from an earnest contemplation of the straight line between the two points of receiving and shipping.

Aluminum for Engineering Structures

SEVERAL pages of a former issue were devoted to a digest of a very remarkable report by Messrs. ROSENHAIN, ARCHBUTT and HANSON on aluminum alloys —namely, the eleventh report to the Alloys Research Committee of the British Institution of Mechanical Engineers. In this issue a brief account of the most remarkable "Y" alloy is given.

Such excerpts give but an inkling of the material contained in the original report, which in turn is little more than a sketch of the results of 7 years' work by a staff numbering at times as high as thirty investigators, and commanding the unstinted resources of the British scientific laboratories. Truly, systematic researches into complex alloy systems have become most prodigious undertakings, far beyond the imagination of the sponsors of the program, started over 30 years ago. Yet it is well that the program was started so early. It is impossible to appraise the influence which the successive reports on steels, brasses, bronzes and aluminum alloys have had on modern technology—they are fundamental.

Aluminum alloys of high strength are not entirely new. The Germans have been using certain of them called "duralumin" for dirigibles since before the war. British and American firms have also been manufacturing duralumin for several years; shop practice is fairly well understood and many laboratory studies have been made on the somewhat bizarre occurrences during heat-treatment. Duralumin contains 3.75 per cent copper, 0.5 per cent magnesium, 0.65 per cent manganese. The present report extends our information by recording the development of "A" alloy, containing 3 per cent copper and 20 per cent zinc; "E" alloy, containing 2½ per cent copper, 20 per cent zinc and 0.5 per cent of both magnesium and manganese; and "Y," containing 4 per cent copper, 2 per cent nickel, 1.5 per cent magnesium.

These newer alloys have all been produced in quantity, and the peculiar combination of properties possessed by "Y" alloy should insure its extended use in industry. It is as light as aluminum, yet as strong as soft steel. It corrodes at an extremely low rate. It retains its strength at moderate temperatures, which fact, coupled with its high heat conductivity, should make it very valuable for engine cylinders and pistons. Furthermore, it has a high endurance limit; that is to say, "fatigue failures" after oft-repeated loadings do not occur until the impressed loads are well up toward the yield point. To appraise this particular property it should be remembered that it is more difficult to add 1,000 lb. to the endurance limit of a metal than it is to add 10,000 lb. to its tensile strength.

We need not expect light alloys of high strength to be adopted as quickly as the radio telephone. They are of course indispensable to aircraft, where weight is a very great consideration and dollars can be spent to save a single pound. Engineers and designers are only slowly realizing that weight is an important factor in all moving parts. But when they are able to convince manufacturers and owners that it is well to put more into a light car or engine and save on its subsequent operation, the aluminum alloys will still have to overcome the competition of heat-treated alloy steels, relatively cheap, very strong and reliable.

Although we can say with much assurance that light metals and alloy steels will form the large structures of the future, it would be vain speculation to attempt to define their mutual relation. The best that scientists can do is to show that such things as high-strength alloys exist; metallurgists then discover how to procure the raw materials cheaply (and here much remains to be done for aluminum) and produce the alloys economically and uniformly. Engineers must then show us how to use these new tools of civilization—even to developing an entirely new technique of design.

Variations in Steel Demand

MEN who are anxious to stabilize business so that things would keep going at a steady pace all the time might well turn their attention to the steel trade. Either they would accomplish something for the industry or they would learn some of the difficulties involved in attempting to modify the actions of others.

There was quite a lot of talk last year about regulating the coal industry because it had become so seasonal in character, more coal being mined in winter and less in summer. It would be better to maintain uniform production, accumulating stocks in summer and drawing upon stocks in winter. If that is a good idea, how about a trade which instead of carrying stocks for purposes of equalization does just the reverse, increasing or decreasing stocks in such manner as to make the swings all the more violent?

That trade is the steel trade. Since the middle of March production of steel has been between three and four times as great as in July, 1921. The producers are not responsible, for they have simply been producing steel as it was bought from them. They cannot run on stock to any extent.

In the first 8 or 9 months of 1920 there was a very insistent demand for steel. Then demand fell off and in July, 1921, the mills were producing steel ingots at only 11,000,000 tons a year when their capacity was between 50,000,000 and 55,000,000 tons. Then production, which was dictated solely by orders received, rose rapidly, and the rate on April 1 was fully 35,000,000 tons.

Last summer stocks of steel in the hands of buyers and manufacturers of steel, not previously distributed, were being drawn upon. In recent weeks, on the other hand, the country has been increasing its stocks again.

It may be said that in times of heavy demand stocks are requisite and in times of light demand they are not. If that were true, some good work could be done by altering the condition. One might suppose that the stocks that stood as a barrier to mill demand in the summer of 1921 had been but recently accumulated. Many steel companies, however, report the curious experience of having had claims made upon them in the past few months against alleged defectives, when the records showed the steel had left the mill in the early months of 1920, before the apparent "scarcity" of steel had reached its height.

Before attempts are made to establish uniform production in industries whose product is actually consumed at varying rates, by establishing stock piles, it would be well to inquire into the cases where variations in demand are produced by variations in the amount of stock carried. A general study would probably show that the variations in demand upon producers of primary material are caused more by psychological than physical reasons, that the ups and downs in market demand are produced more by what men think than by the amount of actual consumption.

Readers' Views and Comments

Atomic Disintegration of Tungsten

To the Editor of Chemical & Metallurgical Engineering

SIR:—I regret that a delay has been necessary since the publication of Dalton M. Goetschius' comment in your issue of April 12 on the recent experiments of Clarence E. Irion and myself in exploding tungsten wires with the production of helium, and regret too that Mr. Goetschius did not have a more complete account of the work on which to base his comment.

Mr. Goetschius is quite correct in pointing out the analogy between the process of explosion such as we employed and the collisions of dark stars in interstellar space. Prof. W. A. Noyes of the University of Illinois has already pointed out in private correspondence that this is "a possible explanation of the sudden flaring up of stars which is sometimes seen," and Dr. J. A. Anderson, in the original paper describing the method used (*Astrophysical Journal*, vol. 51, p. 37, January, 1920), calculated that the same wire which by this method is impressed with 30 calories of energy would generate no less than 80,000 calories in falling from outer space into the sun, though it would probably not reach nearly so high a temperature because of the much longer time required.

The criticism that the production of mercury from tungsten involves an increase in atomic weight and is therefore a startling result which deserves "third degree" examination is also wholly correct, but is based on misinformation. It is regrettable that this work has received so much newspaper publicity and general comment in advance of the publication of the complete paper. Our carefully nurtured chemical publicity is, for once, working all too well. Not only are details ambiguously stated even by the careful reporter for CHEMICAL & METALLURGICAL ENGINEERING but atomic transmutation has been presented to the general public as established when mere decomposition is all that we can hope to have accomplished, and even that is based on preliminary work which cries for confirmation by others, who, fortunately, are already at work.

A brief report on this work will appear soon in the *Proceedings* of the National Academy of Sciences and a complete account is being sent to the *Journal of the American Chemical Society*. From these it will be evident that the helium spectrum was the only one unmistakably present in the gases formed by the high-temperature explosion. There was a background which seemed to be the banded spectrum of nitrogen and there was always a faint evidence of the strongest green line of mercury. This last was mentioned as part of the record, but we cannot but suppose that it was due to a minute backward diffusion of mercury vapor from the pumps used to exhaust the system, escaping the liquid air trap and even the cold charcoal bulb also used for evacuation. It does not justify theoretical speculation. The gas produced in the explosion of a 0.0005 mg. wire occupied slightly more than 1 c.c., on the average, which if it is all helium corresponds to nearly half the entire material of the wire. This should set at rest doubts on the ground of adsorbed or included gases. A further point is that no hydrogen lines were ever observed, which is of interest because the atomic weight of tungsten, 184, is an exact multiple of the atomic weight of helium and in view of the fact that while Sir Ernest Rutherford was able to produce hydrogen in small quantities from B, N, F, Na, P and Al, whose atomic weights are not multiples of 4, he was not able to observe its formation from Li, Be, C, O, Mg, Si and S, which, except for the first two very small atoms, are multiples of the helium weight (*Phil. Mag.*, vol. 42, p. 809, 1921).

GERALD L. WENDT.

Chicago, Ill.

The Soldier Bonus and Editorial Independence

To the Editor of Chemical & Metallurgical Engineering

SIR:—On my way from Geneva to Basel I had the good fortune to meet Nobile Carlo Tommasi, administrator of the Lonza Co. of Basel. He is an engineer. When he learned that I am a member of your staff he took from his brief case the issue of CHEM. & MET. for March 1, 1922.

I glanced through the issue and read particularly the editorial on page 385 and the letters on page 390 relating to the soldier bonus. The next to the last paragraph of the letter signed by Messrs. Webster, Burrows and Wendel particularly attracted my attention on account of its reflection on members of your staff. I quote:

> Speaking as one "having experience, if not authority," you mention that five members of your staff are opposed to the bonus. After your first editorial, it is doubtful if they would come out openly in favor of the measure and still hope to retain their positions.

Of course the imputation is thoroughly unwarranted. May I inform the gentlemen that I am not one of the five members of your staff who are opposed to the bonus and yet I am still in your organization and hope to be a part of it as long as my work is satisfactory? I may add also that I am a former member of the Canadian Expeditionary Forces.

J. S. NEGRU.

En Route, Geneva to Basel,
March 14, 1922.

EDITOR'S NOTE: Although we closed discussion on the bonus, we decided to accede to Mr. Negru's request to comment on this phase of the discussion. He is now making a trip through Central Europe for this magazine.

Fundamental Research on Corrosion

To the Editor of Chemical & Metallurgical Engineering

SIR:—It is very necessary that only the purest metals, those prepared with the most extreme care, be used in studying the fundamental facts underlying the problem of corrosion.

I notice one of the sheets of metal used by the Corrosion Committee of the British Institute of Metals[1] was reported as 99.97 per cent pure. That three-hundredths of a per cent may be very vital in the production of whatever corrosion takes place. Particularly there comes to my mind as an illustration some pure zinc which we had for a determination of melting point

[1] See CHEM. & MET. ENG., Feb. 15, 1922, vol. 26, p. 301.

standards. There were two samples, both of which analyzed as excessively pure materials; one, however, dissolved in ordinary hydrochloric acid immediately and the other only after several days' standing. The only chemical difference that could be found in those two pieces was six-thousandths of one per cent of iron.

It seems to me that in carrying out any corrosion experiments to find the fundamental facts one must start with metals of the greatest purity, otherwise the results may be, if not wholly, at least very greatly misleading. GEORGE K. BURGESS.

Washington, D. C.

Causes of Corrosion in Brass

To the Editor of Chemical & Metallurgical Engineering

SIR:—One or two points brought out in the review of the findings of the Corrosion Committee, British Institute of Metals, published in your issue for Feb. 15, 1922, seem worthy of further comment.

I don't doubt for a moment that the accumulation of deposits in the inside of the condenser tubes is contributory to corrosion, but it does not explain the actual fact that out of a number of condenser tubes placed side by side in the same service, some fail in a few months and others last for years. Comparison of those tubes which have not failed with those companion tubes which do fail has not in my practice revealed any particular deposit on one tube that was absent in a companion tube. It seems as though there must be something more in it than merely the accumulation of deposits.

It does not seem to have been proved that dezincification does not actually occur, but is only apparent because the copper has built up out of the solution by plating back. Most condenser tubes are in service in which the circulating waters are going through very rapidly, and I think it would require considerably more proof than I have been able to find in this summary, that corrosion takes place not through dezincification but only by an apparent dezincification.

It seems to me that not enough attention has been paid to the crystal grain of the various brasses that have been used in the corrosion tests, or the condition of strain or anneal that may or may not be present, and which may be a contributing factor to the rapid deterioration of brass condenser tubes.

Washington, D. C. ALLERTON S. CUSHMAN.

Effect of Composition of Brass on Corrosion

To the Editor of Chemical & Metallurgical Engineering

SIR:—From a microscopic examination of a large number of corroded condenser tubes I have come to the conclusion that quite different action may be expected, according to whether the brass is high in copper and shows only the alpha constituent, or whether it is lower in copper and has a duplex microstructure.

Considering the latter, of which Muntz metal is typical, it was observed that the beta constituent is the first to become attacked, with the result that a porous reddish material, which is practically all copper, is left behind. It would appear that the zinc has been preferentially removed. In some cases the entire tube becomes brittle and almost non-metallic from this cause. Corroded Muntz metal does not generally show pitting, but loses its original metallic properties and breaks into pieces when hammered.

On the other hand, brasses containing more than 65 per cent copper and which have an entire alpha structure usually dissolve away and become thinner when corroded, but do not become brittle. All of the brass tubes are likely to pit, but as a rule the pits in an alpha brass tube are clean, whereas the pits in a Muntz metal tube are usually filled with porous cement copper. Pitting seems to favor the bottom inside portion of the tube, where solutions may concentrate and foreign matters lodge. Condensers at the present time are usually built so that the tubes lie in a horizontal position. If the design were changed so that the tubes would be placed in a vertical position, there would be less tendency for solutions to concentrate and remain in contact with the metal when the condenser is permitted to drain or when it is shut off and the water in the tubes gradually evaporates and leaves behind concentrated corrosive solutions of salts. PHILIP DAVIDSON.

Waterbury, Conn.

Electrolytic Concentration Cells as Accelerators of Corrosion

To the Editor of Chemical & Metallurgical Engineering

SIR:—Light may be thrown on the mechanism of corrosion of brass condenser tubes, discussed in your article[1] "Results Achieved by the Corrosion Committee of the British Institution of Metals," by some work done recently by R. J. Mackay of the International Nickel Co. at the Mellon Institute.

We are all familiar with what we call galvanic corrosion of metals—that is, the accelerated corrosion which results from the presence of two dissimilar metals or two dissimilar portions of the same metals in electrolytic contact. The more electro-positive metal corrodes and the other metal forms the cathode and absorbs the hydrogen which is given off. Mr. Mackay has demonstrated an analogous type of corrosion which he calls corrosion by electrolytic concentration cells, using an idea quite well known to electrochemists, but, as far as I know, not hitherto recognized in its relation to corrosion.

If a uniform rod of metal is placed in contact with a solution which has a different concentration of the corroding ion at one point than at another, that portion of the rod in contact with the more concentrated part of the solution will form the cathode and the other portion will form the anode and the metal will go into solution there. In this manner it is possible to develop differences of voltage between different portions of a perfectly uniform piece of metal, amounting to as high as 0.2 volt, and Mr. Mackay has demonstrated that this condition does cause accelerating corrosion.

The demonstration was made particularly in the case of copper alloys in $CuSO_4$:H_2SO_4 solutions, but he has also shown that it is true of cells which are made up of a concentration of oxygen or air at one portion of the metal and a deficiency of the air or oxygen at another. He has found that such a condition can accelerate the rate of corrosion by as much as fifty times over that when the solution and the metal are uniform.

Could not some of the cases of pitting that have been noticed in the corrosion of condenser tubes be due to somewhat the same situation—namely, that the solution concentrates with respect to the corroding ion lodged upon the surface of the tube and in consequence sets up a concentration cell by which accelerated corrosion results? PAUL D. MERICA.

Bayonne, N. J.

[1] CHEM. & MET. ENG., Feb. 15, 1922, vol. 26, p. 301.

Thermal Problems of Petroleum Refining

Discussion of Petroleum-Refining Practice From the Combustion Engineer's Viewpoint—Adoption of Principles Proved in Other Process Industries Would Greatly Benefit Petroleum Industry—Secrecy and Use of Inbred Talent Is Destructive

BY L. A. MEKLER
Consulting Engineer

OIL REFINING as it is practiced at present is of comparatively recent origin. The petroleum industry has made wonderful progress in the last few years, but due to the past abundance and relative cheapness of the raw material as compared with the finished product and the general tendency toward making rather than saving money the average refinery practice leaves much to be desired in efficiency. As a whole the industry does not utilize the scientific and engineering data developed and proved in similar operating phases of other industries. This is particularly true for the thermophysics of refining.

Each refining operation from the crude down to the paraffine or asphalt depends on the thermal treatment to which the material is subjected. The still is the starting point of all refinery operations, and can be compared to the digestive tract of the human body. The material leaving the still determines the subsequent treatment and the final as well as the intermediate products. On the other hand, since the fuel bill is one of the main items of production costs, the commercial merits of the process are mainly determined by the still. Yet in the average refinery the still proper is the least developed of all the units. In most cases it

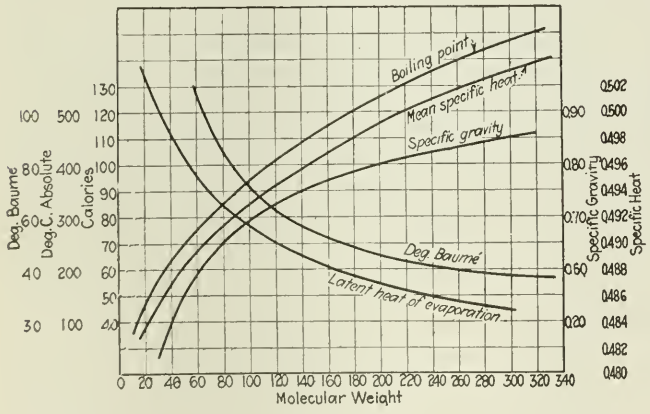


FIG. 1—PROPERTIES OF PARAFFINE HYDROCARBONS

is built on tradition, or on a pet superstition of the practical operator. The result is that, although a still is in its basic principles a boiler where the material is heated to vaporize the different constituents or cuts, the average thermal efficiency of most of the stills is around 20 per cent as compared with 75 to 80 per cent in the modern boiler.

High thermal efficiency is not the only requirement in still practice. The heat developed in the still must produce a certain thermochemical effect upon the oil, and since oil is very susceptible to thermal treatment, both the quantity and the quality of the heat must be such as strictly to meet the conditions favorable to the desired treatment. These conditions are determined by the balance sheet of the operation, which must be the starting point in the design of a refinery unit.

Fig. 1 shows the thermal properties of paraffine hydrocarbons, plotted against molecular weight.[1] Most petroleum products are a mixture of these hydrocarbons, and since any mixture of members of a homologous series has the properties of the member having the average characteristics of the mixture, the thermal properties of any petroleum product can be determined with an accuracy sufficient for all practical purposes.

After the balance sheet is completed the conditions affecting the application of the heat to the oil must be fully considered.

Working Temperatures

The working oil temperatures of straight (non-cracking) distillation are not over 450 deg. F. Since most of the distillation processes employ heat exchangers to preheat the incoming oil by the stored heat of the residue, the working range of a still is really between 150 and 450 deg. F. This is a slightly higher range than that of a boiler using a hot water heater. Yet principles of boiler design and operation cannot be successfully applied in their entirety to stills.

Water is a uniform liquid that does not break up chemically, unless the vapors are heated to 2,500 deg. C. Oil is a complex mixture, very susceptible to decomposition on heating. The thermal capacities of water and oil are also quite different. The total heat content of 1 lb. of saturated steam at 100 lb. pressure is in round figures 1,190 B.t.u., while that of oil is around 240. The specific heat of oil is less than half that of water. Therefore, when the still is operated as a boiler it is very easy to "force" the still and overheat the oil. In nine cases out of ten it is the local overheating that is responsible for carbon troubles, burnt-out bottoms, burst pipes, low yield, inferior products and many other things usually blamed either on the material treated or the subsequent operations.

Types of Stills

Since the working temperature range is the only difference between a straight and a cracking still, in matters of design the stills must be grouped with reference to their types rather than uses.

All stills can be divided into two main types: Cylindrical or conventional stills, and tube stills. Cylindrical stills are the left-overs of batch distillation. Inherently they cannot be efficient as a continuous apparatus, are troublesome in operation, have a tendency to burn out, need frequent cleaning and due to the

[1]Latent heat of vaporization after Trouton, Van't Hoff and Lagerlöf. Mean specific heat after Karawaieff.

large amount of oil heated simultaneously are a source of unnecessary hazards. The tube stills are of comparatively recent development but are today displacing the cylindrical type. The principles of design outlined in this article are, therefore, applicable mainly to tube stills.

The first requirement of a still is the absence of thermal shock to the oil—that is, a *gradual and even bringing up of the whole body of oil to the desired temperature, at a rate that does not exceed the thermal capacity of the oil and the heat conductivity of the container.* The rate of heat transfer $Q = \theta_m K$, where θ_m = mean temperature difference between the gases of combustion and the oil and K = coefficient of heat transfer.

$$\theta_m = \frac{\theta_i - \theta_f}{\log_e \frac{\theta_i}{\theta_f}}$$

where θ_i is the initial temperature difference and θ_f the final temperature difference between the gases of combustion and the oil. Therefore, θ_m will be larger the smaller is the ratio of $\theta_i : \theta_f$—that is, when the initial and the final temperature differences are approaching each other. This is true when the hottest gases come in contact with the hottest oil, or the flows of the gases and the oil in the still are counter-current.

Character of Flow

Fig. 2 shows graphically the difference between concurrent and counter-current flows. T_{GI} is the temperature of the incoming gases; T_{GL} is the temperature of the gases leaving the furnace; T_{OI} is the temperature of the incoming oil and T_{OL} is the temperature of the oil leaving the furnace; θ_{m_1} is the mean temperature difference for counter-current flow and θ_{m_2} that for concurrent flow. By assuming $T_{GI} = 750$ deg. F. (probably ideal for topping); $T_{GL} = 450$ deg. F.; $T_{OI} = 200$ deg. F.; $T_{OL} = 400$ deg. F.; θ_{m_1} and θ_{m_2} will become 297 and 208 deg. F., respectively.

This means that the same still with the same temperatures of the gases of combustion and the oil will heat 42.5 per cent more with counter-current than with concurrent flow, and do it much more uniformly. With concurrent flow the rate of heating at the beginning is about 2½ times as intensive as at the end and if the still does any heating at the end, the oil is overheated at the beginning of the cycle. That this is true in practice is evidenced by the fact that it is the lower tubes with the supposedly cooler oil that plug up or burn out in the average tube still.

The coefficient of heat transfer K depends mainly on the velocity of the fluids. The general formula[2] for two fluids both in motion is K (in calories per sq.m. per deg. C.) $= \dfrac{1}{\frac{1}{a} + \frac{1}{b} + N}$ where $a = 300 + 1{,}800\sqrt{v_1}$; $b = 2 + 10\sqrt{v_2}$; v_1 and v_2 are the respective velocities of the colder and hotter fluids in m. per sec.; N, for iron ¼-in. thick[3] = 0.0014.

Therefore, a still will have a much greater capacity if smaller tubes are used and if a large volume of low temperature gases, rather than a smaller volume of hotter gases, is passed through the heating chamber. Counter-current flow increases the relative velocity of the fluids and permits the use of very low temperature gases. This is another argument in its favor. The use of smaller tubes will not only increase the heat transfer per square foot of heating surface but by increasing the heating surface per unit and cross-section will allow for the same amount of heat to be

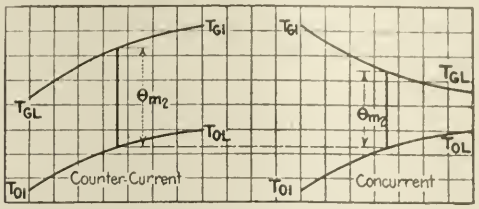


FIG. 2—CHARACTER OF FLOW AND RATE OF HEATING IN A COIL STILL

delivered to the oil at a lower mean temperature difference. As to the possibility of the smaller tubes plugging up, mild temperatures within the furnace thus made possible will eliminate the chances of overheating and remove the main cause of the trouble.

Drop in Gas Temperatures

Since counter-current flow and high velocities are essential for efficient application of heat, the coil still is the better of the two when compared to the header still, particularly if the coil still is overfired. It is a law of nature that cold gases travel down and hot gases go up. In an overfired furnace this natural tendency is assisting the proper flow of the gases of combustion. Even if it is assumed that the header still be fired at the exit header and baffled transversely so as to obtain a strictly counter-current flow of the oil and gases of combustion, the rate of heat transfer will not be as uniform as shown in Fig. 2, which is true for an overfired coil still. There is a sudden drop of temperature of the gases of combustion on both sides of the baffle. At the tubes in the center of the bundle with three baffles in the furnace this drop is one-quarter of the total drop of temperature of the gases. Fig. 3 shows this drop and the effect it has on the rate of heating of the oil.

The velocity of the oil in the header still is lower than in a coil still having the same number of tubes, since it provides a much larger section for the passage of oil than a coil made up of pipe of the same diameter.

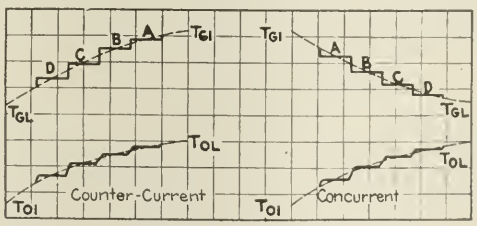


FIG. 3—CHARACTER OF FLOW AND RATE OF HEATING IN A HEADER STILL
Dotted lines are mean temperatures.

This means a lower heat transfer and therefore either a greater heating surface or higher furnace temperatures to produce the same results, which is another disadvantage of the header still, unless means are provided to recirculate the oil within the still proper, as is successfully done in at least one process.

Since proper application of heat depends closely on the correct generation of the heat, in designing a still

[2]Peclet.
[3]Landolt-Börnstein "Tabellen."

full consideration must be given to the principles of efficient heat generation.

The greatest need of the refining industry at present is the introduction of combustion engineering which deals with these principles. The ceramic and the metallurgical industries owe no small part of their progress to the scientific application of combustion engineering, and to these two industries belongs the credit for the development of the modern science and practice of combustion.

The first requirement for efficient generation of heat

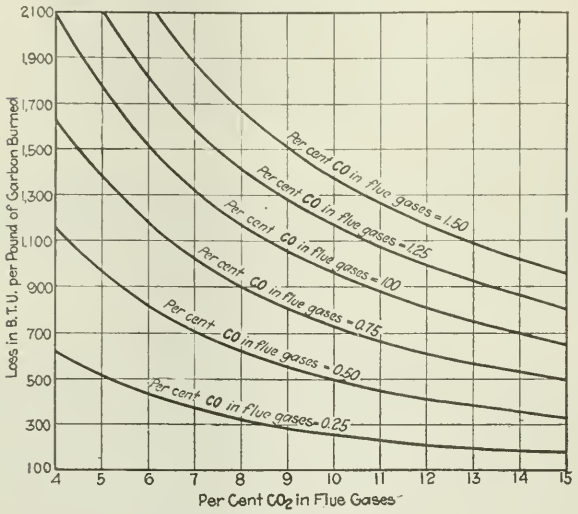

Loss in B.T.U. per Pound of Carbon Burned
Per Cent CO₂ in Flue Gases
Per cent CO in flue gases = 1.50
Per cent CO in flue gases = 1.25
Per cent CO in flue gases = 1.00
Per cent CO in flue gases = 0.75
Per cent CO in flue gases = 0.50
Per cent CO in flue gases = 0.25

FIG. 4—LOSS OF HEAT DUE TO INCOMPLETE COMBUSTION

From "Steam, Its Generation and Use," Babcock & Wilcox Co.

is the proper proportioning and mixing of fuel and the air. Table I shows the theoretical amount of air necessary for the combustion of different fuels. Insufficient air will give incomplete combustion and a loss of efficiency. The loss of heat due to incomplete combustion is about 100 N B.t.u. per lb. of carbon content where N is the CO percentage of the combined CO and CO_2 gases. Fig. 4 shows the losses through incomplete combustion.

Excess of air is just as detrimental as lack of it. Fig. 5 shows the loss of heat in the flue gases due to excess air and the B.t.u. contents of the fuel and air mixture for different fuels at different excess coefficients. A 100 per cent excess (common practice in many refineries) will result in a loss of 25 per cent of the total heat developed if the furnace temperature is 1,000 deg. F.

Mixing Combustion Gases

The importance of proper mixing is shown in curves *CD* and *EF* of Fig. 6. Curve *CD* represents *in hours* the time-temperature curve of complete oxidation of carbon at different temperatures when both carbon and oxygen are at rest and was obtained by heating charcoal in an atmosphere of oxygen. Curve *EF* shows *in seconds* the time necessary for complete combustion of carbon when the carbon and air are mixed and constantly agitated. The coefficient of agitation is determined by the size of the particles and the velocity of impact. Unity is the ideal as yet not obtained in practice even with gaseous fuel.

The best of gas and gasified oil burners have a coefficient of 0.90 to 0.95. Atomizing low-pressure oil-burners seldom exceed 0.80. High-pressure burners have a still smaller coefficient. The reason for this is

TABLE I—AIR REQUIRED FOR COMBUSTION OF DIFFERENT FUELS

Fuel	Heat Value B.t.u. Per Cu.Ft.	Theoretical Air Required, Cu. Ft. Per Cu.Ft.
Illuminating gas:		
Water gas	304	2.63
Carbureted water gas	589	6.84
Coal gas	608	6.00
Producer gas:		
Anthracite	125.7	1.053
Bituminous	125.0	1.120
Coke	126.3	0.985
Lignite	134	1.145
Oil	151	0.990
Peat	141	1.170
Wood	128.7	1.070
Blast-furnace gas	95.2	0.735
Coke oven gas	487	4.76
Natural gas (average)	853	8.95
High hydrogen	834	8.66
Low hydrogen	870	9.20
Oil gas	542	4.94
	Per Lb.	Per Lb.
Kerosene 0.863 sp.gr.	18,755	189
Crude oil (Diesel) 0.877 sp.gr.	18,636	187
Gasoline 0.704 sp.gr.	18,500	193.5
Fuel oil 0.939 sp.gr.	18,183	178

Note: For designing purposes when using liquid fuel assume 140,000 B.t.u. per gal. and an air consumption of 25 cu.ft. per minute per gal. per hour.

the great initial velocity of the mixture, which, due to the difference in size and specific gravity of the particles of the air and the oil, produces a difference in inertia of the particles as soon as the mixture leaves the nozzle, with the result that in cross-section the flame consists of rings of different chemical composition and different temperatures.

Velocity of Combustion Gases

Another important consideration is the velocity of gases of combustion both at the nozzle and after ignition. At the nozzle the velocity must be as close as possible to the velocity of propagation of flame, which is different for different fuels and is about 300 ft. per second for low-pressure gasified fuel. With the proper

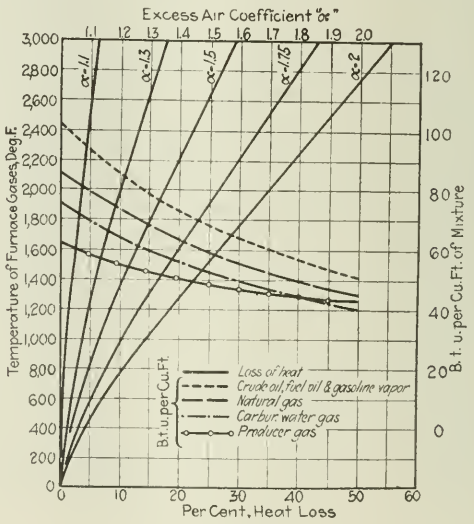


FIG. 5—EXCESS AIR AND FURNACE PERFORMANCE

After Ulbright & Torrance and Richardson.

nozzle velocity there will be no back firing, no flame pulsation and no hard smoky starting up of the furnace, so common in many oil-fired furnaces.

Velocity of the products of combustion within the combustion chamber determines the actual zone of combustion irrespective of the intentions of the designer, and should be such that complete combustion, as determined by the necessary time element from Fig. 6, occurs before the gases enter the zone of actual heating.

The last and the most important factor of efficient heat generation is the design of the combustion chamber proper. There is a certain fixed ratio between combustion space and the amount of fuel burned for each temperature, the ratio being more or less independent of the fuel burned. Fig. 7 shows the maximum actual

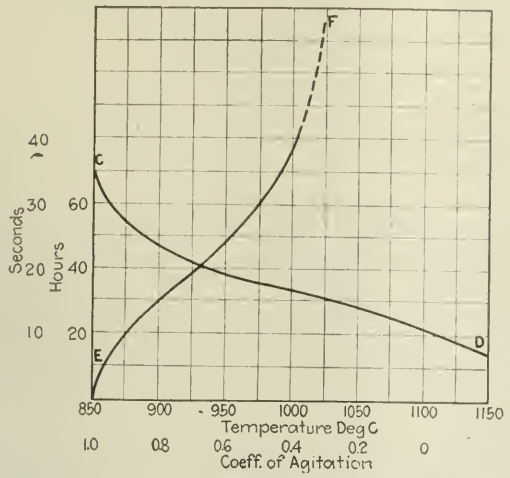


FIG. 6—IMPORTANCE OF PROPER MIXING
Curves after Reid & Wheeler and Le Chatelier.

obtainable temperatures for different ratios of B.t.u. per cubic foot of combustion space, as obtained in a certain furnace tested by the author. The curve is characteristic for all furnaces and depending on the ratio of the fixed losses through the combustion chamber (radiation, leakage) to the total heat developed is either raised or lowered parallel to itself.

Recirculation

A new feature in combustion chamber design is recirculation of the gases of combustion after ignition. Although the least known, this feature is the most beneficial, since it accomplishes secondary mixing of the ignited gases and neutralizes the effects of concentric flame composition; it dilutes the atmosphere within the combustion chamber, and therefore eliminates the existence of hot spots in the path of the flame; the whole combustion chamber is thus converted into a mass

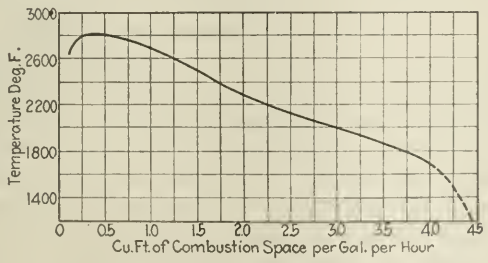


FIG. 7—COMBUSTION SPACE AND MAXIMUM OBTAINABLE TEMPERATURE

of infinitesimal centers of combustion, each point within the chamber as well as on the surface of the walls acting as a source of generation of heat energy. Recirculation further automatically regulates the time element and the velocity of products of combustion, by reducing the travel of gases in a straight line, helps to satisfy the time element necessary for complete combustion and the volumetric relations of the combustion chamber to produce the desired temperature. The recirculating feature permits transformation of the high temperature heat of the fuel into heat of a temperature required for the distilling operation without the losses due to excess air which is commonly employed for the purpose.

Fig. 8 shows a combustion chamber having the recirculating feature incorporated in its design and the effect it has on the path of the gases. The amount of recirculation is determined by the distance of the recirculating baffle *B* from the wall by the size of the opening *O* in the baffle, by the nozzle velocity of the burner, by the velocity of the gases from the combustion into the heating chamber and the mean gas velocity through the complete furnace.

Correct Still Design

Fig. 9 shows the time temperature curve of an automatically controlled oil-fired heat-treating furnace built according to the principles of combustion engineering enumerated above. The maximum variation is ± 5 deg. F., with the minimum approaching ± 2.5 deg. F. The same results can be accomplished with a still if

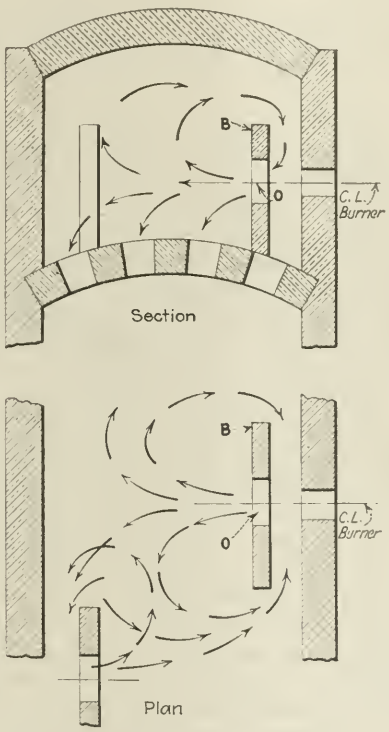


FIG. 8—COMBUSTION CHAMBER WITH RECIRCULATING FEATURE

in the design it is considered a delicate heating apparatus and not just so many bricks, a few buckstays and a burner, all assembled so as to produce "heat" and accommodate a container decided upon mostly on account of its having worked somewhere else. The results obtained in a scientifically designed still will in a very short time compensate for the extra care in designing and the additional cost of installation. This is particularly true for cracking stills.

There is a very delicate equilibrium between the straight and cracked phases of petroleum products depending on temperature and pressure. The aim of successful cracking is to make the transformation of the straight into the cracked phases as distinct and simultaneous as possible and all efforts are bent to separate the zone of heating from the zone of actual

cracking by comparatively sudden changes of temperature or pressure. All other conditions being equal, the more uniform is the heating the less are the chances for the zones to overlap and the less the possibility of premature cracking within the heating zone. It is the uneven heating within the cracker that is responsible for the fact that there are no truly continuous cracking processes, and that a run of 90 to 100 hours is quite an accomplishment. The average run is around 48

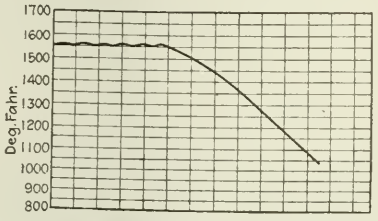


FIG. 9—TEMPERATURE CONTROL OF OIL-FIRED HEAT-TREATING FURNACE

hours, after which period the plant is shut down, often as far as the dephlegmator, to be cleaned of carbon deposits.

An Instance in Operation

The writer knows of a "demonstration run" on a cracking process when a 4-in. pipe was completely plugged up in a few hours on a stock that was treated satisfactorily the previous week. It was a forced run for production. A small portion of the tube became hot, causing a local overheating, premature cracking, deposition of carbon, a decrease in heat transmission of that portion, a further overheating, more cracking, more carbon, and so on. Yet there were twelve good pyrometers on the system and an experienced and conscientious operator in charge. The fault was in the design of the cracker, or rather the construction, since no principles of design were used. Its general arrangement, the combustion chamber, the number and size of tubes were decided upon for the only reason that "it worked" somwhere else under similar conditions, with "pretty good results"—that is, for about 48 to 72 hours with a fuel consumption of over four times the theoretical. It worked, but had a tendency to develop all kinds of trouble at the wrong moment.

Later a firm of consulting engineers was called upon to develop a commercial unit for the process. The engineers worked under a handicap. They had to accept a certain "proved" (but from the combustion engineer's point of view questionable) construction of the cracker. They also had to take for granted certain "fundamental" laws of standard refinery practice. In spite of all this, by paying attention to the causes and not the manifestations of certain phenomena and by utilizing experience obtained in similar branches of other industries, they evolved a unit that made a continuous 18-day run with a fuel saving exceeding the best hopes of the customer.

Conclusion

Such success obtained teaches a lesson that should be taken into consideration by the refining industry. All process industries have many common fundamental operations, even if they are totally different in the finished product. Usually each of these operations is brought to a relatively high degree of perfection in some industry and the industries that make no secrets of their accomplishments have the largest number of perfected operations to their credit.

Oil refining is as yet the most isolated of all the process industries. Except for the laboratory, where there are many chemists that have had experience in other fields, the refineries are too much dependent on inbred talent. The result is seen in the comparison between the chemical and the operating phases of refining. While a large number of new products were developed in recent years, the mechanical features of the methods of production are the same, the changes being rather additions to and not improvements of the practices of the past.

There are without any question many refinery operations that could be greatly improved by adaptation or by a pooling by different plants of experiences in the general operating features. A "give and take" policy as demonstrated in metallurgy, for example, would not only help to abolish the existing troubles, but would raise the standard of operating efficiency and result in better products at less cost.

Chicago, Ill.

Oxygen in Iron Melted Under Air or Gas Flame

A series of melts of electrolytic iron have been made at the Bureau of Standards under air in the induction furnace with additions of varying amounts of metallic calcium as a deoxidizing agent. The addition of calcium up to 0.2 per cent did not increase the soundness of the chilled cast ingots; the amount of oxygen (determined by the Ledebur method) in the ingots was practically the same throughout the series regardless of the amounts of calcium added. The average oxygen content of the calcium treated melts was approximately 0.23 per cent. Pure electrolytic iron melted under the same conditions contained 0.21 per cent oxygen. All the above melts were made in the open under still air. Electrolytic iron melted under a jet of air contained only slightly more oxygen than when melted under quiet air—namely, 0.24 per cent. Ingot iron melted under similar conditions under quiet air and under an air jet contained, respectively, 0.21 and 0.26 per cent oxygen. Ingot iron melted under the oxidizing flame of a gas blast-torch contained 0.26 per cent oxygen, the same as when melted under a jet of air.

Constituents of High-Speed Steel

Tests made at the Bureau of Standards appear to show that there are at least three different constituents present among the imbedded globules or particles in the specimen of high-speed steel, in the "as received from the mill condition," although their nature is unknown. This fact was determined by "sequence etchings" with (1) dilute NH_4OH solution together with a weak electric current, the specimen being made positive pole; (2) 2 per cent alcoholic solution of HNO_3; (3) boiling sodium picrate, and (4) Murakami's reagent (solution of potassium ferricyanide and sodium hydroxide) at boiling temperature.

"Sequence etching" means the etching with two or three reagents in successive order without any repolishing of the section between the etchings, and the taking of micrographs after each etching at the same spot in the microsection in order to note any changes in microstructure produced by the last etching as compared with that developed by the preceding etching reagent.

The System Furfural-Water*—I

A Study of Its Properties With Reference to Their Commercial Application in the Production of Furfural —Boiling Point and Density of Furfural—Density of Furfural-Water Solutions—Solubility Data—Boiling Point Curves—Temperature-Composition Diagram

By GERALD H. MAINS
Color Investigation Laboratory, Bureau of Chemistry

IN THE METHODS of preparation of furfural given in the literature, pentosan- or pentose-containing substances are digested with dilute hydrochloric or sulphuric acids, and the distillate, consisting of a slightly acid aqueous solution of furfural, is collected. The furfural is then concentrated by extraction with ether or other solvents, or by distillation. Several authors note that furfural can be quite readily separated from water by distillation,[1] the greater part of the furfural coming over in the first portions of the distillate, from which, being only partly miscible with water, it can be readily separated. Some recent French patents provide for column distillation during the manufacture of furfural.[2] The author has found in the manufacture of furfural on a small factory scale that the separation of furfural from its aqueous solution by fractional distillation is a very short and effective method. There are, however, no published data, exact or otherwise, available on the relative compositions of distillate and solution, boiling point curves or condensation curves.

Distillation of Partly Miscible Liquids

When a mixture of two partly miscible liquids is distilled, as long as two layers are present the boiling point will remain constant and a distillate of constant composition will be formed. This mixture boils at a temperature below the boiling point of one of the components and often below that of either. When distillation has proceeded to the point where one of the layers disappears, the condition is one of a simple solution of one substance in another, and distillation continues with varying composition of distillate and rising temperature, until one of the components is entirely removed and the boiling point of the remaining component is reached.

The system furfural-water is an example of this class of partly miscible liquids. Furfural is somewhat soluble in water. When more furfural than will go into solution is added to water, two layers are formed, an upper water layer containing some furfural in solution and a lower, heavier furfural layer containing some water. Upon distilling a furfural-water mixture containing only a small proportion of the furfural layer, the boiling point will be slightly lower than that of water and the distillate will be of constant composition until the furfural layer has disappeared. The boiling point will then rise, and the concentration of furfural in the liquid in the distilling flask will decrease more rapidly than in the distillate until practically pure water is left in the still. On the other hand, starting with a furfural-water mixture in which the furfural layer predominates, the concentration of water will be continually greater in the distillate than in the liquid in the still until the point is reached where for practical purposes it may be considered that all of the water has been separated and the residual liquid in the still consists of pure furfural.

It may be here pointed out that the liquid composed of furfural and water at room temperature is a solution of furfural in water when only a small amount of furfural is present, and a solution of water in furfural when only a small amount of water is present; and that between these two extremes two layers having a distinct boundary and differing from each other in composition are present. As the temperature is increased, the range of furfural-water concentrations throughout which the two layers occur becomes smaller, and at the same time the concentrations of the layers vary and approach each other. The liquid system furfural-water is then a solution over part of the range of composition, and over the remainder of the range is a mixture of two solutions, with no fundamental difference between them except concentration. For convenience, and with the theoretical justification already outlined, the liquid composed of furfural and water will be referred to throughout this paper as a solution.

Experimental

In order to study the system furfural-water, especially with respect to the corresponding compositions of solution and distillate (the solution in the flask being the liquid phase and the distillate the condensed vapor phase), an accurate method of determining the amount of furfural present was needed. The standard phloroglucin analytical method[3] was tried, but it does not give results of sufficient accuracy for an investigation of this type. In a number of determinations on known solutions, in spite of all precautions, there was a variation of from 2 to 5 per cent from the true value. Several investigators have recognized the inaccuracies of the method and published data of others show variations of this order.[4] For determinations of small amounts of pentosans in plant materials the method may be sufficiently accurate (far more so than the preliminary treatment to obtain the furfural), but it will not serve for accurate work on pure solutions. It is, moreover, very time-consuming. The precipitation of furfural as the phenylhydrazone is subject to the same objections.

Investigators who have studied the boiling point and condensation point curves of alcohol-water solutions

*Contribution from the Color Investigation Laboratory, U. S. Bureau of Chemistry, Washington, D. C. Published by permission of the Secretary of Agriculture.

[1]Stenhouse, *Ann.*, vol. 35, p. 301 (1840); Hill, *Am. Chem. J.*, vol. 3, p. 33 (1881); Maquenne, *Ann. Chim. Phys.* (6), vol. 22, p. 76 (1891); Adams, Kamm and Marvel, *Univ. Ill. Bull.*, vol. 16, No. 43, p. 5 (1919); Monroe, K. P., *J. Ind. Eng. Chem.*, vol. 13, p. 133 (1921).

[2]Raisin, French Pat. 446,871, Dec. 17, 1912; Lederer, A. and E., French Pat. 464,608, March 26, 1914; Ricard, French Pat. 485,967, Feb. 26, 1918, and U. S. Pat. 1,322,054, Nov. 18, 1919.

[3]A. O. A. C. Methods (1920), p. 96.

[4]For example, Fraps, North Carolina Exp. Sta. Bull. 178 (1901); Dox and Plaisance, *J. Am. Chem. Soc.*, vol. 38, p. 2156 (1916).

have used density tables to determine composition, and in view of the fairly wide difference in density between furfural and water, this method gave promise of accuracy and simplicity. Schwers,[5] with an entirely different end in view, has determined the density of certain solutions of furfural and water at various temperatures. His data cover only three dilute solutions, and the density of his original furfural does not agree well enough with the determinations of the author to permit the use of Schwers' figures for the solutions. Accordingly a number of known solutions were prepared and the densities determined.

Boiling Point of Furfural

In any such determination of the densities of water solutions of a certain substance, the physical properties of the substance used, in this case furfural, are of the utmost importance. The furfural used in these experiments was made by digesting corn-cobs with sulphuric acid (30 per cent). The crude furfural was redistilled with the addition of 2 or 3 g. of sodium carbonate. A colorless product was obtained, and the fraction boiling between 159 and 161 deg. C. (uncorrected) was collected. Of this product 800 c.c. was redistilled, and the middle portion, 400 c.c., boiling constant within 0.1 deg. was collected.

The corrected boiling point of a sample of furfural made by this method, as read by an Anschutz thermometer suspended in the vapor and checked against one recently calibrated by the Bureau of Standards, was 161.8 deg. C. at 762.5 mm. (barometer fully corrected and checked against U. S. Weather Bureau barograph record). The vapor pressure curve for furfural (determined by H. Wales and the author, and to be published shortly) gives the correction value, 1 mm. equals approximately 0.05 deg. C. Using this value, the corrected boiling point at 760 mm. would be 161.7 deg. C.

A second lot of furfural which was used in a number of the experiments was found to have a boiling point of 161.8 deg. at 762.2 mm., or 161.7 deg. corrected to 760 mm. The corrected boiling points of other lots, as determined by an ordinary thermometer with long exposed stem and with consequent inaccuracies in the large stem correction, varied from 161.1 to 161.5 deg. C.

An especially pure sample was prepared as follows: To a portion of redistilled furfural obtained from corn-cobs was added saturated sodium bisulphite solution until the mixture became sirupy in consistency. It was then chilled. At approximately 15 deg. C. white needle-shaped crystals of the furfural sodium bisulphite addition compound separated out, the entire mass becoming nearly solid. The mother liquor was drained off on a suction filter and the crystals washed with ether and dried. The furfural was set free by adding a saturated solution of sodium carbonate. By fractional distillation a concentrated furfural-water solution was obtained and the furfural layer separated off. The wet furfural was then distilled, and, after the water had separated, the portion boiling within 0.1 deg. C. was collected. This sample was redistilled and the boiling point determined with an Anschutz thermometer (recently calibrated by the Bureau of Standards), totally immersed in the vapor and having the bulb covered with cotton batting to insure perfect condensation. The temperature rose rapidly to 161.7 deg. C. and remained constant during the distillation. The corrected barometer reading was 760.9 mm., so that the corresponding temperature correction is less than 0.05 deg. These determinations indicate the true boiling point of pure furfural to be 161.7 deg. C. at 760 mm.

Of the boiling points of furfural previously given in the literature, ranging from 160 to 168 deg., only those of Schiff[6] (160.5 to 160.7 deg. at 742 mm.) and Brühl[7] (161.4 to 161.8 deg. at 754.5 mm.) appear to have been obtained with any great degree of accuracy. Corrected to 760 mm., their results are: Schiff, 161.4 to 161.6 deg. C.; Brühl, 161.7 to 162.1 deg. C. It may be pointed out that with the small quantities used by them it would be difficult to purify the liquid by one distillation, and that in the case of Brühl's work the boiling point range indicates an appreciable impurity. The presence of a small amount of methyl furfural, a quite common impurity, would account for the higher boiling point.

Density of Furfural

The density of the freshly distilled sample of furfural, purified by transforming into the sodium bisulphite compound and recovering, was determined by means of a Sprengel type pycnometer. Because of the high heat conductivity and high coefficient of expansion of furfural the density values could be determined with accuracy only to the fourth place. The observed values corrected to vacuum standard were $D^{20}_{4} = 1.1598$ and $D^{25}_{4} = 1.1545$.

Using specific gravity bottles, as described hereafter, for the furfural-water solutions, density determinations were made on other lots of furfural at various intervals of time. Lot 21.1, from which the furfural-water solutions for the density determinations were made, was 22 days old at the time of making up the solutions. Its density values were $D^{20}_{4} = 1.1610$ and $D^{25}_{4} = 1.1556$. After standing 40 days in a cork-stoppered brown glass bottle the density was $D^{20}_{4} = 1.1631$, an increase of 0.0021. After standing 52 days, the value was $D^{25}_{4} = 1.1586$, an increase in density of 0.0030. This increase in density is probably due to a slow polymerization of the furfural upon exposure to light and air. It is accompanied by a pronounced darkening in color, the liquid becoming a dark brown. Berthelot[8] has described this polymerization and the resulting compound.

TABLE I—OBSERVED DENSITY OF FURFURAL-WATER SOLUTIONS

Per Cent Furfural by Wt.	Density (Referred to Water at 4 Deg. C.) 20 Deg. C.	25 Deg. C.	Per Cent Furfural by Wt.	Density (Referred to Water at 4 Deg. C.) 20 Deg. C.	25 Deg. C.
.....	0.99823	0.99708	4.154	1.00589	1.00448
1.000	1.00009	0.99869	6.036	1.00953	1.00803
1.913	1.00165	1.00041	8.047	1.01308	1.01152

Since the density of furfural increases upon standing, the densities reported in the literature are of little value beyond the second decimal place, because the periods elapsing between the preparation of the samples and the determinations of their densities are not given. The density at $^{20}_{4}$ is given by Brühl[9] as 1.1594, and by Schwers[10] as 1.1593. Calculations from the formula of Jaeger and Kahn[11] ($D = 1.1851 - 0.001176t + 0.00000096t^2$) give values at 20 deg. C. of 1.1620 and at 25 deg. C. of 1.1563. The criticism of the values of Brühl and Schwers is that the furfural used was not collected within a close enough boiling point range to

[5] Schwers, Bull. Acad. Roy. Belg. (Cl. Sci.), 1911, p. 641.

[6] Schiff, R., *Ann.*, vol. 220, p. 103 (1883).

[7] Brühl, J. W., *Ann.*, vol. 235, p. 7 (1886).

[8] Berthelot and Rivals, *Ann. Chim. Phys.* (7), vol. 7, p. 35 (1896).

[9] Brühl, *loc. cit.*

[10] Schwers, *loc. cit.*

[11] Jaeger, F. M., and Kahn, J., *Proc. Acad. Sci. Amsterdam*, vol. 18, p. 617 (1915); *J. Chem. Soc.*, vol. 110, II, p. 128 (1916).

be of absolute purity. Information as to the purity of the furfural used by Jaeger and Kahn is lacking. In order for density to serve as any criterion of the purity of furfural, the determination must be made on a freshly distilled sample.

Density of Furfural-Water Solutions

The furfural used in making up the solutions was lot 21.1, $D^{20}_{4,\,Vac.} = 1.1610$, $D^{25}_{4,\,Vac.} = 1.1556$.[12] The furfural and water were weighed into tared flasks, and the densities of the resulting solutions determined by the use of 30 and 50 c.c. specific gravity bottles having ground-in thermometers. These thermometers were calibrated to 0.1 deg. C. against a thermometer recently calibrated by the Bureau of Standards. The densities (referred to water at 4 deg.) were determined at 20.0 and 25.0 deg. C., and were corrected to a vacuum standard. The value in each case is the mean of determinations made with two specific gravity bottles, except for the 6.036 per cent solution, where it represents the mean of six determinations, two with each of three specific gravity bottles. The probable error in density for this solution at 20 deg. is ±0.00002, and for 25 deg. is less than ±0.00001. The observed density values are given in Table I.

TABLE II—COMPOSITION-DENSITY TABLES FOR FURFURAL-WATER SOLUTIONS

Per Cent Furfural by Wt.	Density (Referred to Water at 4 Deg. C.) 20 Deg. C.	25 Deg. C.	Per Cent Furfural By Wt.	Density (Referred to Water at 4 Deg. C.) 20 Deg. C.	25 Deg. C.
....	0.9982	0.9971	4.6	1.0068	1.0054
0.2	0.9986	0.9974	4.8	1.0072	1.0058
0.4	0.9990	0.9978	5.0	1.0075	1.0062
0.6	0.9993	0.9982	5.2	1.0079	1.0065
0.8	0.9997	0.9985	5.4	1.0083	1.0069
1.0	1.0001	0.9989	5.6	1.0086	1.0073
1.2	1.0005	0.9993	5.8	1.0090	1.0076
1.4	1.0008	0.9996	6.0	1.0094	1.0080
1.6	1.0012	1.0000	6.2	1.0098	1.0084
1.8	1.0016	1.0003	6.4	1.0101	1.0087
2.0	1.0020	1.0007	6.6	1.0105	1.0091
2.2	1.0023	1.0011	6.8	1.0109	1.0094
2.4	1.0027	1.0014	7.0	1.0113	1.0098
2.6	1.0031	1.0018	7.2	1.0116	1.0102
2.8	1.0034	1.0022	7.4	1.0120	1.0105
3.0	1.0038	1.0025	7.6	1.0124	1.0109
3.2	1.0042	1.0029	7.8	1.0127	1.0113
3.4	1.0046	1.0033	8.0	1.0131	1.0116
3.6	1.0049	1.0036	8.2	1.0135	1.0120
3.8	1.0053	1.0040	8.3*	1.0137	1.0122
4.0	1.0057	1.0044	8.4	.....	1.0124
4.2	1.0060	1.0047	8.6†	....	1.0127
4.4	1.0064	1.0051	...	....	.....

* Saturated solution of furfural in water at 20 deg. C.
† Saturated solution of furfural in water at 25 deg. C.

TABLE III—OBSERVED DATA ON MUTUAL SOLUBILITY OF FURFURAL AND WATER

Water Layer: Temp., Deg. C.	Water Layer: Per Cent Furfural by Wt.	Furfural Layer: Temp., Deg. C.	Furfural Layer: Per Cent Furfural by Wt.
16	8.12	8	96.5
17.0	8.18	26.6	94.6
27	8.72	37	93.3
27.2	8.72	44	92.8
27.5	8.68	65	90.9
44	9.80	70	90.3
61	11.9	84	88.0
66	12.5	96	84.5
92	17.0	....	.. .

The composition of solution, expressed as percentage of furfural by weight, was plotted against the density on a large chart and the values were found to lie along a straight line. A variation of 0.01 per cent in furfural concentration produces a density change of nearly 0.00002, so that by using ordinary specific gravity bottles and allowing a probable error of ±0.00004, the concentration of furfural can be determined within ±0.02 per cent without taking any extraordinary precautions except that the room temperature must not exceed by any appreciable amount the temperature at which the density is determined. In Table II the densities read from the curve are given to the nearest 0.0001 for composition intervals of 0.2 per cent furfural.

Solubility Data

Owing to the possibility of separating furfural from water by decantation of the two layers, solubility data at various temperatures become of importance. Rothmund[13] has studied the mutual solubilities of furfural and water in relation to their critical solution point. Since his determinations were not made at constant pressure, but at the vapor pressure of the solution, and as data on the purity of the original furfural are not given, the solubility curves have been determined by the author for atmospheric pressure conditions.

The method followed was to place layers of furfural and water in a flask, bring to approximately the desired temperature, stopper the flask, shake violently 100 times, let the two layers separate, and pipette samples from each. The temperature was taken just as the shaking was completed, and except at room temperatures was read only to the nearest degree. The pipetted samples were necessarily taken as soon as the two layers had separated and before cooling had started any further separation. In determining the solubility in the aqueous layer it is important to have a very thorough shaking, on account of the slow rate of solution of furfural when near the saturation point. Globules of furfural may be present in the bottom of the solution when the solution is far from being saturated. Tests at room temperature indicated that the method adopted, violent shaking 100 times, was sufficient to obtain complete saturation.

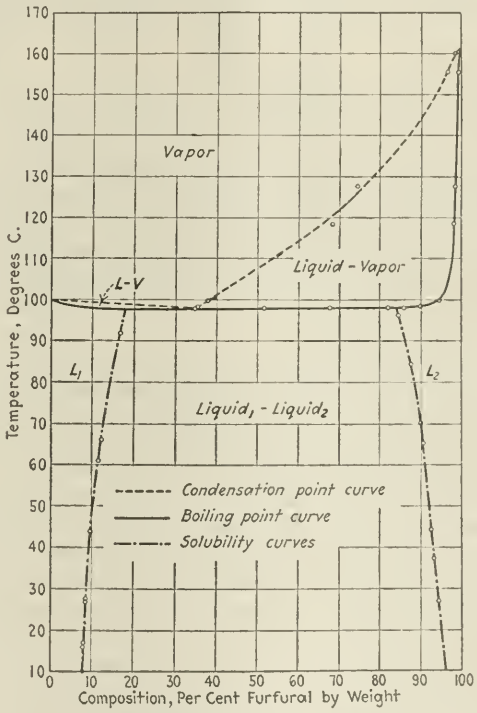


FIG. 1—TEMPERATURE-COMPOSITION DIAGRAM FOR THE SYSTEM FURFURAL-WATER

[12] These values are about 0.001 higher than the density values for freshly distilled furfural. This difference would cause an error in the dilute solutions, however, of only 0.00001 for the 1 per cent solutions, and of less than 0.0001 for the maximum concentration at saturation (8 to 9 per cent furfural at ordinary temperatures).

[13] Rothmund, *Z. Phys. Chem.*, vol. 26, p. 454 (1898)

The concentration of furfural in the pipetted samples was determined by measuring the density of the original or diluted sample, and reading the percentage of furfural from the composition-density chart. In diluting concentrated solutions the aim was to get a solution of 6 to 8 per cent concentration, if possible, in order to avoid error by having a small multiplying factor.

The observed data are given in Table III. The agreement of the three determinations at room temperature indicates the degree of accuracy of the results.

The temperature-solubility curves for both aqueous and furfural layers, plotted from the observed values, are shown in Fig. 1. The values for the furfural layer run in fairly close agreement with Rothmund's data, reaching a maximum variation of 0.5 per cent below his values. The values determined for the water layer are, however, much higher than his, the difference increasing from 0.6 per cent at 10 deg. C. to 2.5 per cent at 65 deg. C., where his figure is 9.9 per cent, as compared with the present observation of 12.4 per cent. The difference decreases thereafter until at the boiling point they are within 0.5 per cent of each other again. There can be no question that all of the higher amount is in solution. The effect of pressure on solubility can scarcely account for the wide difference between Rothmund's figures and those given here. Since his determinations were made by observing the temperature at which the solution contained in small tubes turned from turbid to clear and vice versa without thorough shaking, it is possible that complete saturation did not exist, hence the low results.

TABLE IV—MUTUAL SOLUBILITY OF FURFURAL AND WATER
(Atmospheric Pressure)

Temp., Deg. C.	Per Cent Furfural By Wt. Water Layer	Furfural Layer	Temp., Deg. C.	Per Cent Furfural By Wt. Water Layer	Furfural Layer
10	7.9	96.1	60	11.7	91.4
20	8.3	95.2	70	13.2	90.3
30	8.8	94.2	80	14.8	88.7
40	9.5	93.3	90	16.6	86.5
50	10.4	92.4	97.9*	18.4	84.1

* Boiling point of system when both layers are present.

For convenience the solubility data for 10 deg. intervals as taken from the curves are presented in Table IV.

Boiling Point and Condensation Point Curves

Observations made during the manufacture of fairly large quantities of furfural and the concentration of furfural from dilute solutions by fractional distillation indicated that two-layer solutions of furfural and water boiled at approximately 2 deg. below the boiling point of water. To study the change in boiling point with composition of solution over such a small range of temperature could not give satisfactory results by using the process of distilling in a flask and recording the temperature with an ordinary thermometer. A method was devised in which two similar 500-c.c. distilling flasks were used. with Beckmann thermometers, graduated to 0.01 deg. C., inserted in each flask so that the scale began just above the cork stopper and the bulb was just below the side tube. In one of the flasks distilled water was slowly distilled, and, simultaneously and at the same approximate rate, the furfural-water solution under investigation was distilled in the other. The Beckmanns were calibrated against each other, using distilled water in each flask.

To determine the boiling point of a solution, the procedure was as follows: Furfural and water were weighed into the flask to make a solution of the required strength and a volume of 250 to 300 c.c. The Beckmann was then inserted and the flask contents slowly heated until the first drops of distillate came over. As soon as free distillation was taking place a water-cooled weighed receiving flask was placed over the side tube, and the temperature read. The temperature was then read every minute for 8 minutes as a rule, and simultaneous readings were made of the temperature indicated by the Beckmann in the adjoining flask, in which distilled water was boiling under similar conditions, The average reading of the first Beckmann subtracted from that of the second, with the calibration correction and scale corrections considered, gave the depression of the boiling point of water caused by the furfural in solution. This subtracted from 100.00 deg. C. then gave the average boiling point of the solution at 760 mm. The distillate (15 to 20 g.) was weighed, diluted with a weighed volume of water, and the density determined in duplicate. From this the concentration of furfural in the distillate was calculated. The distilling flask and remaining contents were weighed, and the composition of the residue calculated. From these data the average composition of the solution during distillation was calculated. The concentration of the residual solution was also checked by density determination.

It was found that the distillate was several times as concentrated as the solution, and that above 20 per cent furfural, where two layers were present at the boiling point, the composition of the distillate was practically constant at 35 per cent furfural. A solution containing 34.7 per cent furfural boiled with a depression from the boiling point of water constant to 0.01 deg. for over 40 minutes, giving a distillate which showed the same analysis, 35.0 per cent furfural, for three different portions. The boiling point when both furfural and water layers are present is 97.90 deg. C. at 760 mm.

TABLE V—OBSERVED COMPOSITION AND BOILING POINTS OF FURFURAL-WATER SOLUTIONS

Average Comp. of Solution (Per Cent Furfural by Wt.)	*Average Comp. of Distillate (Per Cent Furfural by Wt.)	Depression From B.P. of Water, Deg. C.	Corrected Boiling Point at 760 mm., Deg. C.
0.79	7.6	0.33	99.67
1.37	10.1	0.55	99.45
2.54	16.2	0.73	99.27
3.54	22.0	1.13	98.87
5.06	25.5	1.52	98.48
6.94	28.4	1.67	98.33
10.2	32.8	1.96	98.04
15.4	34.6	2.09	97.91
21.1	34.6	2.09	97.91
30.0	34.7	2.10	97.90
34.7	35.0	2.10	97.90
52.0	35.0	2.07	97.93
73.0	35.0	2.10	97.90
82.2	35.4	2.10	97.90
86.0	35.2	2.04	97.96
90.2	35.7	1.7	98.3
94.8	38.3	0.2	99.8
98.3	68.5	....	118.5
98.5	74.6	....	127.8
99.3	96.6	....	155.9
99.7	98.3	....	160.1
99.95	99.7	....	160.7
Pure Furfural	....	....	161.7

* Composition of distillate not exact owing to slight fractionation taking place in neck of flask.

When the concentration of the furfural-water solution reaches 85 per cent furfural, the boiling point begins to rise and reaches 100 deg. at about 95 per cent furfural. After that it rises very rapidly, and the distillate contains a much larger proportion of water than the solution, until finally practically pure furfural is left in the flask, and the boiling point is above 160 deg. C. For these last determinations an ordinary thermometer displaced the Beckmann. The thermometer readings change rapidly during the determinations on solutions containing above 95 per cent furfural, hence the readings are probably not accurate to closer than a degree

TABLE VI—OBSERVED COMPOSITION OF SOLUTION AND DISTILLATE

(Fractionation Eliminated by Use of Heated Still Head)

Run No.	Average Composition (Per Cent Furfural by Wt.) Solution	Distillate	Run No.	Average Composition (Per Cent Furfural by Wt.) Solution	Distillate
1 (*c*)	0.38	2.57	4 (*b*)	4.40	21.7
1 (*b*)	0.77	5.83	5 (*c*)	5.54	24.9
1 (*a*)	1.25	8.94	4 (*a*)	5.60	25.1
2 (*c*)	1.62	10.1	6 (*b*)	6.42	26.4
2 (*b*)	2.08	12.7	5 (*b*)	6.42	26.6
2 (*a*)	2.66	15.7	6 (*a*)	7.40	28.3
3 (*b*)	2.88	16.7	5 (*a*)	7.45	28.5
4 (*c*)	3.41	18.4	7	9.49	31.0
3 (*a*)	3.96	20.7	. . .	. . .	. . .

except at the very end, where the distillate is practically pure furfural. As there is a 60 deg. temperature interval for a 5 per cent composition change, however, the relative accuracy is very satisfactory. The observed average temperatures and average compositions of solution and corresponding distillate are given in Table V.

The values in Table V have been plotted on a temperature-composition diagram, and curves drawn through the points give the boiling point and condensation point curves for the entire system. These are shown in Fig. 1, as well as the solubility curves before mentioned. Together they form the complete temperature-composition diagram at atmospheric pressure for the system furfural-water from 10 to 170 deg. C.

Distillate-Composition Values Determined With Heated Still Head

The method just described is especially well adapted to the determination of the boiling points of the solutions, since it provides for the condensing of small drops of the vapor upon the thermometer bulb. However, by insuring correct boiling points there is also brought about an inaccuracy in the composition of the distillate because of the partial condensation and fractionation which takes place in the upper portion of the still head.

TABLE VII—COMPOSITION OF SOLUTION, BOILING POINT, AND COMPOSITION OF DISTILLATE

(Pressure = 760 mm.)

Per Cent Furfural by Wt. Composition of Solution	Composition of Distillate	Boiling Point, Deg. C.	Per Cent Furfural by Wt. Composition of Solution	Composition of Distillate	Boiling Point, Deg. C.
0.2	1.5	99.90	7.5	28.5	98.26
0.4	3.0	99.82	8.0	29.2	98.21
0.6	4.4	99.74	8.3*	29.6	98.19
0.8	5.8	99.67	8.5	29.9	98.17
1.0	7.0	99.60	9.0	30.5	98.13
1.5	10.0	99.42	10.0	31.7	98.07
2.0	12.7	99.25	11.0	32.6	98.02
2.5	15.0	99.11	12.0	33.3	97.98
3.0	17.1	98.99	13.0	33.9	97.95
3.5	19.0	98.87	14.0	34.4	97.93
4.0	20.7	98.76	15.0	34.7	97.92
4.5	22.2	98.66	16.0	34.8	97.91
5.0	23.6	98.58	17.0	34.9	97.91
5.5	24.8	98.50	18.0	35.0	97.90
6.0	25.8	98.43	18.4†	35.0	97.90
6.5	26.8	98.37	18.4–84.1‡	35.0	97.90
7.0	27.7	98.31	....	....	.....

* Saturated solution of furfural in water at 20 deg. C.
† Saturated solution of furfural in water at the boiling point.
‡ Range over which both furfural and water layers are present.

Inasmuch as this method of determining distillate composition curves is open to some criticism,[14] is was deemed advisable to use a method which would eliminate condensation errors.

For the dilute solution of furfural, which must be considered in the commercial production of furfural, the concentration of furfural in the distillate is so many times greater than that in the solution that it is important to obtain a very accurate composition curve.

These errors caused by partial condensation in the still head were eliminated in a second series of determinations by heating the still head. A lead pipe was coiled around the neck of the distilling flask, the entire neck covered with tin foil, to bring uniform heating to all portions, and then covered with layers of asbestos and cloth. A vigorous current of steam passed through the coil kept the temperature of the still head at 100 deg. C., far enough above the boiling point of the solutions in question so that no condensation took place in the still head. As before, solutions of known strength were slowly distilled in the flask, and the distillate collected in

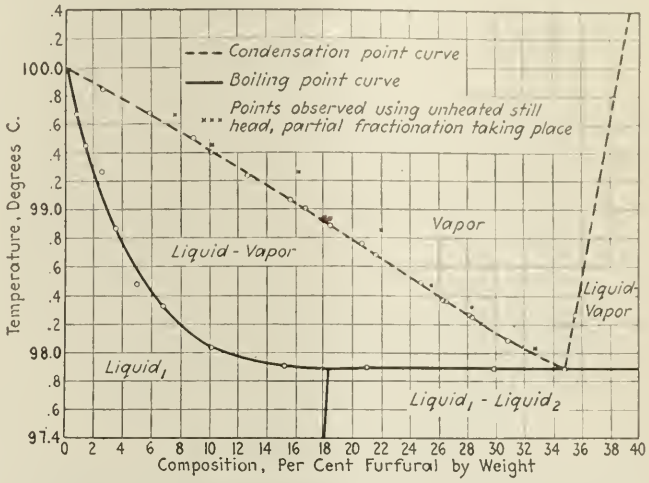


FIG. 2—TEMPERATURE-COMPOSITION DIAGRAM
Portion of Fig. 1 enlarged.

weighed, water-cooled receiving flasks. When about 20 g. of distillate had been collected, a second receiving flask was put in place and the distillation continued. The concentration of furfural in the distillate was determined from the density tables, and the average composition of the solution in the still calculated by the loss in weight. After two and sometimes three fractions of the distillate had been collected, the residual solution was weighed, and its composition checked by density determination.

With the higher concentrations of furfural not more than two samples could be collected from one run, owing to the error introduced by the tendency of furfural to polymerize after being heated for some time. Different runs gave determinations on distillate composition for the same solution composition varying only 0.2 per cent in a total of 26.5 per cent, or less than 1 part in 100. The greatest variation in values of residual solution in the flask, calculated from the original weight and the weight of distillate, and those determined by density was about 1 part in 200. The observed values of corresponding distillate and solution composition are given in Table VI. The notations (*a*), (*b*) and (*c*) in the column headed "Run No." indicate successive samples taken during the same run.

Temperature-Composition Diagram for Dilute Solutions

The data for the boiling point curve for dilute solutions were now plotted on a very much enlarged scale, and the values of distillate composition determined by the second method were plotted at the boiling point temperatures of the solutions with which they were in equilibrium. These boiling point and condensation point curves are shown in Fig. 2.

The distillate composition values, as determined by the first method where the still head was unheated and partial condensation took place, are indicated on the

[14] *Cf.* Lewis, *J. Ind. Eng. Chem.*, vol. 13, p. 169 (1921).

diagram by small crosses. It will be noted that these values are from 0.5 to 3 per cent too high. The values determined by the second method lie in a very smooth curve.

Corresponding Compositions of Solution and Distillate

The data from the curves of Fig. 2 are presented for convenience in Table VII, where, for every change of 0.5 per cent in composition of the dilute solutions, the

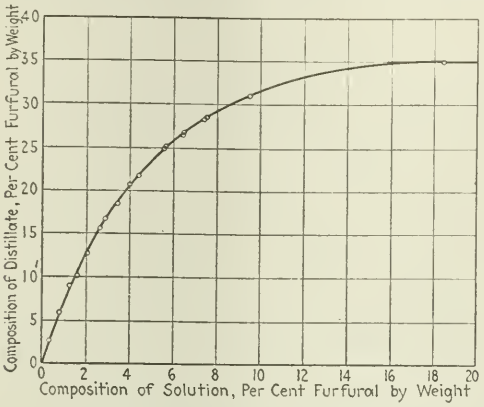


FIG. 3—CORRESPONDING COMPOSITION OF SOLUTION AND DISTILLATE

boiling point and the corresponding composition of distillate are given.

The great divergence of the boiling point and condensation point curves for this system shows why furfural can be so readily separated from water by fractional distillation. The relations between the compositions of the furfural-water solution and the distillate obtained from it are more clearly brought out by plotting the data from Table VI with composition of solution as abscissas and composition of distillate as ordinates. The solution-distillate composition diagram thus obtained is presented in Fig. 3.

Part II, dealing with the practical application of these data, will be published in a subsequent issue.

Domestic Potash Production in 1921

More than 18,200 short tons of crude potash salts containing 7,618 short tons of K_2O was produced in the United States in 1921 from domestic sources, according to the United States Geological Survey. This potash was produced at seventeen plants by fifteen companies, and about 79.5 per cent of it was extracted from natural brines. Three other companies produced considerable potash in 1921, but they have not yet returned their schedules. The annual production from domestic material was less in 1921 than in any other year since 1915.

Twenty-one plants made sales amounting to 8,907 short tons of crude material containing 3,895 short tons of K_2O, valued at point of shipment at $383,218, and twenty-four plants reported stocks on hand amounting to 26,461 tons of crude material containing 10,348 short tons of K_2O. Sales and stocks on hand are reported by several companies that did not produce potash in 1921.

The only plants that reported continuous operation during the year were several that produce potash from the dusts of cement mills and blast furnaces. The inactivity of the fertilizer market and the low price of foreign potash are given as reasons for non-production.

More Efficient Oil Refinery Apparatus Required as Competition Increases

A study of the efficiency of oil refinery equipment is being conducted at the Petroleum Experiment Station of the Bureau of Mines, Bartlesville, Okla. The typical mid-continent "skimming plant" was erected at the time of flush production in some oil field adjacent to the location of the plant and, when completed, oil was at a comparatively low price and easy to obtain. In most cases no particular attention was paid to constructing an efficient plant for the reason that those interested in building refineries of this nature were anxious to get the plant running and obtain returns on their money as soon as possible. Recently conditions have changed to such an extent that a number of these refineries have been forced to shut down because of inability to obtain crude or because they were not able to manufacture products to compete with those turned out by the larger refineries. It is believed that by a careful study of these plants the Bureau of Mines can furnish advice as to the best methods for their operation and aid in preventing enormous wastes due to inefficient equipment.

Another investigation which is to be conducted at this station relates to methods of treating petroleum products. Most of the progressive refiners in the country realize that the methods of treating petroleum distillates have for the most part been handed down from one generation to another and that in many cases they are not satisfactory. They are of the opinion that work should be done to determine proper methods for treating distillates from the various types of crude, for at present a method for treating products from one type of crude may not be satisfactory for treating products of a certain other type. Also, the losses in treating are comparatively high, particularly in the case of the small refiners, who make use of open top agitators and as a result lose large amounts of the lighter fractions through evaporation.

Corrosion of Chromium Steels

It appears from a series of tests which the Bureau of Standards has carried out upon the corrosion of chromium steel that the behavior of the material when subjected to the acid test is not a sure criterion of its resistance to atmospheric corrosion.

Of all the alloys examined, a high nickel-chromium steel, invar, pure iron and medium carbon steel (very slowly cooled from a high temperature) were the most resistant to hydrochloric acid as measured by the loss of weight per unit area per day. High-chromium steels (for example, 13.70 per cent Cr, 0.29 per cent C) were found to be attacked by acid very much more readily. However, when the same specimens were subjected to a weathering test, consisting of a partial immersion in water and exposure to the air, the order of resistance was almost completely reversed. The high-chromium steels were the ones to withstand the treatment best, the low-chromium ones and the pure iron showing rust spots early in the test. The combination of both nickel and chromium appears to make the steel resistant to both acid and weather attack. In general, the steels which were quenched were found to resist corrosion better than the same material in the annealed state, but the differences found were much less than the differences resulting from composition changes, thus indicating that composition rather than treatment should receive primary consideration.

Y Alloy (Aluminum-Copper-Nickel-Magnesium)

A Light Aluminum Alloy Having the Strength of Soft Steel and Good Ductility—Easy to Cast and Roll —Retains Its Desirable Properties in Gas-Engine Parts Working at 250 Deg. C.—Immune From Season Cracking and Corrosion

AS NOTED recently in these columns,[1] a report to the Alloys Research Committee of the British Institution of Mechanical Engineers on "Some Alloys of Aluminum" has been published, a volume of nearly 300 pages. It represents work of 8 years, much of it done under war conditions, involving the whole resources of the National Physical Laboratory. Among its most important disclosures are methods of fabricating a so-called "Y alloy" (containing about 4 per cent Cu, 2 per cent Ni, 1½ per cent Mg, and remainder Al), which in cast and heat-treated form develops strengths as high as 47,000 lb. per sq.in., or when rolled and heat-treated, 54,500 lb. per sq.in. with elongation of 24 per cent in 2 in.

It has been very desirable to discover a light alloy which would retain its high heat conductivity and strength up to at least 200 deg. C. to be used for pistons in airplane or other high-duty gas engines. A comparison with an alloy heretofore much used for this purpose is given in Table I, and shows how well the demand was met.

Many compositions were investigated before the Y alloy was hit upon. It was known that Al:Zn:Cu alloys (ranged in order of importance) were weak at 200 deg. C. Al:Cu alloys containing more than 4 per cent Cu were stiff and hard to extrude, and their tensile strength at 200 deg. C. was not more than 16,000 lb. per sq.in. Additions of 1 per cent manganese seemed to produce an alloy conforming to the desired specifications, but it possessed serious casting difficulties. Small additions of Fe, Mo, W, Cr and V were found to make the casting extremely brittle and porous; intermetallic compounds of high melting point solidified as a skeleton, from which drained the mother metal. After the advantage of combined Ni and Mg when added to an Al:Cu alloy had been found, the relatively high elongation discovered at 350 deg. C. led to successful experiments in rolling and forging of a series of alloys from which the new Y alloy was selected, and which were also found excellent mixtures for casting. Small variations in composition (± 0.75 per cent) do not materially impair the important qualities of Y alloy.

Pouring and Heat-Treating Castings

Molds must properly provide risers of liquid metal to vent the considerable amount of gas evolved from Y alloy just before freezing, and to feed portions where "draws" or shrinkage cavities may be expected. (Total linear contraction is about 1.3 per cent.) Magnesium must be added just before pouring, in relatively large pieces of pure metal pushed below the liquid surface by a small perforated crucible, shown in Fig. 1. Experiments adding magnesium as an 80:20 Al:Mg alloy during melting produced unsound castings containing oxide inclusions. Nickel must be added to the mix as a "hardener," an Al:Ni alloy containing perhaps 20 per cent Ni. Y alloy castings seem to be unusually afflicted with minute holes ("pin-holes") appearing on machined surfaces, a defect which "need not be regarded as seriously deleterious to the casting."

Very important improvement in the physical properties of cast Y alloy may be had by heat-treatment, despite the negative effect of heat-treatment on cast duralumin. In order to approximate the strength of wrought material, chill castings (28,000 lb. per sq.in. ultimate) are given a 6-hour anneal at 530 deg. C., then quenched in boiling water and aged. This treatment, which is about 30 deg. higher than would be safe for duralumin, results in an ultimate strength of 47,000 lb. per sq.in. with 6.5 per cent elongation in 2 in. As shown by a comparison of Figs. 2 and 3, it has apparently caused the solution of some of the intergranular constituents, and a spheroidization of the remainder. Prolonged tempering of chill-cast Y alloy at 250 deg. C. reduces the strength to 22,000 lb. per sq.in. After quenching and aging, however, tempering at 250 deg. C. for 48 hours reduces the acquired strength no more than 10 per cent, and does not affect the elongation.

TABLE I—TESTS OF LIGHT ALLOYS AT HIGH TEMPERATURES

Temp., Deg. C.	88:12 Cu:Al Ultimate	88:12 Cu:Al Elongation	88:12 Cu:Al Conductivity	Y Alloy, Sand Cast Ultimate	Y Alloy, Sand Cast Elongation	Y Alloy, Sand Cast Conductivity	Y Alloy, Heat-Treated Rod Ultimate	Y Alloy, Heat-Treated Rod Elongation
20	30,000	7.2	....	24,000	1.8	....	54,500	24.0
100	.....	...	....	.....	...	....	50,000	21.6
150	.....	...	....	.....	...	....	48,000	23.9
200	14,000	5.0	....	.....	...	....	14,000	24.0
250	9,000	6.0	...	23,000	1.0	....	....	...
300	6,300	6.0	0.37	20,000	1.6	0.37*	.....	..
350	3,400	19.0	....	11,500	6.0	....	.....	.

* Conductivity of gray cast iron at 300 deg. C. is 0.10.

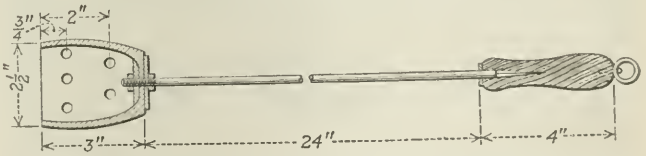


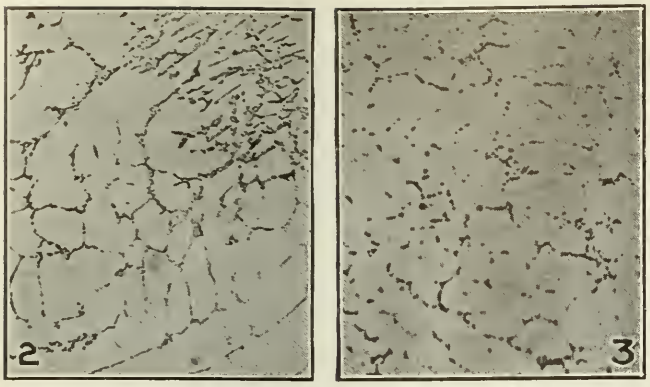
FIG. 1—PERFORATED CRUCIBLE FOR THE ADDITION OF MAGNESIUM TO LIGHT ALLOYS

Reheating to 500 deg. C. and slow cooling completely softens the alloy, and it undergoes no subsequent aging effect.

Development of Y Alloy

The actual development of the wrought Y alloy is interesting, as an instance of successful synthesis. A preceding report to the Alloys Research Committee had indicated superior qualities in a 72:3:25 Al:Cu:Zn alloy. A series of low-copper Al-Zn alloys were therefore taken as a basis for experimentation, particular attention being given to the behavior during forging and rolling. It was soon found that 77:3:20 Al:Cu:

[1] "New Aluminum Alloys of High Strength," CHEM. & MET. ENG., vol. 26, No. 15, p. 689, April 12, 1922.



FIGS. 2 AND 3

Fig. 2—Y alloy as cast. Unetched. × 150.

Fig. 3—Alloy shown in Fig. 2 annealed 6 hours at 530 deg. C. and quenched in cold water. Unetched. × 150.

Zn (alloy "A") was the best of the lot, and complete information obtained on the proper way to roll rods, strip and very thin sheet. Magnesium (0.25 to 0.5 per cent) was next added, hoping that it would have the aging effect induced by its presence in duralumin. Manganese, a known hardener, was also introduced, and alloy "E" having the nominal composition: Cu 2.5 per cent, Zn 20.0, Mg 0.5, Mn 0.5, Fe not exceeding 0.2 per cent, Si not exceeding 0.2 per cent, was discovered, which was much stronger than anything of the sort hitherto known.

Both alloys "A" and "E," however, were deficient in strength at about 250 deg. C. It was thought that alloys containing Ni and Mg, which were not only strong but ductile at high temperatures, should be readily rolled and perhaps would retain their useful properties after working. It was immediately found that the addition of nickel, which was itself a hardener, markedly increased the *ductility* of alloys already so high in copper as to resist rolling. Comparison of tensile tests showed that 92½:4:2:1½ Al:Cu:Ni:Mg alloy was weakened only 10 per cent at 200 deg. C., and this mixture was then studied in detail as "Y" alloy.

Microstructure

Without entering into any detailed description of the microstructure, which indeed is not well understood as yet, it has been found that when Y alloy has been annealed and is in equilibrium, no compound corresponding to the $CuAl_2$ of duralumin is in existence. Nickel, even when present to less than 2 per cent, seems to form a ternary compound with aluminum and copper, as well as a compound $NiAl_3$. Thermal studies show the absence of critical points below 554 deg. C. The liquidus is also considerably above 540 deg. C. Consequently the microstructure and rationale of heat-treatment is entirely different from that of duralumin.

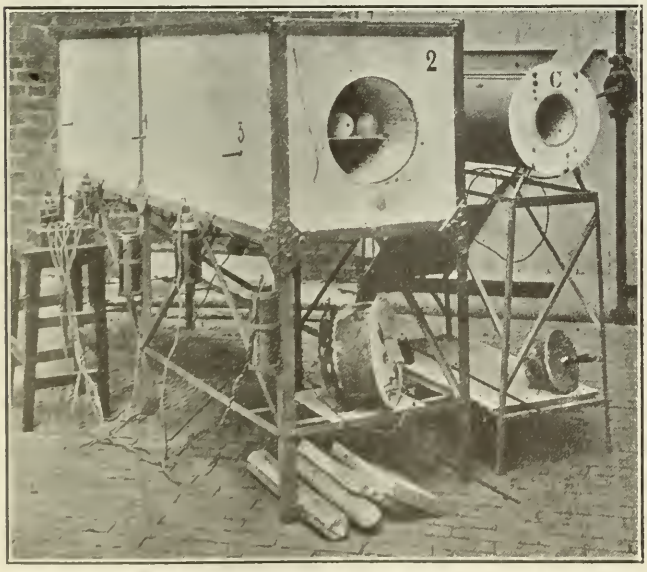


FIG. 4—ELECTRICALLY HEATED MUFFLE, 12-IN. DIAMETER, FOR HEATING LIGHT ALLOYS

Experimental Plant

Alloys were melted without charcoal or flux, about 25 lb. at a time, in covered salamander crucibles placed in an oil-burning pit, and poured into one 3-in. chill-cast round billet, 19 in. long; three chill-cast rods, 1 in. round x 7 in. long, and four shaped sand castings. Temperature was regulated by pyrometers, and no allowance was made for loss in melting.

Rolling was at first done in a commercial plant, but this was so unsatisfactory that a two-high 15-in. mill was erected at the National Physical Laboratory. It is driven by a 60-hp. direct-current motor, using storage batteries for source of power. By regulating the voltage applied, linear velocity of the rolls can be varied from 50 ft. to 200 ft. per minute. A removable attachment consisting of a double row of gas burners playing upon the slowly rotating rolls imparted to them the heat which they acquire during ordinary mill practice.

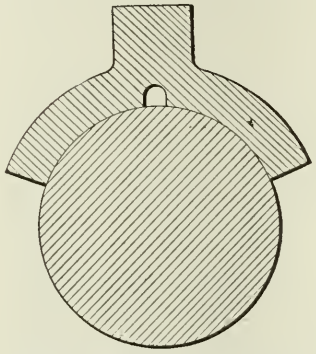


FIG. 5—ALUMINUM SADDLE FOR THERMOCOUPLE JUNCTION

Reheating and annealing was done in a large muffle shown in Fig. 4. It consists of a 12-in. steel pipe, 7 ft. long, covered outside with a layer of micanite and then wound with several sections of nichrome ribbon. The whole is bricked in with magnesia brick, and iron bound. Electrical heating coils are also provided for the ends, and a temperature gradient of ± 10 deg. C. is readily maintained at 400 deg. C., with a current consumption of 2 kw. This furnace has made over 1,000 heats in 5 years without any repairs or renewals whatever.

Temperature of the round billets was taken, without the necessity of drilling them for a thermocouple, by placing the aluminum saddle shown in Fig. 5 over them, and slipping the thermocouple junction in the groove between saddle and billet. When slabs were being heated, a spare slab, drilled for pyrometer, was charged in the furnace with the others.

Correct Forging and Rolling Practice

Difficulties with cracking during rolling, early encountered, were traced to surface defects in the cast billets. Preliminary forging seemed to close these surface imperfections somewhat, but billets free from surface defects were eventually made by pouring very slowly, in fact just raipdly enough to avoid cold shuts. For this purpose the molds (preheated to 100 deg. C.) were tilted to 45 deg., and the metal poured to match the solidification so that only a very shallow layer remained constantly liquid. Thus shrinkage cavities were

abolished. Surface and edge cracking occurring when rolling thin sheet in the experimental plant and later when much larger slabs were rolled in commercial practice was traced directly to surface defects in the slab—a slab which had been milled all over $\frac{1}{8}$ in. deep rolled perfectly. In the rolling mills various mechanical aids were tried, the most successful being the provision of a small V-shaped runner down the lower edge of the tilted mold. The tongue left on the slab is cut off before rolling starts.

Some of the alloys seemed to require a preliminary "breaking down" under a hammer. While chill-cast slabs of Y alloy $\frac{3}{4}$ in. thick will give no trouble in rolling[1] to rods, it is desirable to forge it before rolling into sheets. With $1\frac{1}{2}$-in. slabs, a reduction of 10 per cent should be given by forging in two heats at 240 deg. C. Then reheat the blanks to 480 deg. C. and roll to $\frac{3}{8}$-in. plate in five or six passes. Subsequent rolling can then be done at high speed and heavy draft.

Summary of Physical Properties

Table II gives a summary of the tensile properties of rolled Y alloy rods and sheets after heat-treatment. Table I also contains physical properties at elevated temperatures of a $\frac{3}{8}$-in. rolled rod, quenched from 480 deg. C. and aged 4 days. From this and a comparison of its strength in the rolled condition given in Table II

TABLE II—SUMMARY OF TENSILE TESTS ON ROLLED Y ALLOY

Material	Condition	Elastic Limit	Yield Point	Ultimate	Reduction of Area	Elongation in 2 In.
$\frac{1}{2}$-in. rod	Hot-rolled	.....	26,900	39,400	30.0	20.0
	Quenched from 530 deg. C. and aged	17,200	34,500	54,000	33.0	23.0
	Cold-rolled from $1\frac{1}{4}$-in., hot-rolled, quenched from 530 deg. C. and aged	17,200	34,000	54,100	34.0	25.0
$\frac{1}{2}$-in. rod	Cold-rolled from $\frac{3}{4}$-in., hot-rolled, quenched from 520 deg. C. and aged	.....	33,400	51,200	31.0	26.0
0.05-in. sheet	Hot-rolled; quenched from 480 deg. C., aged	.....	36,000	52,000	....	19.0
	Hot-rolled, quenched from 530 deg. C., aged	.....	38,500	58,200	..	19.0
	Cold-rolled; quenched from 530 deg. C., aged	22,000	46,500	60,200	...	17.0
0.018-in. sheet	Cold-rolled; quenched from 530 deg. C., aged	.....	47,000	62,800	..	17.0

it appears that prolonged heating to something over 200 deg. C. will remove the hardening effect. On the other hand, test-pieces held 100 hours at 150 deg. C. and tested at that temperature give the same tensile results as though the heating had endured but 30 minutes. Wohler fatigue tests on tubular test-pieces at 150 deg. C. (designed to show the expected endurance as connecting rods) gave a safe range of alternating stresses of $\pm$ 18,500 lb. per sq.in., wherein the metal may be expected to endure indefinitely, as compared to $\pm$ 23,000 lb. per sq.in. at room temperature. Table II also shows that an increased strength and unimpaired ductility may be had by quenching in water from 530 deg. C.—about 50 deg. higher than the proper temperature for duralumin. Even higher strengths may be had by cold-rolling $\frac{1}{4}$-in. plate, reducing thickness 10 per cent in each stage, and separating stages by a quenching from 480 deg. C. Sheet so prepared 0.05 in. thick, after quenching from 530 deg. C. in boiling water, shows an ultimate strength of 58,000 to 61,000 lb. per sq.in., and elongation of 16 to 18 per cent in 2 in.

[1]Rolls must be kept well lubricated to prevent them seizing and splitting the hot metal.

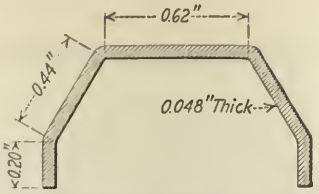


FIG. 6—ROLLED CHANNEL FOR COMPRESSION MEMBER

A channel, shown in Fig. 6, was made in a bending machine from heat-treated rolled strip, and cut into 6-in. lengths with squared ends. This was seated on ball centers, and tested in compression. A buckling stress of 30,600 lb. per sq.in. was developed by Y alloy, a figure 13 per cent higher than duralumin.

Corrosion Resistance

Y alloy is as light as any of the stronger aluminum alloys which have yet been produced, and is distinctly superior to most in the ease of manufacture. Its great superiority lies in a very remarkable resistance to corrosion, and its entire immunity from intercrystalline cracking under prolonged loading (season cracking). Without presenting details—since corrosion investigations are in the hands of the Institute of Metals committee—the eleventh alloys research report notes that both in the cast and rolled condition the Y alloy possesses considerably better powers of resisting corrosion, even when immersed in sea water, than the other high-strength aluminum alloys.

War Gases to Be Used for Extermination of Pests

Experiments on the use of poison gases for exterminating obnoxious birds, rodents and insects will be undertaken this fall, when the Biological Survey, in co-operation with the Chemical Warfare Service, will make a trial of the method on blackbirds in the Imperial Valley of California. In that region these birds are said to do at least $50,000 worth of damage to the milo crop each year. Because of their feeding habits it is impossible to destroy these birds with poisoned baits, but, as they roost on the reeds in the marshes, it is thought that they can be killed by a gas cloud at night when the wind is favorable. The blackbirds are migratory and return to the same places year after year. It is thought that a big killing in a certain locality will probably free it of the pests for many years. A few other birds in the blackbird-infested marshes will be killed at the same time, but the department believes that these local birds will soon reach their normal numbers again.

Arrangements also are being made by the Biological Survey with the Chemical Warfare Service for investigating the possibility of using poison gases on such burrowing rodents as rats, prairie dogs, ground squirrels and woodchucks. Tests on pocket gophers and ground squirrels by these two co-operating branches of the government in California show that chlorine may be used with good results if handled properly. The Chemical Warfare Service used phosgene on rats in Porto Rico with promising results. Some of these war gases will be compared with carbon bisulphide for the killing of woodchucks and other rodents in their burrows.

Entomologists of the department have already worked in co-operation with the War Department in testing various gases on insect pests of growing plants and those that infest stored grain, but it has not yet been found advisable to recommend anything to take the place of hydrocyanic-acid gas or carbon bisulphide.

New Developments in the American Glass Industry

Description of the Plant of the Kimble Glass Co., at Vineland, New Jersey—Development of Automatic Machinery for Making Glassware—Making Precision Scientific Apparatus in the United States—Development of a Force of Skilled Glassworkers

By G. L. MONTGOMERY

SHORTLY after the outbreak of the World War in 1914 it became extremely difficult to obtain certain articles for which the United States had been almost entirely dependent upon imports from Europe. As a direct result of this condition the more enterprising among our manufacturers began to take steps toward developing the manufacture of these articles in this country. One of the most important items which we were unable to get was technical glassware—that used by chemists, metallurgists, biologists, physicians, pharmacists and other scientists, and also by the United States Bureau of Standards. Small amounts of this product had been previously manufactured in this country; but production was not generally on a commercial scale, and the greater part of our demands had been filled by imports from the Central Powers.

One of the plants which undertook to stop this gap in our commercial structure was the Kimble Glass Co., of Vineland, N. J. Founded in 1907, this company had taken over a small, single-furnace plant of about 2½ tons daily capacity and 20,000 sq.ft. of floor area. In 1910 expansion had commenced and at the outbreak of the war the floor space had quadrupled and the plant was turning out a line comprising rods, tubes, homeopathic vials, test tubes, Babcock milk test bottles, and various other articles. At that time all processes both in the hot and cold metal plants were hand processes. The products were confined to such as could be made in quantity by hand and did not call for highly trained workers and technical control.

Developing the Manufacture of Glass by Automatic Machinery

In the manufacture of the Babcock milk test bottle this company had proved its ability to produce an accurately graduated article. In the emergency the government requested the company to go more extensively into the manufacture of graduated ware. The developing of a graduating department was immediately commenced. At the present time this department has over one hundred skilled operatives and turns out all types of precision graduated glassware, including apparatus complying with the specifications of the Bureau of Standards. Along with this development has also come the blowing and finishing of the complicated pieces of testing and surgical glassware formerly produced only in Austria and Germany. It was necessary to train the men for these new processes, as there were at the time no men available with sufficient skill. Those who had been engaged in the normal operation of the plant were trained along the new lines; but the shortage of labor prevalent during the period made it difficult to obtain workers to fill their places. From this has grown the manufacture in quantity on automatic machines of homeopathic vials, test tubes and other articles made from tubing.

The machines to perform these last-named operations were experimentally worked out in the plant, and have all been designed and patented, and are now manufactured there. The advantages following the use of these machines consist in larger output with fewer operatives, a uniform and high-quality product, and the provision of a staple quantity line in constant demand to back up the production of the varied line of special ware for which the demand may fluctuate.

Factors Governing Location in Vineland

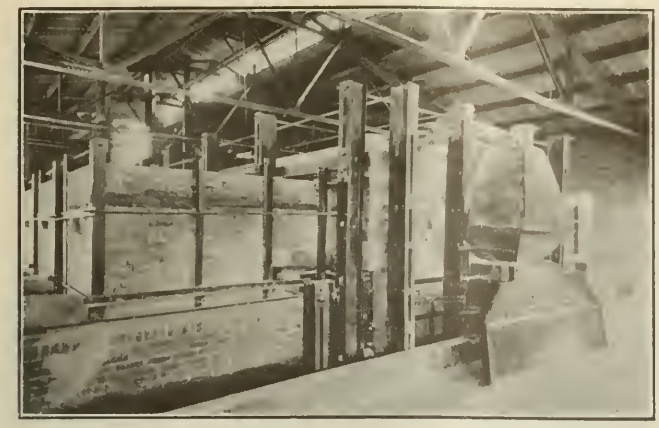
The town of Vineland is in the heart of the New Jersey glass sand district, and proximity to the source of the most important raw material and accessibility to the Eastern market and the ports of New York and Philadelphia were the factors determining the location at this point. About 900 tons of the glass sand are used annually. It is mined and washed at the company's mine, located near the plant, and is about 99.8 per cent SiO_2. The other materials used comprise yearly amounts of about 2,400 tons of gas coal, 2,800 tons of steam coal, 300 tons of soda ash, 150 tons of lime, and smaller quantities of coke, red lead, litharge, hydrofluoric acid, wax and various other commodities. These are brought in on the Central Railroad of New Jersey, which has two tracks leading into the plant. The Pennsylvania Railroad is also close by.

How the Plant Is Housed

The buildings of the plant are all one-story, reinforced concrete and brick buildings with wood deck roofs on steel trusses, except the structures containing the glass-blowing and machine departments and that housing the office, graduating and lamp departments. The glass-blowing and machine departments are one-story steel frame buildings with corrugated asbestos and brick veneer walls and asbestos roofs. The office, graduating and lamp departments are in a two-story mill type building. The total floor area of the plant is approximately 130,000 sq.ft., of which the raw material and batch building occupies 3,500 sq.ft., the hot metal plant about 30,000, the cold metal plant about 39,000, packing and warehouse about 43,000, power and heating 6,000, machine shop 3,600, laboratory 1,500 and office 1,500.

Handling the Raw Material

The raw materials for glass are brought to the plant by rail and delivered to the batch house. Due to the comparatively small quantity of these materials used, large storage space is not provided and the materials are stored in small piles on the floor. The batches are mixed here by hand and placed on large barrows, 1,000 lb. to the batch. It is essential that the batches be in accordance with an exact formula and the necessary care and attention can be had only by hand mixing.



TANK FURNACE OF 20 TONS DAILY CAPACITY

From the batch house the barrows are wheeled to either the glass factory or the tube machine building, which constitute the hot metal department.

The First Process in the Making of Scientific Glassware

The glass factory is the department in which the shapes used in the manufacture of scientific apparatus are blown. The equipment comprises a furnace for closed pots having a daily capacity of five 1,000-lb. pots, a "glory hole" and two hand-operated lehrs. Connected with the building, one on each side of the blowing floor, are two pot arch furnaces.

The glass to be annealed is placed in and removed from the lehrs by hand. This method is used in preference to mechanically operated lehrs because of the varied product, each different shape requiring a different amount of annealing. The pot furnaces are heated by direct coal fire underneath, being fed from the basement level by coal supplied from a trestle on the adjacent railroad siding. The lehrs are heated by oil, the burners being placed beneath the lehrs and fed from an oil supply in two nearby 10,000-gal. storage tanks. This means of heating the lehrs gives a better temperature control than is available by using coal or gas. Both the pot furnace and the lehrs are provided with indicating pyrometers in the glass factory and recording pyrometers in the plant laboratory, enabling both the factory foreman and the plant chemist to keep the temperatures under continual observation.

A tank furnace is at present being constructed in this building with a daily capacity of 5 tons for use in making resistance ware—i.e., ware which can be subjected to extreme variations in temperature without breakage. This tank is of the low arch type and will be heated by oil burned in pressure burners. The air necessary for combustion will be heated in a recuperator, situated on the same floor level and at the rear of the tank. A novel feature of this tank is that the charging of the batch and the extraction of the melt are both accomplished from the same side. This is possible due to the substitution of oil firing for the usual gas firing and the consequent elimination of flues on the sides of the tank. As a result it has been possible to place the tank in such a way as to conserve more floor space for blowing than is possible in the average installation.

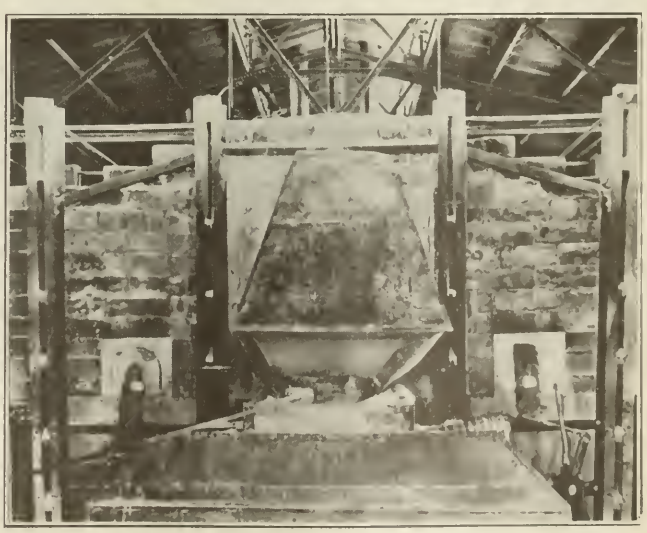
This department also contains two experimental furnaces for the development of new types of glass. One of these is a tank furnace called a day furnace and holding sufficient melt for a one-day run. The other is a pot furnace with a capacity of a single pot holding 500 lb. of batch. The glass pots used in the glass factory are purchased from outside the plant except in special cases of experimental development.

The manufacture of the complicated shapes used in making scientific apparatus requires blowers of more than ordinary skill. In training these blowers to meet the war emergency, the glass-blowing art of the United States has been brought level with that of Europe. If the art is allowed to prosper here, we need never again be dependent on others for articles of this type.

Drawing Tube and Rod Automatically

The tube machine department houses the equipment for drawing tube and rod automatically. The glass is melted in a continuous tank furnace of 20 tons daily capacity. This furnace is heated by producer gas supplied from the adjacent producer house under pressure and is of the regenerative type. It is provided with an indicating pyrometer. Placed immediately behind the refining end of this tank are four tube-drawing machines, fed with glass through separately heated feeding furnaces. These machines, which are a new and successful application of automatic machine principles to the glass industry, are manufactured by the Libbey Glass Manufacturing Co., of Toledo, Ohio. By means of them tubes or rods can be automatically drawn covering a wide range of diameters. A detailed description of the operation is given toward the close of this article.

The tube or rod is cut to lengths of 5 or 6 ft. in the tube machine and delivered by this machine to a storage rack. From this rack it is taken to the grading and sorting tables. Here the diameters of the rods are carefully measured and they are sorted into grades varying by $\frac{1}{32}$ in. These different grades are then placed in wooden boxes and taken either to the warehouse for shipment or stock, or to the cold metal department for manufacture into towel bars or similar articles. The tubes are carefully gaged inside and outside and are sorted into groups according to the inside diameter and the wall thickness. The drawing machines make about five different wall thicknesses for each different inside diameter of tube drawn. After sorting, the tubes are disposed of in the same manner as the rods, except that in the cold metal department they form the basis of the manufacture of a great many objects such as vials,



CHARGING END OF TANK FURNACE

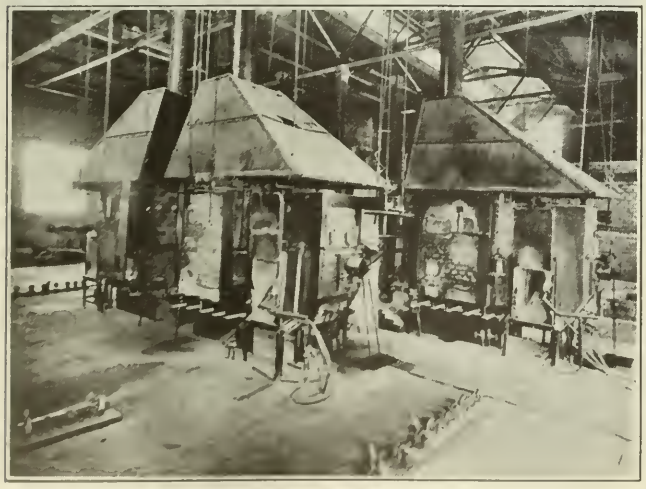
test-tubes, gage glasses, containers, oil cups and parts of scientific instruments.

Cutting and Sorting Glass Tubes

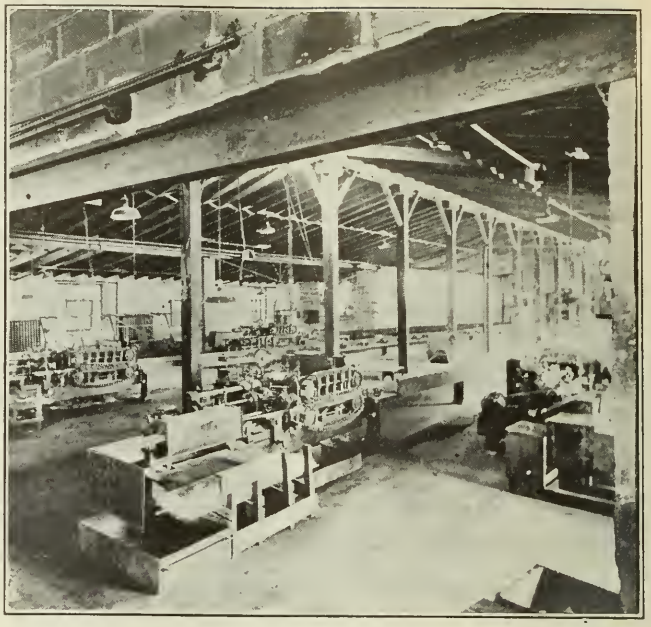
The cold metal plant consists of the cutting, sorting, lamp, machine, graduating, etching and finishing departments. All the products of the hot metal plant which are to be finished in this works are first brought to the cutting building. Here tubes and rods are cut to the required lengths and the remains of the gather and other superfluous glass are trimmed from the blown shapes. The trimming of shapes is done by hand. Rods and tubes are cut by circular glass saws, some hand fed and some machine fed.

From the cutting building the glass is taken to the sorting department on the ground floor of the building in which the lamp and graduating departments are located and immediately adjacent to the building housing the automatic vial machines. Here the stock for the lamp department is separated from that for the machine department and the sorted stock is stored for delivery to these departments as required.

An interesting machine has been developed for sorting the tubing for the machine department into the five different weights in which each diameter is made. A large number of pieces of tubing, each of the required diameter and cut to the required length, say 5 or 6 in., is placed in the hopper at the top of this machine. From this hopper the pieces are fed one by one onto a reciprocating and oscillating step bar having six steps and made of two similar steel strips spaced about 3 in. apart. The upper step has one groove for receiving the tubes and the five other steps each have two grooves. The reciprocations and oscillations are both accomplished in the same plane, at right angles to the axis of the piece fed from the hopper and having an axis inclined to the vertical about 45 deg. The amplitude of the oscillations from this axis is at a maximum about 3 in. either side, so that each groove describes a complete and rather flat ellipse for each cycle. At each upward stroke the reciprocating bar picks up in the groove on its top step a piece of tubing. As the bar starts on the downward trip, a pivoted and counterweighted piece, situated between the two parts of the bar, takes the piece of tubing off the top step into a groove cut in its outer end. Should the piece be of the lightest grade, it is not sufficiently heavy to tip this pivoted piece and on the return of the reciprocating bar it is picked up by the outer groove on the second step. All pieces heavier than the lightest grade tip the pivoted piece sufficiently to cause the tube to be picked up by the inner groove of the second step. Pieces in the outer groove are tripped off into a tray at the next oscillation of the bar, while those on the inner groove are picked up by the second pivoted and counterweighted piece. By a repetition of this series of movements the five different weights of tube are separated one from the other.



FEEDING FURNACES AND DRAWING MACHINE IDLERS



DELIVERY ENDS OF AUTOMATIC DRAWING MACHINES SHOWING RACKS FOR RECEIVING LENGTHS OF TUBE

How the Scientific Ware Is Finished

All the stock which is to be worked up by hand is taken from the sorting area to the lamp department, on the second floor of the same building. Here the different articles are made by the usual combination of gas burners and hand tools. It is here that the complicated pieces of scientific ware are formed and it is worthy of note that this art has been developed by American workmen on a commercial scale, proving that the United States is able to compete in highly skilled hand trades, at least in her own markets, with the products of low-paid European labor.

A large portion of the product, on leaving the lamp department, is completed and is taken directly to the packing rooms. Other pieces which are for measuring purposes require graduation. The pieces on entering the graduating room are first calibrated and tested by men especially trained for the work, which requires delicate skill and extreme accuracy. These men place gage marks on the articles delimiting the portion of which the volumetric capacity has been determined. The pieces are then thoroughly covered with wax. They are then placed in the graduating machines and the required number of spaces is marked off between the determined points by making scratches through the wax to the glass.

The graduating machines are of both the hand-operated and motor-driven types and are similar to the dividing machines usually seen. However, in order to obtain the extreme accuracy required for scientific instruments, it has been necessary to build these machines

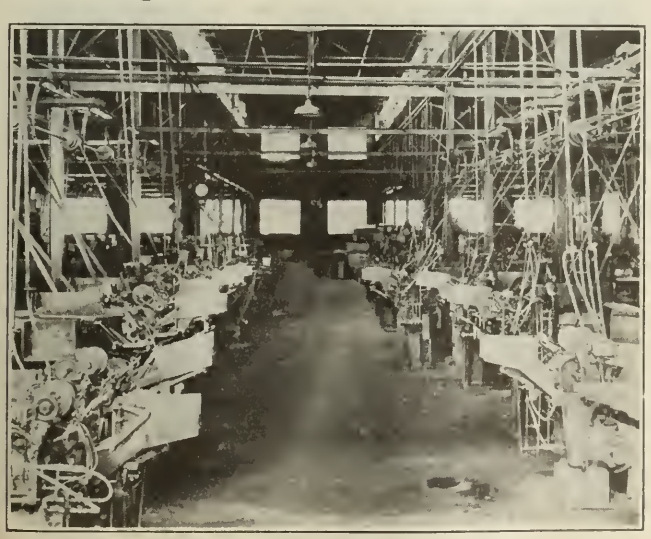
for the special service of this plant, as the ordinary machine such as is used in graduating thermometers is not of sufficient accuracy. At the present time, new machines are in course of construction, by means of which it is expected that the Bureau of Standards ware can be machine graduated. This ware is now graduated in the laboratory by hand by the most skillful workers employed in the plant.

Etching

For placing the figures, letters and other symbols on the ware to be etched, there are several machines adapted from the principle of the pantograph and very much like the machines used in engraving. The operator traces an enlarged outline of the desired character, and this outline is transmitted through the motion of the machine, in reduced size, to the desired place on the work. After the desired markings are made through the wax covering, the pieces are attached to trays by means of melted wax. These trays are then dipped into a bath of hydrofluoric acid, which etches the glass through the scratches. On removal from the acid bath, the glassware is placed in a machine similar to the ordinary dishwashing machine, where it is exposed to a live steam spray. The wax is melted off, and together with any acid which was on the piece, is washed down a drain to the floor below with the condensed steam. Here the wax is separated from the acid and water, is purified and is then returned to the graduating department to be used again. The etched pieces are dried. The markings are then filled with a substance to make them stand out clearly. In another part of this room such finishing operations as the grinding of stoppers, cock-valves, etc., placing electrodes, finishing and polishing towel bars are performed.

Automatic Manufacture of Vials and Test-Tubes

The tubing which is to worked up into quantity products such as test-tubes and vials is brought from the sorting room into the adjacent building which houses the automatic machines. These machines are a development of this plant and represent a distinct departure in the glass-working industry. The principle of operation is the same, no matter what the product turned out, and different products are obtained by different applications of heat, compressed air and mechanically operated forming tools.



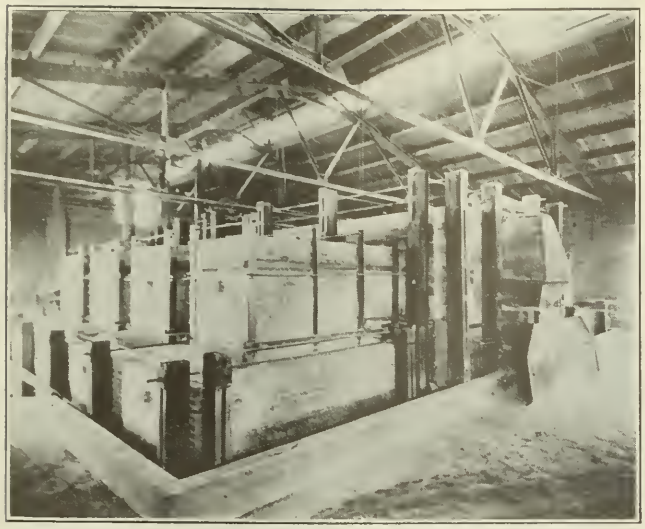
AUTOMATIC MACHINES FOR MAKING CORKAGE ON VIALS

AUTOMATIC MACHINES FOR MAKING BUTTS ON VIALS

The machine used for making test-tubes is a good example of the methods followed. Here the stock is fed from a hopper, one piece at a time, down an incline to a point where it is taken up between two sets of revolving rollers. These rollers are mounted in pairs on shafts parallel to each other and to the axis of the piece of tubing. The tubing lies in the groove formed between the two sets of rollers. The rotation of the rollers causes it to revolve, and at the same time one end is subjected to the heat from several gas burners. When it is sufficiently heated, the gas burners automatically move out of the way and a forming tool or die is brought into play which forms the flange of the heated end of the tube. This flange being formed, the piece is then ejected from the first set of rollers and moved along a set of conveying rolls to another set of rollers similar to the first. Here the flange is formed on the other end of the tube. The piece then moves to a third set of rollers. Here the heat is applied to the middle portion in such a manner that when the tube is drawn slightly apart by a pressure exerted on the two flanges, it is separated into two pieces, each piece having a closed end. While these closed ends are sufficiently hot to be worked, the gas burners are withdrawn and a forming tool is brought into contact with each of them. At the same time compressed air is introduced into the outer ends of the tubes and the hot glass is caused to form an even spherical butt for the tube, filling out the cup in the forming tool, the glass being evenly distributed throughout the butt. This completes the tube, and it is released and conveyed into a hopper at the end of the machine for finished pieces. The cycle of operations is repeated for every tube made by the machine, and as a result the product is absolutely uniform. Also, due to the fact that in forming the butt the air pressure is under absolute control and the glass is caused to spread evenly and is more homogeneous than in the hand-made product, a test-tube is made of much greater strength than by the older method. At the same time it looks better and can be sold at as low a price.

The Packing, Shipping and Warehouse Departments

After the glass has been through the final manufacturing process it is taken to the packing rooms to be placed in the appropriate containers. These containers are made on the ground from semi-finished stock pur-



TANK FURNACE FOR AUTOMATIC DRAWING MACHINE

chased outside, and are of both paper and wood. The department is commodious and well arranged, but the methods used are the usual methods of hand packing and present no feature worthy of special notice.

From the packing rooms the filled containers are either shipped by truck or rail, or taken to the warehouses and placed in stock. These warehouses are conveniently placed on either side of the main track leading out of the plant. The stock is handled into and out of the packing rooms and warehouses on storage battery trucks or on hand trucks as may be convenient.

There is a very complete machine shop in the plant, used for making repairs to the existing equipment and for the manufacture of the automatic machinery which was described above. This department is located in a separate building, placed directly adjacent to the machine department, where most of the work for the shop originates.

Power, Heat and Producer Gas

Electric power is purchased from the Vineland Electric Co., about 15,000 kw-hr. being the monthly load for all purposes. High-pressure steam for the compressors, the producer and for process use is supplied from a 125-hp. water tube boiler. Low-pressure steam for heating purposes is supplied from four small heating boilers, placed in a separate building located centrally to the buildings where this heat is needed. The producer, supplying gas for the tube-machine tank furnace and for process uses in the various departments, is a standard Chapman producer. The amount of gas produced is about 1,000,000 cu.ft. per month.

Laboratory

The laboratory consists of two divisions, physical and chemical. The physical laboratory tests the products after annealing for strain and for strength and makes other similar tests as needed. For the present the Bureau of Standards ware is calibrated and marked here, but this work will be transferred to the graduating room when the graduating machines mentioned above are in operation. The chemical laboratory does experimental work in the development of new kinds of glass, makes tests for process control, and tests the materials used in the plant. These tests do not include the specification tests on raw materials, which are periodically made in an outside laboratory by a consulting chemist.

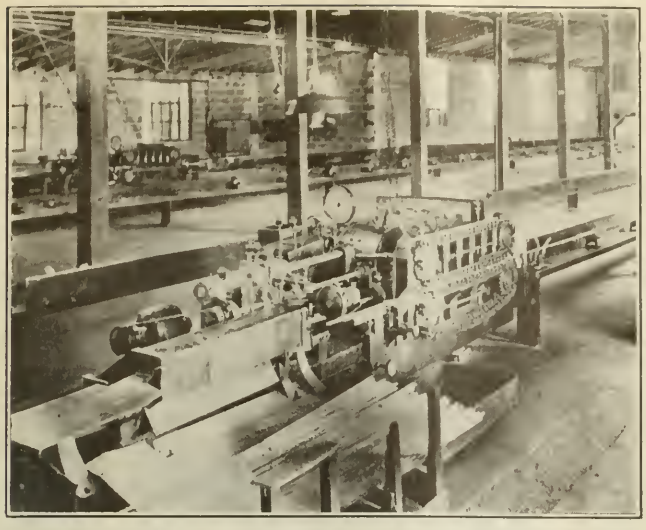
Machinery for Automatically Drawing Tubing

The machine used in the automatic manufacture of tubes and rods is not a new development peculiar to this plant; but as its use is by no means general, a description of it should prove of interest. The molten glass is fed onto a slowly rotating arbor which is situated in a heating furnace. Four of these heating furnaces are placed at the refining end of a tank furnace opposite the feeder openings. The feeder opening is connected to the heater furnace by a separately heated trough, so located that the glass flowing through the trough flows onto the arbor and forms a complete film over it. The arbor is mounted with its delivery end somewhat lower than the other end and in the start of the process a knob or lump forms on this end as the glass flows over the arbor. The operators attach a bar to this knob and walk rapidly away from the arbor. At the same time a current of compressed air is introduced within the glass from a hole in the delivery end of the arbor. In this manner the propagation of the tube is commenced.

As soon as the tube has been drawn out by hand to a suitable diameter, the operators place it in the machine and the drawing is continued as long as the supply of liquid glass continues to flow over the arbor.

Immediately following the rotating arbor and on a line which is a continuation of the horizontal projection of the axis of the arbor is a series of grooved idler wheels. These wheels are placed near the floor of the building and at a somewhat lower level than the delivery end of the arbor. In the machines in use at the Kimble plant the row of idlers is about 120 ft. long. The tube, which is placed in the grooves of these idlers and held there by means of asbestos guides, passes over them into the pulling machine. This machine supplies the motive power for the drawing after the operators place the tube in it. The pulling element consists of two endless chain belts, one above the other, in line with the tube as it leaves the idlers. These belts are made of links from 3 to 4 in. in length and carrying at the outside surface of the chain over each joint a pivoted, asbestos-covered plate which serves to grip the tube. The lower chain runs over a rigid guide, and the lower strand of the upper chain runs through an ad-

HEATING FURNACES, ARBOR AND INTAKE OF DRAWING MACHINE, SHOWING TUBE ON IDLERS



PULLING MACHINE, CUT-OFF AND STORAGE RACK

justable guide which holds the chain on the tube by spring pressure and can be moved up or down to accommodate different sizes of tubing. The pair of sprockets driving the upper chain are also provided with a vertical adjustment. This pulling machine is driven by a motor.

How the Automatically Drawn Tube Is Cut in Useful Lengths

On the other side of the pulling machine from the train of idlers is located the cut-off. This consists of a circular glass saw with its axis of rotation parallel to the travel of the tube, arranged to be moved back and forth along the path of the tube and also capable of being moved against and away from the tube. The machine can be set to cut the tube in various lengths as desired. When a sufficient length of the tubing projects from the pulling machine the saw is brought forward horizontally so that its swiftly rotating edge is against the tube. At the same time it is caused to travel with the tube and at the same speed. When a notch is completed the saw is withdrawn horizontally and makes a quick return to its first position in time to pick up the next length of tube as it issues from the pulling machine.

The piece of tubing which was notched by the saw is broken off by the movement of a slotted disk forming one end of a wheel made up of a series of long sheet metal vanes. It falls between two of the vanes and by its weight causes the wheel to revolve. As the vane inclines the piece of tubing rolls off into the storage rack and the wheel comes into position to receive the next piece broken off. All the motions described above may be set to suit the particular work to be done and are then accomplished automatically until the setting of the machine is changed. To make rod instead of tube the only difference is that a solid arbor is used at the head of the machine, no current of air being needed.

Conclusion

In conclusion, the writer believes that the plant described above is noteworthy for three reasons: First, for the development of the manufacture of glass by automatic machinery; second, for the manufacture of precision scientific glassware in the United States on a commercial scale, and last, for the training of a force of skilled glass workers capable of blowing and working up the most complicated articles.

Recent Developments in the Sulphur Industry

In connection with the recent announcement by the Freeport Sulphur Co. that it had reached an agreement with the Texas Co. by which the Freeport obtains the sulphur lease at Hoskins Mound, the sulphur deposit owned by the Texas Co., attention is called to the growth of the industry in this country by an article in *Financial America* of March 25, 1922. It is believed in trade circles that the arrangement just concluded will have a stabilizing influence over the industry, particularly as it eliminates the possibility of a fourth sulphur company in this country. The Texas Co., it is stated, has been endeavoring for a couple of years to enter upon such an arrangement, and other companies besides the Freeport have also made proposals.

The total sulphur reserves of the Texas Gulf Sulphur Corporation are estimated at over 15,000,000 tons, notwithstanding that in excess of 2,000,000 tons of commercial sulphur already has been taken out of its mines. The Union companies' sulphur reserves are estimated as in the neighborhood of 4,000,000 tons, those of the Texas Co. in the Hoskins Mound at between 5,000,000 and 6,000,000 tons and those of the Freeport Sulphur Co. at around 2,000,000 tons. The Freeport Sulphur Co. has not been operating its mines since April 1, 1921. The amount of sulphur that it had mined up to that time was slightly in excess of 2,000,000 tons, of which there was then above ground 343,609 tons.

Engineers who have been employed to ascertain the facts relative to the extent of the deposits in the Hoskins Mound say that it will probably require 2 or more years completely to develop and equip it and until the first two or three hundred thousand tons have been actually placed on the surface it will be impossible to predict whether the quality of the sulphur will be such as to meet the trade requirements.

Would Increase Chilean Iodine Production

Recently objections have been voiced in Chile against the monopoly which has been exercised for 34 years in the control of the iodine trade, according to the statement of Commercial Attaché C. G. McQueen, of Santiago. Claims are made that the possibility of modern application of iodine to industrial processes would warrant a thorough extraction of the material and the lowering of prices to a commercial scale. The present arrangement requires that all iodine contained in the ore whose extraction is not permitted by the quota assigned the plant must be thrown away and lost entirely. Statements are made that in place of the quantity of iodine now extracted and exported (something over 500 tons annually) from 10,000 to 14,000 tons could be produced if all the iodine contents of the treated ore were recovered.

The advocates of free elaboration and sale of iodine base their arguments on the three following grounds: The greater revenue derived by the government from a greatly increased exportation, even at a lower rate of duty; the possibility of using a free production of iodine and its sale at a fair profit as a means of adding to the revenues of individual producers and lowering the cost of the nitrate of soda to a point which will aid in recovering the ground recently lost to artificial nitrogenous fertilizers; and the liberation of iodine from exclusive use in pharmacy on the presumption that a lower price would encourage its use for other purposes not practiced because of prohibitive cost.

The Piette Coke Oven

By Hector Prud'homme

Vice-President and General Manager,
Belgian American Coke Ovens Corporation

THE Piette type of coke oven was built experimentally for the first time in the United States by the Franco-Belgian Coke Oven Corporation of Brussels, Belgium, at the Carondelet coke-oven station of the Laclede Gas Light Co., St. Louis, Mo. This construction of eight ovens was made for the purpose of a demonstration preliminary to the organization by the Franco-Belgian Coke Oven Corporation of the Belgian American Coke Ovens Corporation. Very minute tests have been conducted on these ovens by the Laclede Gas Light Co. during 30 consecutive days and the ovens have been in regular operation for over 14 months. The Franco-Belgian Coke Oven Corporation has more than 1,500 modern ovens in commercial operation in several countries in Europe. However, the construction in St. Louis, which was made exclusively at the expense of the Franco-Belgian Coke Oven Corporation, was experimental and, therefore, limited to eight ovens.

The efficiency of the new ovens has drawn the attention of experts in metallurgy and gas works of many states of the country. They are regarded by their designer as the coronation of many years of effort toward improving processes for carbonizing coal and the recovery of byproducts. Beyond any doubt these ovens will materially assist toward a more economical utilization of the natural resources of the country.

General Character of the Oven

The Piette oven is of the horizontal type, with vertical flues, transverse regenerators and reversing arrangement. The regenerator chambers run the whole

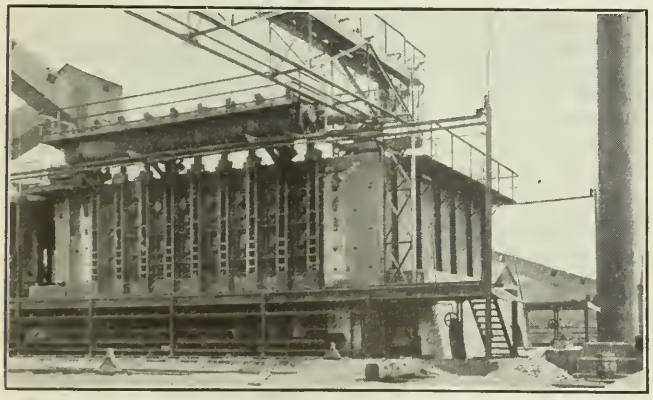


FIG. 1. GENERAL VIEW OF OVENS

length of the battery at right angles to the heating walls and oven chambers. This intercrossing of the walls is designed to give maximum of stability to the whole structure. Arrangements are provided for expansion when the ovens are heated, so that no fractures will occur to interfere with the proper working of the ovens.

Although arranged in longitudinal chambers, the regenerators are actually of the transverse type, and the products of combustion cross through the checkerwork in a direction parallel to the center line of the oven and travel longitudinally only after arriving in the free space of the secondary chamber. The total resistance is thus lowered to 5 or 6 mm. of water-gage, instead of the 30 mm. usual in longitudinal regenerators. In this way the pressures in the oven chambers and heating flues are more nearly equalized, and a maximum of gas-tightness and a maximum recovery of byproducts is assured.

While not essential, the use of a fan for the air supply will tend more nearly to equalize the pressures between the oven chamber and the heating wall, and

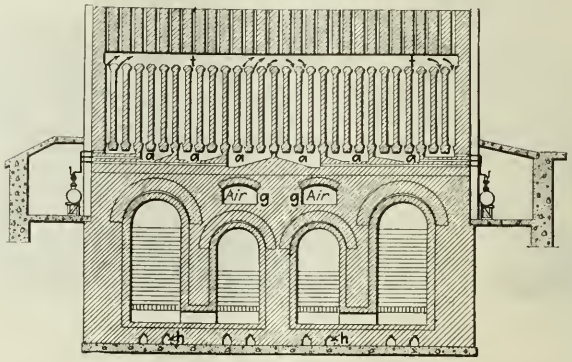


FIG. 2. SECTION THROUGH HEATING FLUES

prevent the passage of gases in either direction as the ovens become older.

Regulation of Gas and Air to Heating Flues

The center-line of the battery divides the heating wall into two symmetrical parts, reversals being made from one half to the other. The space between the sole flues of each half is divided into four chambers *a* (Fig. 2), each fed by an individual gas supply pipe provided with its regulating cock and distributing the gas to four vertical flues. Independent of these cocks, there is also a control cock common to each half-wall. The air for each half is regulated by a damper *r* (Fig. 3), at the inlet to the sole flue *s* (Fig. 3) of the oven adjoining. The area of the air-nozzle for each burner is determined with great care.

This oven may also be constructed, if desired, by arranging the reversal from one group of two or three flues to the next group of two or three, by slightly modifying the method of coupling the vertical flues with the sole flues, and using suitable reversing cocks.

The air for combustion is drawn through flues *g* (Figs. 2 and 3) to absorb the heat radiated downward from the sole flue, as well as through air ducts *h*, to take up the heat radiated downward from the regenerators. Thus preheated, the air arrives at the reversing valve and is there directed alternately into one or other of the secondary regenerators.

The several means of control, to which there is easy

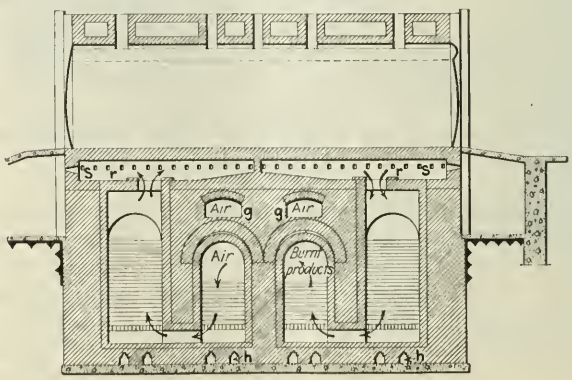


FIG. 3. SECTION THROUGH OVEN CHAMBER

access, enable great regularity of heating to be obtained, at a high, even temperature. The reversal of the draft and the operating of the burner valves are carried out by the working of a single lever.

To make the operation of the oven easy and certain, sight-holes for the examination of every part are provided, one for each vertical heating flue on top of the ovens, one in each half of the sole flue *s;* one in each horizontal flue *t* (Fig. 2) in the heating wall; one in each regenerator chamber. Those who are superintending and controlling the ovens have thus every facility for even heating of the battery at any speed.

Operating Test of Experimental Battery

The dimensions of the eight ovens installed at St. Louis are as follows:

Height of oven chamber	9 ft. 10⅝ in.
Length between doors	37 ft.
Average width	19¾ in.

The ovens were maintained in regular operating condition for the production of coke of good quality and for maximum yield of available gas of high calorific value. The 30-day test was begun after the ovens had been operated for 3 months. The figures in Table I show in more detail the results obtained.

The mixture of coal charged in these ovens during the 30 days of tests was as follows: 65 per cent of high volatile coal (Elkhorn from the Consolidation Coal Co.) and 35 per cent of low volatile coal (Pocahontas from the Cleveland-Western Coal Co. of West Virginia). The average analysis of this mixture was:

	Per Cent
Moisture	4.43
Volatile	29.06
Fixed carbon	61.37
Ash	5.14
	100.00

The yield of coke and the researches as to its nature were made by weighing daily the load of one oven, which was then screened and the samples submitted to laboratory tests. The results are given in Table I. The screening was done on an inclined 2½-in. roller grizzly screen.

These figures show that the yield in available B.t.u. would be, after deducting the B.t.u. needed for heating the ovens, 60.9 per cent of the total quantity of B.t.u. produced. This already very satisfactory proportion does not, however, represent the real power of this system of ovens.

A small number of ovens can, of course, not give the same yields as a bigger battery, of say fifty or sixty or more ovens of the same type. In the case of a big battery the gas used for the heating of an end-wall, which was found to be more than half the amount used on one oven wall for intermediate flues, is distributed over a larger number of ovens and as a matter of course over a larger quantity of the coal distilled. If the heat used in one end-wall is distributed over a battery of fifty to sixty ovens, the average number in a modern battery, the reduction in B.t.u. consumed in comparison with a battery of eight ovens is about 6 per cent. Taking this into account, the calorific balance sheet of the Piette ovens working under the conditions described above at St. Louis is as follows:

	Per Cent
B.t.u. produced, 3,301.7 per lb. of coal	100
B.t.u. in the surplus gas, 2,088.4	63.25
B.t.u. consumed in the heating gas, 1,213.3	36.75

TABLE I—RESULTS OF TESTS

A.	Ovens and coal:	
	Number of ovens charged and pushed	282
	Average coking time	20 hr. 18 min.
	Average load per oven	26,770 lb.
	Total quantity of coal charged in 30 days	7,549,400 lb.
	Average quantity of coal charged in 24 hr. per oven	31,455 lb.
	Average temperature of the smoke at the outlet of the heat regenerators corresponding to 3 8 per cent oxygen or an excess of 25 per cent of air	624 deg. F.
B.	Coke:	
	Total yield of dry coke calculated on coal as charged, per cent	69.19
	Proportion of foundry coke in total coke	38.15
	Proportion of other grades of coke	61.85
	Average analysis of the total coke obtained, per cent:	
	Moisture	1 94
	Ash	6 77
	Fixed carbon	90 33
	Volatile matter	0 96
	Specific gravity:	
	Apparent	0 973
	Real	1 906
	Shatter test	55 57
	Porosity:	Per Cent
	Coke substance by volume	51 03
	Air spaces by volume	48.97
	Total quantity of coke produced in 24 hours in one oven, lb.	21,764
C.	Heating gas:	
	Volume of gas burnt during the 30 days in cu.ft. at 30 in. pressure and 60 deg. F.	20,332,000
	Volume of gas burnt per lb. of coal charged	2,695
	Heating value of this gas (B.t.u. per cu.ft.)	479.3
	Consumption in B.t.u. per lb. of coal charged	1,290.7
D.	Gas produced and B.t.u. available:	
	Total volume of gas produced during the 30 days at 30 in. and 60 deg. F., cu.ft.	44,159,000
	Volume of gas produced per lb. of coal charged in cu.ft.	5.849
	Average calorific value of this gas (B.t.u. per cu.ft.)	564.5
	Total quantity of B.t.u. available per lb. of coal charged (non-debenzolized gas)	3,301.7
	B.t.u. (surplus) available per lb. of coal treated	2,011.0

Average analysis of the gas produced:

	Per Cent		Per Cent
CO_2	1.7	CO	6.1
C_nH_m	3.4	CH_4	29.8
O_2	0.4	N_2	6.8
H_2	51.8		

Average specific gravity at 30 in. mercury and 60 deg. F. 0.39. Yields of byproducts per ton (2,000 lb.) of coal carbonized:

Ammonia (NH_3), lb.	5.63
Tar, dry, gal.	7.01
Benzene (product distilling below 200 deg. C.), gal.	3.42

This consumption is the smallest yet realized in the United States considering the conditions imposed by the tests.

Advantages Claimed for the Piette Oven

The most important characteristics of the Piette oven are:

1. The carbonization chamber and the whole structure are perfectly tight, which has been shown during the St. Louis tests. This, together with a perfect regulation of the heating and the excellent heat regeneration qualities, has permitted the extraction from the coal of the maximum of byproducts.

2. Short-circuits in wall flues have been done away with through the reunion, in two continuous series, of the upward-flame and downward-flame flues. This arrangement acts favorably in the exchanges of heat with the consequence that the work of the regenerators is facilitated.

3. The distribution of the gas in each oven wall by several compartments fed by individual tuyeres, each supplying the gas to three or four flues, permits the regulation of the quantity of gas admitted at every point of the oven in such a manner that it takes into account the effects of the taper and the cooling from outside.

4. The use of fixed regulating sections for the entrance of the air under the soles and the outlet of the burnt gases through the top of the vertical flues, which sections are calculated and confirmed by practice, makes the use of sliding bricks unnecessary. The placing of such sliding bricks is always very difficult for the heater who has charge of them, and it has been found many times that these small bricks remain stuck after some time, which fact prevents a first-class regulation of the

batteries where such device is employed. The unremovable regulation sections of the Piette ovens are superior, because they need no adjustment of any kind and are not exposed to the consequences of the whim or indifference of the heaters. More uniform heating of the oven walls is obtained, as was shown under every kind of running conditions at the new battery at the Laclede Gas Light plant.

5. The fact that the longitudinal regenerators work transversely, and thus establish an automatic regulation of the temperature of the combustion air, assists materially in the equalization of the heating of the several ovens of the battery, an advantage which does not exist in the ovens having individual transverse regenerators. The uniformity of the temperature of all the ovens of the battery which was noted daily at the St. Louis plant was a feature of the tests.

6. The two transversal-conjugated-regeneration galleries on each side of the center line of the battery allow (through a convenient regulation of the sections of the communicating openings existing between the primary gallery and the secondary gallery) for compensating the effect of the drop of pressure in the outlet gallery for the combustion products and for establishing correspondingly a uniform working of the depression for all the ovens. These sections are so calculated and the quantity of checkerwork placed in the secondary gallery is such that they are perfectly sized for the products going out and in the following period for the air coming in through them.

7. The aërating galleries *g* between the soles and the secondary regenerators as well as the galleries *h* under the heat regenerators assure a convenient cooling of the combustion products and a saving of radiating heat through a reduction of this radiation. These advantages were clearly shown during the tests referred to in this article, the air being heated to 200-280 deg. F. before entering the regenerators proper.

8. The stability of the ovens is remarkable. The regenerators are longitudinal to the center line of the battery and therefore perpendicular to the center line of the oven-walls and the arches of the ovens. This intersection of the walls and the ovens makes for a maximum solidity of the mass of the battery. Then the expansion of the linings and of the arches of the regenerators, as well as of the flues connecting the primary regeneration galleries with the sub-sole flues, is rendered completely independent of the general sustaining mass of the battery. The result thereof is that the refractory material which constitutes the sole-oven walls and the ovens are built on an absolutely rigid monolithic block which cannot be deformed. Such a disposition is remarkably advantageous with the silica bricks so extensively used in the United States which expand so much. The system in which the oven-walls proper of the oven are placed on regenerator walls, of which they are a part, can evidently not realize a similar tightness. The unequal temperatures which are found from the foot of the regenerator walls to the top of the oven-walls justify unequal expansions from level to level which cannot but cause cracks.

9. The ovens are easily operated and watched. As explained above, sight-holes are placed all along the passages of the flames and the gases, which are thus made accessible everywhere. The sight-holes placed at the end of the primary regenerators permit an inspection of the top of the checkerwork for the whole length of the battery. The progress of the heating is easily followed by heat coloration and general aspect of the ensemble. This inspection shows whether any oven-wall is being insufficiently heated, due, for instance, to an accidental obstruction of a cock or of a gaspipe.

To these advantages let us add the very special care taken by the builder of this type of oven to avoid anything that may complicate the construction or the operation. The whole oven gives an impression of solidity and simplicity.

The Franco-Belgian Coke Oven Corporation builds other types of ovens also—ovens without heat regeneration, ovens heated from the top of the oven-walls adapted to special kinds of coals, and finally ovens heated either by producer gas or blast-furnace gas. In this article, however, only the type of oven installed at St. Louis is described.

Synopsis of Recent Chemical & Metallurgical Literature

The Strength of Mechanically Welded Pressure Containers.—In a paper published in *Mechanical Engineering*, April, 1922, and to be read at the spring meeting of the A. S. M. E., Prof. R. J. Roark gives the results of an investigation made for the Vilter Manufacturing Co., of Milwaukee, to determine the strength and uniformity of pressure containers with electrically welded head joints. The containers were made of lap-welded pipe and were provided with spherical flanged heads. Their dimensions

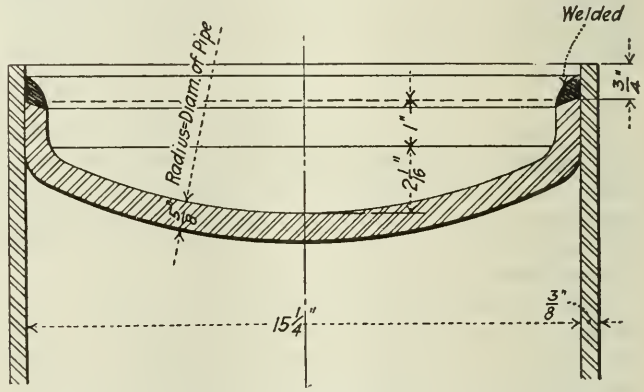


FIG. 1—SHAPE AND DIMENSIONS OF SPECIMEN CONTAINER

are given in Fig. 1. The average physical and chemical properties of the steel used were as follows: Yield point, 38,000; ultimate, 64,000; elongation, 27 per cent; carbon, 0.17 per cent; manganese, 0.44 per cent; phosphorus, 0.010 per cent; sulphur, 0.027 per cent.

It was proposed to determine the absolute strength of such containers by pressure tests on representative samples and to establish a comparison with vessels of like form and dimensions, but with gas welded and riveted heads. The tests were in three separate sets—namely, tests on containers, tests on specimens cut from containers and tests on special specimens of welded metal.

The tests on containers consisted in subjecting the specimen to an internal hydraulic pressure which was gradually increased until rupture resulted or such rapid leakage developed as to make further increase of pressure impracticable. The results of these tests are given in Table I. The values given for maximum shearing stress and maximum tensile stress in Table I do not represent the strength of the material in shear and tension, but simply the approximate shear and tensile stress produced in the welded joint

TABLE I.—RESULTS OF PRESSURE TEST ON CONTAINERS

Specimen Number	Description of Specimen	Pressure in Lb. Per Sq.In. at First Observed Leakage	Pressure in Lb. Per Sq.In. at Disking of Heads	Pressure in Lb. Per Sq.In. at Maximum	Method of Failure	Stresses on Head Joint at Maximum Pressure: Longitudinal shear lb. per linear inch of joint	Radial tension lb. per linear inch of joint	Bending moment inch-lb. per linear inch of joint	Max. resultant shearing stress lb. per sq.in.	Max. resultant tension stress lb. per sq.in.	Remarks
1	Standard commercial container with electrically welded heads, size 16 in. x 10 ft.	1,925 (1,820)		2,150 (2,040)	Longitudinal crack, started at nipple	7,770	870	1,780	9,800	15,000	
2	Standard type container with gas welded heads, size 16 in. x 10 ft.		2,150 (2,040)	2,200 (2,090)	Head forced off	7,960	900	1,820	10,500	16,000	Fracture on section *B-B*
3	Standard type container with riveted heads, size 16 in. x 10 ft.	1,200 (1,120)		2,100 (2,000)	Excessive leakage						
4	Container with gas welded heads and gas welded longitudinal butt joints, size 16 in. x 10 ft. (weld by Le Quelle)			1,600 (1,540)	Split along long. butt weld						
5	Container with gas welded heads and gas welded longitudinal butt joints, size 16 in. x 10 ft. (weld by Vilter)			1,300 (1,240)	Split along long. butt weld						
6	Container with electrically welded heads and electrically welded longitudinal butt joints, size 16 in. x 10 ft.			1,400 (1,340)	Split along long. butt weld						
	Reinforced container with electrically welded heads (3 concentric shells, concrete filled), size 10 in., 12 in., 14 in. x 3 ft. 2 in.		4,500 4,800	(4,800) (4,680)	Head forced off	11,860			18,000		Fracture on sections *B-B* and *C-C*
8	Reinforced container with gas welded heads (3 concentric shells, concrete filled) size 10 in., 12 in., 14 in. x 3 ft. 2 in.	4,350 (4,230)	4,100 (3,980)	4,350 (4,230)	Excessive leakage at weld joints	10,720					
9	Special container with one electrically welded; one head riveted, size 16 in. x 2 ft.	1,750 (1,670)		2,500 (2,390)	Split along lap weld	9,100			11,600	17,600	

by a pressure which caused failure at some other point. In making tests on specimens cut from containers, tests were made for shear and tension. The form and part of containers from which the specimens were cut are shown in Fig. 2. Specimens of Type A were tested in tension, the ends being held in wedge grips. The breaking load, eccentricity at rupture and manner of failure were noted. From these data the computed ultimate stresses on the weld were determined. Specimens of Type B were tested in shear.

The tests on special specimens of welded metal were made with the purpose of determining the actual tensile and shearing strength of the welds.

In conclusion, the author states as follows:

1. *Weak Points in Containers.*—None of the welded containers of standard design failed primarily at the welded head joint. The nature of the fracture shows that the weak points in the containers were, first, the lap weld in

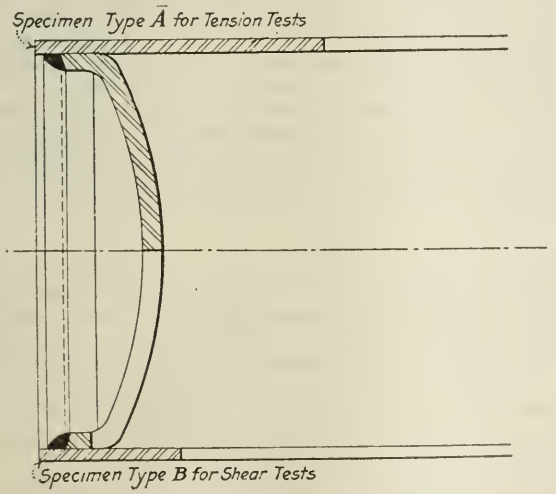


FIG. 2—SHAPE AND LOCATION OF SPECIMENS SUBJECTED TO SHEAR AND TENSILE TESTS

the pipe forming the shell, where failure occurred due to circumferential tension, and, second, the body of the shell at its junction with the head flange, where failure occurred due to the combination of longitudinal tension and bending. It appears that leakage is likely to occur first where couplings and nipples are welded in. This is due to the fact that the metal of the shell stretches and pulls away from the nipple, which does not have a corresponding strain induced in it by internal pressure.

2. *Strength of Electric Welds.* The average tensile strength of electrically welded joints was found to be 28,500 lb. per sq.in. From tests on specimens cut from containers, the average shearing strength of electrically welded joints was found to be 25,500 lb. per sq.in. The mean variation from the average tensile strength per linear inch of weld was found to be 2 per cent, and the maximum variation 4.5 per cent. The mean variation from the average shearing strength per linear inch of joint was found to be 5.2 per cent and the maximum variation 7.8 per cent. The results of eccentric tension tests on specimens cut from containers showed that no one of the specimens was markedly weaker than the average for the lot. It is believed that the uniformity of strength thus indicated is of special interest and importance.

3. *Relative Strength of Electrically Welded and Riveted Joints.* The tension tests on specimens of Type A indicated that the resistance to tension applied with a large eccentricity is greater for the riveted joint than for the welded joint. The shear test on specimens of Type B indicated that the resistance to shear per linear inch of joint is greater for the welded joint. Measurements to determine the elastic and permanent protusion of the container heads showed that for the two specimens so tested the welded container withstood a somewhat greater pressure without permanent distortion. In the case of the riveted containers, leakage occurred at the head joints under moderate pressures. In the case of the electrically welded containers there was no leakage at the head joint under any pressure.

4. *Efficiency of Electrically Welded Joints.* While it is customary to speak of the efficiency of a joint, whether welded or riveted, meaning the ratio of the strength of joint to strength of plates joined, the writer does not believe that this ratio is especially significant in the case of electrically welded joints or that any value can be given it that can be regarded as generally applicable.

It is apparent that while the strength of the plates joined is dependent solely on the physical properties of the base metal, the strength of the weld is in great measure dependent on the properties of the filling metal. Furthermore, the per cent excess thickness of the weld, which influences its strength, varies with the thickness of the plates. Accordingly the efficiency of a weld depends on the properties of the base metal, the properties of the filling metal and the thickness of the plates.

The writer believes that the correct method of computing the efficiency of an electrically welded joint is on the basis of a specified minimum strength of base metal, a specified minimum excess thickness of weld and an experimentally determined average strength (per sq.in.) of the metal of which the finished weld is composed.

Elektron.—Lieutenant-Colonel Grard published a note on "Light Alloys Used in Aëronautics" in Revue de Métallurgie, 1921, p. 567, from which the following notes on the German alloy elektron are extracted:

Elektron contains approximately 90 per cent Mg, 5 per cent Zn and 5 per cent Al. Sheets of a similar alloy of French make test as follows:

Elastic limit, lb. per sq.in.	27,000
Ultimate strength, lb. per sq.in.	36,000
Elongation, per cent	22
Specific gravity (33 per cent lighter than aluminum)	1.8

German alloys are advertised with the following properties:

	Alloy "GM"	Alloy "Z"	Alloy "AZM"
Electrical conductivity	22	17	12.5
Temperature coefficient	0.0038	....	.....
Thermal conductivity	0.38	0.38	.....
Specific heat	0.25	0.24	0.24
Thermal expansion	0.000027	....	....
Melting point, deg. C.	650	635	530
Specific gravity	1.74	1.83	1.84

Lowering the temperature from 20 deg. C. to 0 deg. C. lowers the elastic limit, ultimate strength and elongation all about 4 per cent. At 100 deg. C. the elastic limit is reduced 12 per cent, the ultimate strength 5 per cent, and at the same time the ductility increases.

Elektron shavings are flammable, especially when moist. Masses of metal do not burn until melted. It is not attacked by alkalis except ammonia, but is corroded rapidly by acids, even weak organic acids. It reacts violently to salt solutions, chloride and sulphates of heavy metals. It is perfectly resistant to acid-free petroleum products. It may not be used where it is continually wet; atmospheric corrosion builds up a gray coating. Recommended protective coatings are varnish and condensation products like Bakelite.

Elektron must be separated from copper by sheets of aluminum or of fiber.

Elektron cannot be welded or soldered. Cast ingots can be forged or stamped at 225 deg. C.; and drawn or rolled from 400 to 300 deg. C. Extrusion is performed at 400 deg. C. Annealing is done at 400 deg. C.

Properties of Some Steels in the Hardening Range.—W. R. Chapin[1] has made some interesting tests on some oil- and water-hardening steels which harden to the center in ½-in. sections when quenched from about 1,500 deg. C. The steels were ordinary water-hardening carbon tool steels, of the following approximate compositions: C 1.10, Mn 0.3, Si 0.3; nickel-chromium steels with C 0.9, Mn 0.4, Si 0.16, Cr 0.8, Ni 1.5, and a "non-shrinking steel" with C 0.77, Mn 1.48, Si 0.41, Cr 0.06, V 0.19. He would quench these steels, and remove them from the bath when in the hardening range (400 to 500 deg. F., judging by tempering colors), caliper them and make hardness tests quickly before the steel had cooled very much. It was found that oil-hardening steels in and just above the hardening range were non-magnetic, soft to Brinell impressions[2] (180 to 190) but file hard. They were also shrunken, as compared to the original annealed condition, to the extent of a little more than ¼ of 1 per cent in linear dimension.

Magnetism returns slowly to the steels as the temperature drops; the Brinell hardness also increases greatly. Eventual hardness appears to be unaffected by the rate of cooling below the hardening range, and amounts to 650 ± 25. However, there is less distortion and less ultimate change in volume and a better developed martensitic structure after a very slow cooling from the hardening range; hence the logic of removing from the bath at 300 deg. F. and burying in lime, or immersing it for perhaps 15 minutes in an oil bath at 250 deg. F. Shrinkage observed at the hardening range is more than recovered in subsequent cooling to room temperature, despite the concurrent contraction due to drop in temperature, which alone amounts to 0.25 per cent. Total increase in length due to the transformation is therefore about 0.55 per cent, corresponding to a volume increase of 1.65 per cent.

[1] *Transactions*, American Society for Steel Treating, March, 1922, p. 507.

[2] Brinell impressions are rounded at the edges.

Oil-hardened steels tempered 15 minutes at 250 deg F. remained at 683 Brinell and were file hard. Drawing 15 minutes at 400 deg. F. decomposes some martensite, the Brinell hardness remains practically unchanged, but it can be filed slightly. A second 15-minute draw at 400 deg. F. drops the Brinell hardness 25 points, and the sample files easily. If drawn at 800 deg. F., the steel shrinks 0.20 per cent in length from its hardened state.

Water-hardening steels ½ in. square are magnetic in the hardening range, and are not shrunk in volume. If the thickness be reduced to 0.05 in., the same steel hardens readily in oil, and develops the same characteristics discussed at length in the foregoing paragraphs.

All these facts support the theoretical conclusion that the Ar range is depressed to at least 500 deg. F. by quenching; above that temperature, ductile, non-magnetic gamma iron exists. Below that temperature, magnetic alpha iron, of slightly less specific gravity is stable.

Dr. Jeffries pointed out that the volume change recorded in the interval between hardening range and room temperature was about that which would be computed from the change from the space lattices characteristic of gamma iron to that of alpha iron, less the thermal contraction, and disregarding entirely the contraction due to the formation of Fe_3C from molecular carbon and iron. He interpreted the results to mean, therefore, that the formation of martensite involves the allotropic change in the iron, but not the formation of any cementite.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Nitric Acid Fume Recovery.—The invention describes an apparatus designed to recover the nitric acid fume loss from nitrating operations. The apparatus consists of three brick towers in series packed with acid-proof brick or rings. The fumes are drawn from the nitrators by a fan which discharges into the top of the first tower. The gas passes down through the first two towers, over which there is no circulation, the packing surface merely acting as a condenser. The uncondensed fumes rise through the last tower, meeting a spray of water which removes the last traces. The principle claimed is the precipitation of the fumes by the expansion when they enter the tower and by the large condensing surface of the packing. (1,406,353. W. de Sveshnikoff. Feb. 14, 1922.)

Removing Iron and Titanium From Artificial Aluminous Abrasives. — Addition of carbon to calcined bauxite or emery does not effect complete reduction of iron oxide and titanium dioxide during the subsequent fusion. Nor is it possible to extract these impurities from the crushed product. A preliminary roast with an alkaline compound, however, will leave the impurities in a seggregated state so that they can be extracted with acid. Clarence J. Brockbank, of Philadelphia, outlines the process as follows:

To a bauxite (Al_2O_3, 54.8; combined water, 30.5; SiO_2, 4.5; Fe_2O_3, 6.2; TiO_2, 4.0) is added sodium or potassium carbonate in the approximate proportion of 50 lb. to each ton of ore, the resulting mixture being then roasted in a rotary calciner to a temperature of approximately 1,100 deg. C., which is sufficient to remove the combined water. During this roasting process, the alkali combines with the metallic oxides and the silica, forming easily fusible silicates. The ore from the calciner is next mixed with sufficient coke to effect reduction of silica and iron, due allowance being made for the effect of the carbon electrodes, and the mixture fused in an electric furnace. For the above-described bauxite, coke in the proportion of approximately 22 lb. to 400 lb.

of the calcined bauxite will be found sufficient for reduction purposes.

After fusion, the pig or ingot of fused material is broken down, crushed by rolls to powder and then treated with a solution of sulphuric acid in the following manner:

The crushed grains are placed in a lead-lined wooden tank or other suitable receptacle, and sufficient of a 10 per cent solution of sulphuric acid added to completely cover the mass. Heat is applied by means of a lead steam coil, and the treatment continued for approximately 6 hours, when the material is washed and graded to different sizes of grains. (1,402,714; assigned to the Abrasive Co., Philadelphia. Jan. 3, 1922.)

Cellulose Acetate Solution.—Among the solvents which have been suggested for cellulose acetate is ethylene chlorhydrin, CH_2ClCH_2OH. While the acetate is readily dissolved, the solution is so extremely slow drying that it has not been used commercially. By adding an alcohol and an aromatic hydrocarbon to the chlorhydrin, however, a solvent is formed which will dry rapidly. The mixture may consist of: ethylene chlorhydrin, 5 to 25 parts; ethyl alcohol, 15 to 45 parts; benzene, 60 to 25 parts. To the solvent mixture thus provided the cellulose acetate is then added with stirring, the proportion of the latter to the former depending on the character of the product desired. One part of acetate to ten of the solvent mixture will give a clear, limpid solution, which may be readily poured or applied with a brush and which, upon exposure to the air at normal temperatures, will dry promptly, leaving a transparent film that will remain flexible indefinitely. (1,406,224; Mark E. Putnam and William E. Kirst, of Midland, Mich., assignors to Dow Chemical Co. Feb. 14, 1922.)

Production of Ethyl Alcohol From Acetaldehyde.—In the known processes for the production of alcohol by passing acetaldehyde vapors over a catalyst the yields depend largely on the exclusion of oxygen and acetic acid. But when oxygen is completely excluded from the mixture of gases, the resulting alcohol will often contain ether, which is objectionable in certain uses. If a large excess of hydrogen is used in the process, certain impurities such as CH_4, CO_2 and CO are formed, and of these the carbon monoxide is particularly injurious to the catalyst. According to a recent patent all of these objections are avoided by passing over the contact body a mixture of acetaldehyde, an excess of hydrogen and up to 0.3 per cent of oxygen and then carrying out the process by removing the heat of reaction, at least in part, and after separating the alcohol formed, returning the excess hydrogen to the operation. The temperature is kept between 90 and 170 deg. C., because below 90 deg. the formation of alcohol is slow, while above 170 deg. the decomposition of the acetaldehyde rapidly increases.

The yield under such improved conditions is compared with the results of the complete exclusion of oxygen, in the following table:

	Experiment No.				
	66–67	68	69	70	71
Percentage of oxygen in the gases used	0	0.06	0.06	0.1	0.1
Added water, per cent of the condensed products	0	0	2.6	0	2.6
Yield of alcohol, per cent of the aldehyde	88	92	93	94.8	95.2
Content of aldehyde in the condensed products (in per cent)	2	0.15	0.6	0.08	0 07
Content of ether in the condensed products (in per cent)	3.5	1.5	1.5	0.5	0.5

(1,408,794; Theodor Lichtenhahn, of Basel, Switzerland, assignor to Elektrizitatswerk Lonza, of Gampel and Basel, Switzerland. Jan. 17, 1922.)

Dehydrating Petroleum Emulsions.—A series of patents relating to the dehydration of petroleum oils by the use of an electric current were granted on Jan. 31, 1922, to Ford W. Harris, of Los Angeles, Cal., assignor, by mesne assignments, to the Petroleum Rectifying Co. of San Francisco. As is well known, many oil wells produce an emulsion of oil and water and in many cases the water is present in the form of infinitesimal globules. Many investigators have recognized that by subjecting this emulsion to an electric current there is an agglomeration of the water globules, with consequent removal of the water by settling. In most of previous processes the oil which is being subjected to the action of the current is carried in open vessels in which the treating electrodes are suspended. It remained for this inventor to devise a number of novel ways in which the emulsions could be broken without the necessity of providing a plurality of electrodes.

According to patent 1,405,117 a single containing vessel is used and but a single electric field is employed. The body of the fluid is repeatedly circulated through this field and hence repeatedly subjected to its action. By this means the inventor claims to obtain a large capacity at a small initial expense.

In patent 1,405,118 there is described "an electrical dehydrator comprising a tank, a treater, electrodes, a means for impressing an electromotive force between the electrodes, means for circulating oil from a tank through the treater and back into the tank, a pipe for withdrawing clean oil from the top of said tank, a water outlet pipe for withdrawing water from the bottom of the tank and means for introducing the wet oil to be treated into the tank."

The next patent in the series (1,405,119) provides an apparatus in which the emulsion, while being subjected to the electric current, may be safely heated to temperatures considerably above the boiling point of the lighter constituents. Heating some of the very heavy oils, such as those from 9 to 16 deg. Bé., has been found to be of considerable assistance in the coalescence of the water globules. Patents 1,405,120 and 121 deal, respectively, with a system of water controls for electrical dehydrators, and a closed dehydrating tank in which a body of water is constantly retained at the bottom.

A dehydrating apparatus utilizing a very concentrated electric field of small area and through which the emulsion is passed at a high speed is described in patent 1,405,122. A pair of electrodes in axial alignment gives the field. A vertical pipe forms the outer electrode and an iron chain supported within it forms the inner electrode of a dehydrator described in patent 1,405,123. Another dehydrator comprising a tank in which are disposed concentric cylinders adapted to alternate electric polarity and open at their tops and bottoms forms the basis of the next patent. Patents 1,405,125-127 are modifications of dehydrators previously discussed.

The claim of patent 1,405,128, however, depends on a new principle in dehydration—namely, the magnetic displacement of the current-carrying path. In this invention the currents flowing through the emulsions are formed in a magnetic field which is so arranged that the current path is constantly being forced around, thereby coming into contact with fresh portions of the emulsions, so that the whole mass is rapidly dehydrated. According to another process (1,405,129), the emulsion is forced under pressure through a confined space from which air is excluded and in which static charges are caused to take place. The last patent of this series (1,405,130) describes a dehydration which comprises mixing a coarse emulsion with a fine emulsion and subjecting the mixture to the action of the electric current. Apparently the addition of water in the form of a loose emulsion will often very greatly increase the capacity of the apparatus.

Manufacture of Lead Arsenate.—In order to prevent or substantially inhibit the clustering of particles of lead arsenate and the consequent settling when suspended in water, Robert E. Wilson, of Cambridge, Mass., has suggested the addition of a relatively minute quantity of some organic material capable of serving as a protective colloid. He has shown, for instance, that the addition of ordinary glue in the proportion of 0.005 to 0.5 per cent of the weight of the lead arsenate will produce a product which when shaken up with water shows scarcely any tendency to settle in so far as leaving a clear layer at the top of the mixture is concerned. Without such addition even some of the best products leave a substantially clear layer over the settled particles at the rate of ½ in. per minute. It is claimed that the insecticidal power of the product is unimpaired and that its increased covering power makes the improved product more effective and economical to use. (1,393,474; assigned to Pittsburgh Plate Glass Co. Oct. 11, 1921.)

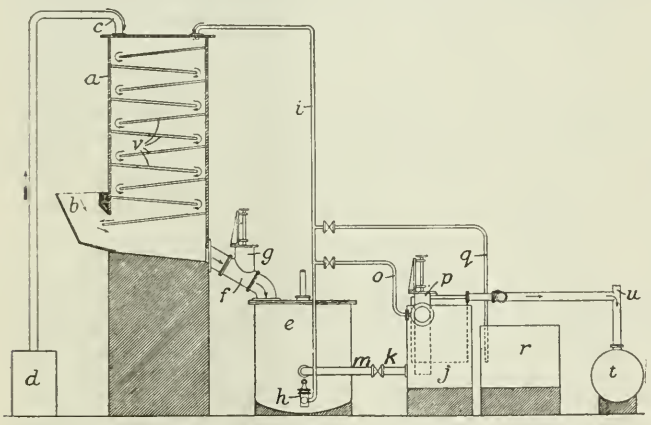
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Fire Extinguisher.—A fire extinguisher contains a self-propelling mixture of methyl bromide with another liquid or other liquids having vapor pressures below atmospheric pressure at normal atmospheric temperatures, such as carbon tetrachloride, trichlorethylene or dichlorethylene, the methyl bromide being sufficiently volatile to cause the mixture to be self-propellant. The liquid may be discharged from the container by means of a valve, etc., or by snapping off a tube which may be indented or cut for this purpose, the end being sealed by flattening it and bending it over after the container has been charged. (Br. Pat. 172,573. A. Henning, London. Feb. 1, 1922.)

Material for Handling Molten Glass.—Apparatus for handling or working molten glass is made of a metal or alloy having a high melting point, not evolving gas when heated and forming an adherent and insoluble coating of oxide which protects it from attack by the molten glass. Alloys of chromium or aluminum with iron, cobalt, and nickel are mentioned. An alloy of 60 per cent iron with 40 per cent chromium in particular is suggested. (Br. Pat. 172,610. Naamlooze Vennootscap Philips' Gloeilampenfabricken, Eindhoven, Holland. Feb. 1, 1922.)

Sodium Thiosulphate.—The production of strong solutions of thiosulphate from which the salt is crystallized without any evaporation as described in specification 12,599 (1915) is carried out by simultaneously forming sodium sulphite from sodium carbonate and sulphur dioxide, and digesting the sulphite with sulphur, sodium carbonate being prefer-



ably maintained in small excess throughout. Sulphur dioxide from a burner *d* is admitted by a pipe *c* to the top of a tower *a* having shelves *v* down which flows sodium bisulphite solution which contains some sodium carbonate or bicarbonate. Sodium carbonate and sulphur are charged in at *b* where carbon dioxide and nitrogen escape. The reaction mixture passes by a pipe *f* carrying a froth destroying device *g* into a digester *e* which may be jacketed for heating or cooling, and is provided with a stirrer.

Liquor from the digester *e* is raised by a pump *h* and supplied by a pipe *i* to the top of the tower *a*. From the pipe *i* a portion of the liquor may be withdrawn by a pipe *o* and fed through a froth-destroying device *p* to a filter tank *j*, but normally the liquor in the digester *e* is circulated to and from the tank *j* through pipes *m*, *k*, under the action of a stirrer. In the tank *j* a number of vacuum filter plates of known form hang, clear solution being withdrawn from the interior of the plates and led to a store tank *t*. The vacuum pump is connected with a pipe *u*. The liquor may be withdrawn from the apparatus by a pipe *q* to an auxiliary filter tank *r* when it is desired to remove accumulated impurities, such as sodium sulphate, which are insoluble in the thiosulphate solution, but alternatively a proportion of the solid materials separated on the filter plates may be continually withdrawn and rejected. The froth-destroying devices consist of a tubular part containing a spindle carrying disks which are perforated and carry downwardly directed vanes to direct the liquid particles downward. (Br. Pat. 172,858. L. Hargreaves and A. C. Dunningham, Middlewich, Cheshire. Feb. 8, 1922.)

Calcium Carbide.—Agglomerates for subsequent conversion to calcium carbide are manufactured by heating a mixture of limestone with pitch, heavy oils or like heavy hydrocarbons to a temperature above 700 deg. C. for a period from 20 to 40 hours. The limestone is preferably ground before mixing and the heating is continued until the carbonizaton is complete. The preferred form of retort enables the carbonization to take place continuously and the gases used to heat the retort are pre-heated by utilizing the heat evolved by the cooling agglomerate. By spraying the latter with a mixture of hot tar and pitch or by introducing coal or coke-oven gases or some hydrocarbon into the retort during the last part of the carbonization, the agglomerate is protected from moist air during storage by a deposit of carbon produced by the splitting up of the hydrocarbon present. (Br. Pat. 172,685. Alby United Carbide Factories, Ltd., London. Feb. 1, 1922.)

Hydrochloric Acid.—In the manufacture of hydrochloric acid by direct combustion of hydrogen and chlorine, an igniting safety flame, preferably produced by burning a mixture of hydrogen and chlorine, is provided at the junction of the streams of the entering gases, which are so arranged as to cause the combustion to take place in a downward direction. The main gas supply is controlled in order to give equimolecular proportions of hydrogen and chlorine. A shaft furnace having means for cooling the walls may be employed for the process and the gases are introduced at the top through two sets of pipes, the one pair surrounding the other. The larger and outer pair supply the main flame and the inner pair supply the small safety jet with hydrogen and chlorine. To effect complete combustion, the reaction gases are passed preferably after partial cooling over or through contact material placed at the lower end of the furnace and consisting of brick, chamotte, pumice, quartz lumps, etc., with or without metals or metal salts acting as chlorine carriers. The resulting hydrochloric acid is withdrawn at the bottom and passed to absorption vessels. (Br. Pat. 173,300. Badische Anilin & Soda Fabrik, Ludwigshafen on Rhine. Feb. 15, 1922.)

Aluminum Salts.—The invention relates to the precipitation of iron from impure solutions of alumina in mineral acids by partly neutralizing the solution in the presence of iron oxide, which acts catalytically. The iron oxide, after being used, is re-activated by treatment with dilute acids or with an acid solution of alumina having a higher hydrogen-ion concentration than that necessary for the complete precipitation of the iron present. The solution from which the iron is to be removed may be used for this purpose, the iron being subsequently completely precipitated by neutralizing, or by expelling acid by evaporation. The activating process may also be combined with the dissolution of the raw aluminous material in acid. Active iron oxide is introduced during the dissolution of the raw material in acid and the quantities are so regulated that the hydrogen-ion concentration is too great for complete precipitation of the iron but is sufficiently low to cause reprecipitation of most of the iron that has been dissolved. Thus active iron oxide is produced, so that if the raw material contains sufficient acid-soluble iron, when the process has once been started no further addition of iron oxide is necessary. (Br. Pat. 172,944; not yet accepted. Aktieselskabet Labrador, Christiania. Feb. 8, 1922.)

Extracting Copper.—Copper is extracted from its oxidized ores or other oxidized products by converting the oxidized copper contents into cement copper by the action of a reducing agent on a pulp comprising a mixture of the crushed ore or product, water and an acid or salt. Finely crushed ore may be mixed with water, finely divided iron and a small proportion of ferrous sulphate, sulphuric acid or a mixture of ferrous sulphate and common salt, and steam blown through the mixture; or such a mixture containing sulphuric acid may be allowed to stand for some days. The separation of the resulting copper from the gangue and slime may be effected by settling, flotation or other means.

Aluminum or zinc may be used as a reducing agent instead of iron. In some cases a medium such as an acid which has been used for one precipitation may be utilized as a salt solution for subsequent precipitations. (Br. Pat. 172,926; not yet accepted. P. W. Nevill and H. Soanes, Perth, Western Australia. Feb. 8, 1922.)

Refining Anthracene.—Crude anthracene is purified by dissolving it in hot cresols or the mixture of phenol and cresols known as 60 per cent phenol, cooling and filtering and washing the separated anthracene with petroleum ether. Carbazol may be separated from the anthracene so purified by dissolving the anthracene in hot pyridine, cooling, removing the separated anthracene and distilling the pyridine solution to recover the carbazol. The carbazol may be purified by crystallization from toluene and sublimation. (Br. Pat. 172,864. A. Kagan, Brighton, Feb. 8, 1922.)

Book Reviews

THE PRACTICAL CHEMISTRY OF COAL AND ITS PRODUCTS. By *A. E. Findley* and *R. Wigginton.* London: Benn Brothers, Ltd. 140 pp., 23 figures. Price 12s. 6d. net.

The authors indicate that the purpose of this work is to present "one reliable method for determination," including particularly those needs of testing which were taught in the course of fuel technology at the Sheffield University. Teachers of gas and fuel analysis will for this reason doubtless find the book of considerable interest, particularly suggestive of those methods which they should include in their own courses.

The volume is not at all suited to general reference use for the industrial laboratory or for the chemist at gas works or coke ovens in this country. For such workers the volume by A. H. White on the "Technical Gas and Fuel Analysis" or the forthcoming "Gas Chemists' Handbook" of the American Gas Association are distinctly superior. The present volume is much too brief and written from entirely the wrong point of view to serve the commercial or industrial laboratory for which the two other works cited are so admirably prepared. R. S. McBride.

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PRECIOUS METALS (LES METAUX PRECIEUX). By *Jean Voisin.* Encyclopédie de Chimie Industrielle, Librairie J. B. Baillière & Fils, Paris, 1922. 264 pp. illustrated.

The first volume of the Encyclopédie de Chimie Industrielle (see Chem. & Met., Dec. 21, 1921, p. 1153) to reach us is that of "Les Métaux Précieux" by Jean Voisin. The author has treated the subject from the point of view of their properties, industrial applications and their economic rôle. The six chapters deal respectively with:

Chapter I, Gold, pp. 1-63, in which are summarized the physical and chemical properties, a brief description of the occurrence of native gold and gold ores, a description of the metallurgical treatments and refining.

Chapter II, Silver, pp. 64-111, in which is followed the same plan as in the chapter for gold.

Chapter III, Platinum and Platinum Group Metals, pp. 112-135, containing brief descriptions on the metals platinum, iridium, palladium, rhodium, osmium and ruthenium.

Chapter IV, pp. 136-151, is a very interesting review of the past and present economic rôle of precious metals.

Chapter V, pp. 152-205, deals mainly with assaying the precious metals used for coinage and jewelry.

Chapter VI, pp. 206-239, contains succinct descriptions of the production of precious metals, salts, gold and silver plating, applications to electrical industries, medicinal uses, photography and platinum as catalyzers.

The bibliography, pp. 241-256, is divided into four distinct groups—namely, (1) historical, (2) physical and chemical properties, (3) mining and metallurgy and (4) refining and applications. J. S. Negru.

ALUMINIUM AND ITS ALLOYS. By *C. Grard,* translated by *C. M. Phillips* and *H. W. L. Phillips.* 184 pages, 17 plates and 83 figures. New York: D. Van Nostrand Co. Price, $5.

"Aluminium," by Grard, is a book for discriminating readers, but they should be able to discriminate between the aluminum and the dross which, unfortunately, clings to the book in spots. One's criticism of the work is tempered, however, by the fact that there is somewhat of a dearth of authoritative books on the subject, and this book is a creditable effort to supply the existing demand for information on the properties and heat-treatment of aluminum and its alloys. According to the title page, the subject is "Aluminium and Its Alloys; Their Properties, Thermal Treatment and Industrial Application," and the principal shortcomings of the book may be traced to the fact that the author's data and selection of data are inadequate to cover the field outlined.

The method of producing aluminum is tossed off in six pages, and statistics on the world's production in another six pages. One wonders, in reading the description of the physical properties of aluminum on page 15, whether the same kind of judgment as used there was exercised in selecting data for the succeeding sections of the book. For example, the atomic weight of aluminum is given as 26.9 instead of 27.0, the thermal conductivity as 36 (silver=100) instead of 51 or 52, and the melting point as "about 650 deg. C," which latter figure is not a very close approximation to 658, considering the state of the art of pyrometry. On a succeeding page the argument would have been just as strong if the melting point of alumina had been given as 2,050 deg. C. instead of 3,000 deg. C. It would have been a kindness for the translators to have called these and sundry other errors to the author's attention in preparing this edition.

In discussing the mechanical properties of aluminum, the author is more at home, and presents some very interesting data obtained for the French Aëronautical Service at various governmental and private laboratories. Quite a comprehensive series of data on the working and annealing of aluminum is given. The author's conclusions with respect to cold work might have been modified if he had obtained more data. The statements that "the maximum cold work, beyond which deterioration and disintegration may set in, is reached when the tensile strength is approximately doubled" and "that 200-300 per cent cold work is the maximum for the working of aluminum" are scarcely precise, to say the least. The tensile strength of aluminum will still be found increasing when the cold work has passed 4,000 per cent as cold work is defined by the author (ratio of the reduction in area to the final area). Aluminum sheet having about 900 per cent of cold work, as thus defined, is a commercial article. The author's curve is defined by four points at 0, 50, 100 and 300 per cent cold work.

In the annealing experiments, the temperatures of the specimens were controlled by immersion in an oil bath or a bath of fused salts. Such a method is much superior in point of precision to the more customary method of heating in an oven or air bath, and the results are correspondingly more reliable.

The second half of the book is devoted to the alloys of aluminum. A useful description of the properties of the aluminum-copper, aluminum-zinc-copper and aluminum-magnesium alloys, as cast, is followed by a section on the heat-treatment of aluminum alloys containing copper and magnesium. The last section of the book deals with the copper-rich aluminum alloys commonly called the "aluminum bronzes." In the appendix will be found the French Aëronautical specifications for high-strength aluminum alloys.

The book is a useful contribution to the metallurgy of aluminum, and is particularly interesting as reflecting the experience and experiments of the French Aëronautic Service. It is not, however, an authoritative work, for the reasons above indicated. Junius D. Edwards.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

No Shortage of Nitrates for Fertilizer, Says Secretary of Agriculture

A statement of the Secretary of Agriculture in reply to a telegram sent to him by Andrew L. Felker, Commissioner of Agriculture for New Hampshire, states his opinion that there is no shortage of nitrates among the fertilizer companies. Mr. Felker complainted that fertilizer companies are unable to get nitrates to fill farmers' fertilizer orders and as a result the latter are seriously handicapped. Secretary Wallace replied in part as follows:

"I am not able to understand the basis for the belief that there is a serious shortage of nitrates and that fertilizer companies are not able to supply fertilizer needs of farmers because of this shortage. Apparently, from the record of imports during the past two years, there has been no shortage of nitrates. The normal importation of nitrate of soda before the war was about 600,000 short tons, and I am told that of this about 250,000 tons were used for fertilizers. In 1920 we imported 1,480,519 short tons of nitrate of soda, or something more than a two years' normal supply. This would have supplied the demand for fertilizers for 1920 and for 1921 and leave a surplus of approximately 200,000 tons for 1922. The fertilizer tonnage for 1921, however, is believed to have been little more than one-half the expected tonnage, and it is therefore reasonable to believe that the nitrate surplus for 1922 was considerably more than 200,000 tons.

"In 1921 nitrate of soda imports amounted to 413,474 short tons. In that year also the War Department released 80,000 tons, making available during that year 493,474 tons, in addition to the more than 200,000 tons of surplus presumably carried over from 1920. In January and February of this year we imported 32,065 short tons. There has been no lack of available nitrate of soda in Chile, for on June 30, 1921, there was said to be a visible supply of 2,435,000 long tons, while the most hopeful estimate of the world demand was about 1,600 000 long tons.

Companies Do Not Buy War Department Surplus

"Now, as to the statement that fertilizer companies are not able to buy nitrates, permit me to call your attention to the fact that on Thursday of last week the War Department offered at public sale 40,000 tons of nitrate, the conditions being that in quantities of 500 tons or more the War Department might reserve the right to demand an equivalent amount of nitrates within ninety days, but sales of less than 500 tons would be considered final sales. I am told that a large number of representatives of fertilizer, powder and chemical companies attended this sale in Washington. In all there were about 11,000 tons definitely sold, but from the report of the sale evidently less than 2,000 tons were bought by fertilizer companies, the remainder of the 11,000 tons going to chemical and powder companies. I do not know why fertilizer manufacturers who are complaining of the difficulty of getting nitrates did not attend this sale and buy when they had an opportunity. One company made a bid for 23,000 tons under the condition which gave the War Department the right to demand repayment in nitrates, but the price bid was considered by the War Department altogether too low, and I am informed that this sale was canceled.

"Reasoning from the statistics quoted in the foregoing, I think you must agree with me that apparently there is no shortage of nitrates to meet the needs of fertilizer manufacturers. Had there been such shortage as seems to be indicated by your telegram it would seem that fertilizer companies would have taken advantage of the offerings of the War Department last week."

Rival Muscle Shoals Offers Discussed—Farm Bloc Backs Development

In testimony before the Senate Agricultural Committee, T. W. Martin, president of the Alabama Power Co., emphasized that the proposal submitted by his company conforms with the provisions of the Federal water power act and if given a lease, the company would operate under the supervision of the Federal Power Commission. The company has prepared a pamphlet embodying the terms of the offer and the letters of comment by Secretary Weeks and Mr. Martin.

The agricultural bloc of the Senate, composed of an influential group of Senators determined to secure legislation in the interest of the agricultural industry, and which has heretofore scored numerous legislative successes, has come out strongly for the development of the nitrate project. In a Senate speech, Senator Capper, of Kansas, chairman of the bloc, said the organization favors the development of the project, as it will contribute to a permanent and prosperous system of agriculture. He believes that work should be resumed on the fertilizer and power plants on the Tennessee river, and says it is possible to reduce the nation's fertilizer bill from $250,000,000 to $125,000,000 if the Muscle Shoals program is carried out.

One of the first decisions reached by the House Committee on Military Affairs was to eliminate Dam No. 3 and the Gorgas steam plant from any present consideration. It is the intention of the committee to present an inventory of all unencumbered property which the government has at Muscle Shoals. This list, along with certain decisions of the committee, will be presented to those who have made bids and each will be given an opportunity to modify his offer to conform. The committee now is engaged in an examination of the Ford offer.

Speaking before the Kiwanis Club in Detroit, Ernest G. Leibold, personal secretary to Mr. Ford, dwelt on the theme that the world has reached a stage where gold can no longer function as an international medium of exchange. He pointed out Mr. Ford's scheme to raise the $30,000,000 for the completion of the project by the issuance of special currency which will be retired in 25 years by the accumulating 4 per cent interest that Mr. Ford wishes to pay annually, "without one dollar of interest having been taxed on the public."

Structural Steel Society Disbands Because of Depression and Government's Attitude

After 11 years of activity the Bridge Builders and Structural Society will disband at the end of this month, according to a recent announcement from its headquarters in New York. The society has been one of the so-called open-price associations whose purpose has been to spread the information among members of the prices at which the structural steel fabrication projects were taken. The decision to disband was made because of doubt as to the government's attitude toward the society and its practices and to the depression in the steel industry in 1921. Besides the open-price discussions, one of the activities of the society has been the gathering of monthly statistics as to the amount of fabricated steel contracted for throughout the country. These figures are taken by steel experts as one of the barometers of the steel industry. The Structural Society has volunteered to continue this latter work.

The decision to disband has been known in inner circles for several weeks. Prices have not been exchanged since the first of the year. The membership embraced the leading independent steel fabricators.

Regulating the Activities of the Trade Association

Of late the attention of the business public has been focused on the trade association. It has been recognized as an element of growing importance in our industrial program, but with this realization has come the need for a better understanding of its activities, particularly those in which perplexing legal questions are involved. The discussions in the newspapers and technical press by lawyers, economists and business men have served to clarify certain of the relations of the trade association to industry. It remained for the recent Trade Association Conference held under the direction of Secretary Hoover to emphasize the desirability for defining the government's relation to the trade association.

The Edge-McArthur Resolution

It was with this in view that Senator Edge of New Jersey and Representative McArthur of Oregon introduced legislation in Congress for the purpose of definitely establishing the status of the trade association. They proposed a Congressional investigation by a commission composed of three Senators and three Representatives which by next December should report legislation defining the rights and limitations of co-operative organizations as distinguished from illegal combinations in restraint of trade. The resolution points out that business is now hesitating because it is unable to secure guidance which will clearly indicate proper lines of conduct.

The Edge and McArthur bills, which supplement their joint resolution, propose that trade associations shall be under the jurisdiction of the Federal Trade Commission. Unless excused by it, each association would be required to file with the Federal Trade Commission a statement of its general character and proposed activities, the names and addresses of its members, officers, minutes of meetings and resolutions or agreements, expressed or implied, whether between members of the association or between the association or its members and others.

The bills would also require trade associations to file with the commission statistics collected by them as to production, shipments, stocks, contracts, prices, credit information, and all others respecting the trade. The commission may, if it sees fit, give publicity to such statistics for the public interest, and unless prohibited by the commission the association may distribute among its members statistics which have been filed with the commission.

Resolution Is Sidetracked in Senate

The resolution was introduced to the Senate on April 17, but met with considerable opposition. Senator King of Utah expressed the fear "that the business men and manufacturers of the country, profiting by their experience in the war, when we winked at combinations in restraint of trade and destructive of competition, want to perpetuate that condition and want the government to modify the Sherman anti-trust law so that they may organize to throttle and destroy competition and build up gigantic monopolies."

Senator Hitchcock, failing to see the need for the investigation, declared that no other of our laws has been as thoroughly defined by the courts of the United States as the anti-trust law. Senator Edge contended, however, that the Supreme Court's decision in the case of the Hardwood Manufacturers Association has left industry in a state of acute legal and economic uncertainty.

Further opposition was developed by Senator Cummins, who had helped to frame the original Federal Trade Commission act. Finally Senator Walsh of Montana urged that the resolution should be referred to the Judiciary Committee, and since there was no objection it was so ordered.

On April 19 the resolution was again brought up, but by a vote of the Senate it was displaced by other business. Senator Edge then gave notice that he would ask the Judiciary Committee to hold public hearings on his bill. It is reported, however, that Chairman Nelson of the Judiciary Committee is not inclined to order hearings at this time, in which case there is but little chance of the resolution being revived.

Gains From Open-Price Associations Are Greatly Exaggerated

Trade association practices which come under any suspicion whatever constitute such a small percentage of the benefits accruing from the work of these organizations that there is no justification for the continuance of questionable activities. This point was brought out strongly at the Trade Association Conference held at the Department of Commerce. It was shown that only seventy out of 3,000 organizations can be classed as out and out open-price associations. Even among the open-price associations the opinion was expressed that 90 per cent of the benefits to members come from other activities. One of the conclusions that may be drawn from the meeting is that the value of so-called open-price statistics has been exaggerated.

While it was brought out clearly at the meeting that the legality of open-price statistics has not been passed upon and that associations doing such work cannot be denounced as lawbreakers, particularly when their figures are made public, yet it was made perfectly plain that the Department of Commerce will not co-operate with that type of organization. No one will be surprised if the Department of Justice should institute proceedings against such associations. At any rate, the Department of Commerce is not going to jeopardize its usefulness to other trade associations by co-operating with those which are operating within the twilight zone.

Hoover Favors Publicity but No Governmental Control

In this general connection, those high in authority are impressed particularly with the inhibition against secrecy which runs through the opinion of the Supreme Court in the Hardwood Lumber case. Since the Supreme Court seems to aim particularly at statistics which are available to members only of associations, the Department of Commerce is interested in giving evidence that publicity is taking place. There is no desire on the part of the department, Secretary Hoover points out, to force any association to file its figures with his bureaus. In fact the department is entirely out of sympathy with legislation giving actual control over any trade association activity. There are a few instances, one of which is in the chemical industry, where statistical information as to important basic commodities is refused by manufacturers. It is admitted that legislation may be required to remedy that situation.

The Department of Commerce has on file a long list of the constructive things which trade associations can do. The list is growing. It is believed that its growth will be accelerated as trade associations realize that they have been covering only a portion of their field. Heretofore attention has been concentrated largely on matters intended to accelerate production. Very little has been done toward improvement in distribution—an area that should be closely studied. Sight also seems to have been lost of the fact that no restraint of trade is involved when buyers and sellers get together. Were trade associations to arrange for committees of buyers to confer with committees of sellers, it is believed that much waste could be eliminated and the spread between the price obtained by the producer and that paid by the ultimate consumer could be narrowed materially.

Chemical Plant Equipment Manufacturers Meet to Organize Association

Plans for the organization of an association of chemical plant equipment manufacturers will be consummated at a meeting to be held at the Chemists' Club, New York, on May 10 at 10 a.m. After completion of the details of organization, plans for future activity will be discussed, at which time representatives of the Chemical Exposition, the Boston Textile Show, the New York Automobile Show and the Ice Cream Supply Dealers' Association will be heard. Representatives of firms who may become members of the new organization are invited to be present at these meetings.

Patent Working Clause Hearings Postponed

Hearings on pending legislation requiring the operation of patents which were scheduled to reopen before the Senate Patents Committee on April 18 have been postponed to a date to be announced later. The explanation offered is that with the tariff bill before the Senate members of the committee cannot take the time to study such an important proposal as is embodied in the Stanley bill.

Original Purpose of Dye Investigation Lost In Discussion of Embargo System

Sight seems to have been lost of the monopoly charges made against the domestic dye industry in the investigation being conducted by the Shortridge sub-committee of the Senate's Judiciary Committee. During the past week the hearing has resolved itself largely into a discussion of the respective advantages and disadvantages of the selective embargo system.

The questions asked consumers of dyes usually reveal that the witness is impelled by a desire to get dyes at the lowest possible price. These witnesses frequently are embarrassed by efforts to explain their position. If they were allowed to take advantage of the prices Germany is willing to make at this time, it is brought out repeatedly, they soon would be left to the tender mercies of the manufacturers in that country, who would not be restrained as they were formerly by the fear of possible American competition. If after all the expenditure of capital and effort and after the advantages which have come from 8 years of embargo, it is found impossible to build up a dye industry in this country, it is certain no other effort will be made if this one fails. It has been brought home to the consumers of dyes several times during this hearing that instead of placing obstacles in the way of the development of the domestic industry, they above all others should be interested in encouraging whatever steps are necessary to insure its permanency. Witnesses for the consumers dislike to talk about the value of the dye in relationship to the selling price of the article into which it enters. One witness refused point-blank to put such prices into the record. In several instances these witnesses were not closely in touch with the situation. The American control over imports was blamed for delays caused by the strikes in Germany. On the whole their testimony has been theoretical.

Textile Representative Denounces Embargo

Ward Thoron, treasurer of the Merrimack Manufacturing Co., of Lowell, Mass., and Huntsville, Ala., manufacturer of plushes, velveteens, corduroys, moleskins and fustians, declared that the embargo puts an intolerable burden on the textile trade. He expressed the conviction that unless the dye industry can get along without the embargo and licensing system, the American dye users cannot afford to continue to patronize it. "American manufacturers must abandon the dyes they cannot make without more protection," he said. "I don't object to a tariff of 100 per cent protection," continued the witness, "but I do object to the license and embargo system. If these people can't manufacture at 100 per cent protection, let them perish."

When the witness was requested to show the proportion of the cost of dyes to the selling price of his goods, he declared, "That I absolutely refuse to do. It has nothing to do with the costs. The selling price varies from time to time and depends upon supply and demand."

Senator Shortridge attempted to bring the testimony back to earth by asking the witness his opinion as to the existence of a monopoly, but his ideas on this subject seemed vague.

Mr. Thoron said that a group of Massachusetts textile men had, in July, 1921, addressed a circular to a number of dye users asking their opinion on the embargo system. The result was sixty-three replies against and thirteen in favor of the selective embargo system. "Frankly," he added, in closing his testimony, "I dislike the teamwork among the Chemical Foundation, the bureau of investigation of the Alien Property Custodian's office, the Textile Alliance and the American Dyes Institute with the dye manufacturers. It augurs no good to the dye users."

F. S. Dickson, head of the dye and chemical section of the customs division, Treasury Department, expressed the opinion that some of the complaints of the textile men against the embargo were due to lack of funds to maintain a laboratory and a trained technical staff. Mr. Dickson thought that some arrangement might be worked out later whereby importers might keep surplus stocks of foreign dyes on hand.

King Still Wants Examining Counsel

A letter was read into the record from Senator King in which he reiterated his statement that the committee should have counsel to examine witnesses and mentioning Samuel Untermyer as the logical man for the job. Senator King also replied to suggestions that he should cross-examine witnesses himself, saying that he doubted the propriety of such a procedure, inasmuch as he had introduced the resolution calling for the investigation.

Charges of Falsified Invoices Against I.G.

Charges, accompanied by documentary evidence, that the German dye monopoly has falsified consular invoices for the purpose of furnishing dyestuffs to importers in this country at prices less than those charged for the reparations dyes by the Textile Alliance are contained in a letter under date of April 11 from A. M. Patterson, president of the Textile Alliance. Under the emergency tariff, duty on the reparations dyes is assessed on the home consumption price or the export price, whichever is higher. It is therefore necessary to have the German manufacturers certify in the consular invoices the export price, as well as the home market price. By certification of erroneous prices in the consular invoices, the dyes were subject to excess duties for overvaluation and penalties for undervaluation, neither of which is recoverable.

The letter submitted consular invoices of the Bayer Co. showing that the company sold alizarine blue-black B to the Textile Alliance at $2.85 per kilogram but to a United States importer at $1.87. The shipment to the importer was undervalued and a similarly worded invoice with different figures and signed by the same signature of the Bayer Co. was sent to the Textile Alliance.

Knitting Mills Not Represented in Alliance

George Deming, counsel for the National Association of Hosiery and Underwear Manufacturers, appeared in opposition to the embargo. Mr. Deming will be remembered as having handed Senator Shortridge a letter attacking the conduct of the hearings some weeks ago. The substance of this letter was later repudiated by J. N. McCullaugh. manager of the association.

The two principal reasons for his clients' opposition to the embargo are, first, that it increases production costs and, second, that there is no sound justification for singling out the dye and organic chemical industry as the only beneficiary of special protection. If the embargo is applicable to the dye and chemical industry, it is more applicable to other American industries, he declared.

In answer to questions, Mr. Deming said he believed that competition exists among manufacturers at the present time, and that the administration of the embargo is honest and plays no favorites.

Mr. Deming's testimony was interrupted several times by Samuel Isermann, president of the Chemical Co. of America, who demanded to know who pays the witness. The lawyer replied that he was not paid by the association but by some of its members and other consumers of dyes. The embargo was attacked by the witness as hampering, restrictive and involved with red tape. He also attacked the Textile Alliance, declaring it presumptuously took upon itself the self-imposed task of speaking for the entire textile industry when from 2,600 to 2,700 knitting mills, constituting an important part of the textile industry, were not represented in the Alliance.

Some of Mr. Deming's remarks precipitated a discussion as to the quality of American dyes, Dr. Isermann declaring that American dyes are at least equal in quality to any others for dyeing hosiery.

Infringement Suit on Stainless Steel Against Ludlum Steel Co. Dismissed

The suit of the American Stainless Steel Co., of Pittsburgh, alleging infringement by the Ludlum Steel Co., Watervliet, N. Y., of the Brearley and Haynes stainless steel patents, has been dismissed by the United States District Court at New York. The court on April 13 issued a lengthy decision dismissing the complaint on the ground that no infringement was shown.

The Brearley and Haynes patents cover high-chromium, low-carbon steel for producing stainless cutlery. The Ludlum Steel Co. has patents covering chromium-silicon alloy steel. The Ludlum steel, although high in chromium, contains less chromium than the steels put out under the Haynes and Brearley patents. The Ludlum steel is low in carbon, as are the steels made under the Brearley and Haynes patents, but it runs high in silicon, unlike the Brearley and Haynes steels. In its complaint the American Stainless Steel Co. alleged that the Ludlum company's steel constituted an infringement of the Brearley and Haynes patents, claiming that the addition of silicon was made in order to evade the two patents and had no effect upon the stainlessness of the steel. The Ludlum Steel Co., in defending the action, denied that it used silicon to evade the Brearley and Haynes patents, but claimed that the addition of silicon made the product a different and better one.

The court held that the Ludlum steel without the silicon would not constitute an infringement of the Haynes and Brearley patents; that without the silicon the steel would not become stainless upon hardening as disclosed in the two patents and that the addition of silicon to the steel, while making it stainless, could not create infringement, because the stainless result was obtained by something not disclosed in the Haynes and Brearley patents.

The court did not pass upon the validity of the Brearley and Haynes patents, but merely held that the silicon-chromium steels of the Ludlum Steel Co. do not infringe.

Pittsburgh Meeting, American Society for Steel Treating

Technical sessions as follows are planned for this occasion to be held at the auditorium of the Pittsburgh Station, Bureau of Mines, located in Schenley Park:

THURSDAY, MAY 25, 1:30 P.M.

Professor McIntosh, Carnegie Institute of Technology, "Fiber in Steel and Iron."

W. B. Crowe, metallurgist, Carnegie Steel Co., "Mass Influence on Heat Treating."

FRIDAY, MAY 26, 1:30 P.M.

Mr. Cox, R. D. Nuttall Co., "Abrasive Qualities of Carbon and Alloy Steels."

J. A. Succop, Heppenstall Forge & Knife Co., "The Importance of Properly Heating and Cooling Steel."

Mr. Smith, Union Spring & Manufacturing Co., New Kensington, Pa., "Manufacture of Springs."

Mr. Grossman, Electric Alloy Steel Co., Youngstown, Ohio, "Shrinkage of High-Speed Steels."

A banquet will be held at the University Club Thursday evening, and a smoker at the Bureau of Mines Friday evening. Opportunity will be extended to visit several steel mills and manufacturing plants.

Would Extend Maryland Clay Workings

The Commercial Club, Frostburg, Md., has concluded arrangements with the Bureau of Mines, Washington, D. C., for a complete and exhaustive investigation of clays in Allegany County, particularly in the western section, in the vicinity of Frostburg. Clay from this district has been used for many years past for the manufacture of brick, as well as hollow tile and certain other burned clay products, but it is believed that the forthcoming investigation will indicate a wider range of use for the material, showing the commercial value for other clay products. The clay mines are adjacent to extensive coal properties, making unusually fine plant site conditions.

Western Reserve University Offers Summer Courses in Chemistry

Announcement has been made by the Western Reserve University of a series of courses in chemistry especially designed for teachers and for students desiring work of senior college or graduate grade. These courses will continue for 6 weeks, from June 19 to July 29, and will include studies in general inorganic chemistry, chemistry of the metals, organic chemistry, qualitative and quantitative analysis, chemical microscopy, glass blowing and applied electrochemistry. Further information may be obtained by addressing the registrar, Cleveland School of Education, Cleveland, Ohio.

Harding Shows Interest in Activities of Federated American Engineering Societies

The work of the Federated American Engineering Societies was discussed April 11, when Mortimer E. Cooley, the president of the Federation, and L. W. Wallace, its executive secretary, conferred with President Harding. The President showed keen interest in the organization and recalled the part which Secretary Hoover took in its formation.

Dean Cooley outlined the work that the Federation plans for the immediate future and called the attention of the President to a list of the activities which have concerned the Federation since its foundation, 17 months ago. The list is as follows:

Investigation of industrial waste; participation in the settlement of jurisdictional disputes among unions of the construction industry; study of the relative merits of the eight-hour and twelve-hour shifts in continuous process industries; actively supported Patent Office relief bill, topographic survey bill, business cycle bill, railway transportation bills, and legislation providing a commission status for sanitary engineers of the U. S. Public Health Service; study of the Muscle Shoals and Great Lakes-St. Lawrence waterway projects; participation in the Unemployment Conference's investigation of business cycles; participation in the activities looking to the reorganization of the federal government's executive departments, including the bill providing for a Department of Public Welfare, and particularly proposals looking to the establishment of a Department of Public Works; participation in numerous conferences called by the Department of Commerce.

Institute of Metals

A joint meeting of the Institute of Metals Division of the A.I.M.E. and the American Foundrymen's Association will be held in Rochester, N. Y., June 5 to 9, 1922. (Headquarters at Powers Hotel.) A preliminary announcement of the technical program includes the following:

"Physical Properties of Cartridge Brass," by C. Upthegrove and W. G. Harbert, of the Department of Chemical Engineering, University of Michigan, deals with the effect of annealing and rolling.

"Electrical Properties of Nickel and Monel Wires," by M. A. Hunter, F. M. Sebast and A. Jones, of Rensselaer Polytechnic Institute.

"Blue Constituent in Manganese Bronze," by E. H. Dix, Jr., Air Service, U. S. A., at Dayton, Ohio, shows the effect of this little known constituent as determined by experiments at McCook Field.

"Gas Absorption and Oxidation of Non-Ferrous Metals," by Bruno Woyski and John W. Boeck, metallurgists of the Lumen Bearing Co.

"Testing Artillery Cartridge Cases," by J. Burns Read and S. Tour. It summarizes, as far as possible, the metallurgical information and experience gained by the Ordnance Department during the war on the manufacture of artillery cartridge cases, describes the tests to which the cases were put, and summarizes the knowledge and experience gained in this testing.

Upon publication, copies of these papers will be mailed to interested parties who send a request to the secretary of the Institute, 29 West 39th St., New York City.

N. J. Chemical Society on Record for American Valuation—Harkins Talks on Isotopes

At a well-attended meeting of the New Jersey Chemical Society in Newark, N. J., on April 17, all the officers were re-elected for the coming year by unanimous vote. A lively discussion on the chemical schedule of the tariff bill was precipitated by a resolution introduced by N. W. Haynes, editor of *Drug and Chemical Markets*, urging the adoption of rates based on American valuation. The resolution was amended and adopted in the following form:

"Therefore, be it resolved that we, the members of the New Jersey Chemical Society, do urge upon Congress the adequate protection of the chemical industry by the prompt adoption of tariff schedules on chemicals based upon American valuation except those chemicals already adequately protected by an embargo."

W. D. Harkins, professor of chemistry at the University of Chicago, addressed the meeting on "Isotopes and the Structure of Atoms." Prof. Harkins gave a sketch of developments which led up to the discovery of isotopes and showed a number of photographs of the path of alpha particles emanating from radioactive substances and the disintegration of the atom. He also described the apparatus and method used for isolating the isotopes of chlorine and mercury and showed how the atomic weight of the elements depends upon the number of isotopes which form the atom.

Prof. Harkins explained his whole number rule, which may be stated very simply as follows: The atomic weight of any pure isotope, with the exception of hydrogen, is almost exactly a whole number. It is evident that, if this rule is valid, any element of which the atomic weight is not a whole number must consist of two or more isotopes. With the aid of a chart showing the atomic number and atomic weight of all the known isotopes, he explained the method used for predicting the number of isotopes and their atomic numbers that an element should have.

Prof. George B. Pegram of Columbia University and Prof. George Winchester of the State University of New Jersey led in the discussion which followed.

Tentative Program Announced for Atlanta Meeting of A.S.M.E.

The tentative program for the spring meeting of the American Society of Mechanical Engineers, which is to be held in Atlanta, Ga., May 8 to 11, includes a number of features of interest. Headquarters will be established at the Piedmont Hotel, and numerous social features and excursions to points of local interest will be interspersed in the technical sessions. A discussion of the Muscle Shoals nitrate plant and the nitrogen supply by Major J. K. Clement will feature one of the general meetings. A paper on centrifugal castings will be presented by Leon Cammen at the same session, and W. K. Lewis will submit a paper on the evaporation of a liquid into a gas. Among the subjects scheduled for the power sessions are "Power Development in the Southeast," by Charles G. Adsit, "Economics of Water Power Development," by C. A. Mees, and "New Developments in Hydro-electric Design," by J. A. Sirnit. A symposium on welding will be held at which will be presented a number of papers dealing with the strength of electrically welded pressure containers and other phases of the subject. Plans for the entertainment include a visit to Muscle Shoals.

A.I.M.E. Co-operates With Government in Survey of Mineral Resources

Mining engineers who have specialized in war minerals are to be designated to co-operate with army officers in the study of the strategic mineral situation in the hope that peace-time activities can be directed along lines which will contribute most to the national defense in case of an emergency. The entire subject of war minerals was discussed in Washington last week by Pope Yeatman, J. E. Spurr, George Otis Smith, H. Foster Bain and Arthur S. Dwight, who are members of the committee of the American Institute of Mining and Metallurgical Engineers requested to co-operate with the War Department.

New Infringement Suits by Patentee Claiming Interest in Minerals Separation Patent

Infringement suits have been brought against the Kennecott Copper Co., the Nevada Consolidated, Ray and Chino companies, with home offices in Maine, and Federal Mining & Smelting, Belmont & Wagner, Calaveras Copper Co., and Miami Copper Co., Delaware corporations, by J. W. Wolf, for infringement of his patent No. 787,814, April 18, 1905.

It is explained that the delay in bringing infringement suit until within a few days of the expiration of the patent has been due to the fact that Mr. Wolf was financially unable to undertake the prosecution of such suits, and also that it had not been possible for him to ascertain the facts as to the operations of those who had been using his process.

A few months ago Mr. Wolf brought a suit against his financial principals, alleging that it was through their failure to carry out the terms of their contract that he was deprived of enormous royalties which were then being paid to others—namely—Minerals Separation, Ltd. It is an interesting fact that Mr. Wolf went to Sulman & Picard, as consulting independent engineers, to have them develop the details of an improvement in bulk oil process for the use of sulpho-chlorinated oils, in the year previous to the issuance to Sulman, Picard and Ballot of the now famous Minerals Separation patent.

More Engineers Being Employed

Distinct improvement in the unemployment situation in the engineering profession is reported by the Federated American Engineering Societies' Employment Bureau, 29 West 39th St., New York. During the first quarter of this year 778 available positions were sent to the bureau, as against 347 for the same period in 1921. The number of men placed showed an increase of 41 per cent, rising from 293 during the first 3 months of last year to 415 during the quarter just passed. The number of new men registering with the bureau fell from 552 last year to 421 during the first 3 months of this year.

Many of the positions available are in the junior grades, but there is an increased number noted in the higher grade openings which are sent in, practically unheard of at the same time last year.

The gradually increasing activity does not appear to be confined to any particular line, but is more or less general. The architectural field seems to be fairly busy, and building construction shows somewhat of an onward trend. General manufacturing indicates slow improvement. There are many large projects which are rapidly reaching the definite stage, and some big work will probably be opened up within the next few months.

It is stated that business men are gradually realizing that the engineer is not a narrow specialist, but is a trained man capable of handling a non-technical job.

English Ceramic Society Plans Tour Through Scandinavian Pottery Plants

The Ceramic Society of England has arranged a tentative program for its foreign trip to Sweden and Denmark which is to take place from May 27 to June 10, 1922. The trip will include visits to potteries at Gothenberg, the power plant, carbide, graphite and smelting plants at Trollhättan, "the Swedish Niagara Falls," and the works of the Kopparbergs Bergslag, which is the largest private works in the country and manufactures iron, steel, paper, copper and timber. Visits will also be made to the universities and schools at Upsala and Stockholm and the pottery plants in this vicinity. The refractory brick plants at Höganäs and near Copenhagen will entertain the visitors, as will the china works around the city. The party will return to England from Copenhagen.

A special train will be provided to carry the party from town to town, so that early morning starts will not be necessary. Considerable time is left open so that members will have opportunity to visit points of individual interest.

French Societies Move to Assure Funds for Compilation of Annual Tables

The confederation of French scientific societies has renewed for the year 1922 its contribution of 40,000 francs in support of annual tables of constants and physical, chemical and technological data. The total subscription in France to this project during the year 1921 was 80,000 francs.

At the approaching meeting of the International Union of Pure and Applied Chemistry which is to be held at Lyons in June, the matter of organizing the work of annual tables upon a solid financial basis will come up for consideration. This important international project has had a very precarious existence since 1914 and the fact that the work has been continued at all has been due to the efforts of the general secretary, Dr. Charles Marie. Plans for providing a certain and sufficient budget for the work during the next 5 years are in preparation, based upon definite annual contributions from the various countries in the International Union.

Fellowships in Mining and Metallurgy Announced by University of Utah

Announcement is made by the department of mining and metallurgical research of the University of Utah of a number of fellowships in that department during the year 1922-23. This department is maintained in connection with the Utah Section of the United States Bureau of Mines and is a department of co-operative research maintained by these two organizations. The problems which are to be continued during the coming year include ore-dressing problems dealing with crushing and flotation, study of the chemical reactions involved in the chloridizing roasting, oil-shale technology, hydrometallurgy of zinc and problems inherent in the chloridizing volatilization process, including equilibrium measurements and fume treatment.

These fellowships are open to college graduates with a good training in chemistry and applications will be received for them up to May 15, 1922. Applications should be addressed to J. F. Merrill, Salt Lake City, Utah.

Newly Organized Company Will Erect Large Pulp and Paper Mill in Canada

The Bathurst Company, Ltd., has been organized with a capital of $3,000,000 for the purpose of taking over 200 square miles of timber limits, east of Prince George, B. C., and establishing a paper and pulp factory that will have an output of 150 tons per day and will give employment to close to 1,000 men. Among those interested in the new organization are Angus and H. K. McLaren, of Montreal; Frank Jones, of the Canada Cement Co.; Peck Bros., of Pennsylvania and Lord Beaverbrook, who owns the *Express* and several other papers in England. The construction of the plant is to be started about June 1. The organization of the company has been in contemplation for some time, and a number of concessions have been obtained from the British Columbia Government. When completed it will be the largest single pulp and paper concern in the province.

New Bureau of Mines Publication on Preparation and Uses of Tar

The issuance of Technical Paper 268, "Preparation and Uses of Tar and Its Simple Crude Derivatives," by W. W. Odell, fuel engineer, is announced by the United States Bureau of Mines. This paper discusses the uses to which some of the various tars are put and shows briefly the usual methods of working up tar into some of its simple or easily prepared derivatives. Although coal tars are given chief consideration, the properties and characteristics of water-gas tar are mentioned. This publication is not a handbook on tar distillation, but is published by the Bureau of Mines as a general treatise on the utilization of tar.

It may be obtained by addressing the Bureau of Mines, Washington, D. C.

New Power Map of Pennsylvania Shows Stations and Lines of Public Utilities

A map of Pennsylvania showing the location of the power stations and electrical transmission lines used by public utility companies has just been published by the United States Geological Survey, Department of the Interior.

This map is the second of a series now being published, that of New York having been recently issued. Two other maps are nearing completion, one covering New Hampshire and Vermont and the other covering Massachusetts, Connecticut and Rhode Island, and maps of Maine, New Jersey, Maryland and Delaware are also in preparation. These maps were prepared in collaboration with the power companies.

The two maps already published may be bought from the Director of the United States Geological Survey at Washington for 50 cents each.

Civil Service Openings for Junior Chemists

The United States Civil Service Commission invites attention to examinations to be held on May 24 and June 21 to fill positions of junior chemist in the departmental service at Washington, D. C., at entrance salaries ranging from $1,200 to $1,800 a year. These examinations require written tests in the examination room in addition to a rating on education, training and experience.

Further information regarding the pending examinations and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the civil service board at the post office or custom house in any city.

U. S. Chamber of Commerce to Discuss Effect of European Conditions

"European Conditions and Their Effect on American Business" will be the main topic at the tenth annual meeting of the Chamber of Commerce of the United States, to be held in Washington, May 16 to 18. This announcement was made by the Chamber when it made public a tentative program for the meeting.

Because of the interest of business men throughout the country in the general subject it is predicted that the convention will be one of the largest ever held by the Chamber. More than 1,400 business organizations have been asked to send representatives and an attendance of from 4,000 to 5,000 business men is looked for.

New Course in Alloys at Wisconsin

Alloys and alloy steels will be studied intensively by about sixty students in the department of mechanical engineering of the college of engineering of the University of Wisconsin. This subject is included in a new course in metallography. An increasing demand from factories and shops for men who know the heat-treatment of metals and alloys as well as understanding the properties of alloys has brought about the introduction of this new study.

American Fertilizer Association Plans Meeting

The convention committee of the American Fertilizer Association is at work on the business and entertainment program for the twenty-ninth annual convention of the society, which is to be held at White Sulphur Springs, W. Va., the week beginning June 12.

Speakers will address the convention on subjects of importance to the fertilizer industry. Meeting headquarters will be established at the Greenbrier.

Alien Property Custodian Reports Activities

Alien Property Custodian Miller has transmitted to the Senate a detailed report of activities of his office since the declaration of war in the administration of trusts covering alien property, which includes chemical plants among some 33,000 active trusts under control of this agency. The report is in response to a resolution of inquiry by Senator King of Utah.

French Government May Co-operate in Development of Haber Process for Munitions

The Finance Committee of the French Chamber of Deputies is considering a bill relative to an agreement made on Nov. 11, 1919, by the Minister of Industrial Reconstruction and the Badische Anilin concerning the Haber process for synthetic ammonia. Amendments have been proposed by M. Loucheur aiming at the exploitation of the Haber process by a French commercial company, acting for account of the state in the form of an interested administration. The state would interfere directly as little as possible, and the intervention, if necessary, would be limited to the erection of the buildings necessary for the exploitation of the process.

It appeared from the discussion in the commission that the Haber process is to be instituted at the Toulouse powder mill, which will be equipped to produce daily the 100 tons of nitrogen which might eventually be necessary for the defense of the country.

Comparison of National Standards of Mass Made at Bureau of Standards

A comparison of certain platinum and platinum-iridium standards of the Bureau of Standards with the two national standards (kilogram No. 20 and kilogram No. 4) was completed during March and represents the most elaborate work of the kind that has been done by the bureau in many years.

One of the most gratifying features of the work is the complete agreement of the results based on the two national standards, notwithstanding the fact that one of them has been used several times, while the other has not been employed for actual weighing since it was received from the International Bureau of Weights and Measures in 1889.

About an equal number of weighings was made in determining the actual values of some of the gold-plated bronze standards. The computation of these results is not entirely complete, but it is evident that they will not be quite so accurate.

Personal

HARRY EASTWOOD, formerly with the American Radiator Co., Kansas City plant, is now research chemist for the Cook Paint & Varnish Co., North Kansas City, Mo.

E. E. KIMBLE and A. H. OTIS, president and sales manager, respectively, of the Kimble Glass Co., Vineland, N. J., sailed April 11 on the Aquitania to obtain first-hand information on conditions in the technical glass industry of France, Germany, Italy, Czechoslovakia, Switzerland, England and Scotland.

JOHN C. MILLER, sales manager of the Oklahoma Producing & Refining Corporation, Tulsa, Okla., has resigned. He will be succeeded by D. L. GILLAND, heretofore head of the distributing division of the company.

W. C. PETERSON, metallurgist engineer for the Atlas Crucible Steel Co., resigned April 1, to accept the position of manager of the alloy steel division of the Electric Alloy Steel Co., Youngstown, Ohio. Prior to the position which Mr. Peterson held with the Atlas Crucible Steel Co. he spent 12 years with the Packard Motor Car Co. as supervisor of materials in charge of metallurgical laboratories, heat-treating departments, etc.

C. E. POTTS, who recently resigned as superintendent of the sheet mills of the Inland Steel Co., Indiana Harbor, Ind., owing to ill health, will take up a residence at Los Angeles, Cal.

H. E. RICE, formerly with the R. R. Donnelley & Sons Co., is now in charge of research and development work for the American Printing Ink Co., Chicago, Ill.

R. L. SHEPARD, formerly research engineer for the Solvay Process Co. of Detroit, is now in charge of the die-casting department of the Shepard Art Metal Co., Detroit, Mich.

Dr. S. E. SHEPPARD, chief of the research laboratory of the Eastman Kodak Co., Rochester, N. Y., recently addressed the local section of the American Chemical Society on "Gelatine in the Photographic Process."

JOHN TOMEC, president of the Thac Industrial Products Corporation, Trenton, N. J., left recently for an extended trip to England, France, Germany and Austria.

PERCY WEDLAKE, formerly with the Washington Steel & Ordnance Co., Washington, D. C., is now with the Wilson-Maeulen Co., New York.

E. J. WINTER, formerly chief engineer of the American Cyanamid Co. and more recently the consulting engineer of the United States Food Products Corporation, of Peoria, Ill., is now associated with Bonn & Co., of New York.

Obituary

Dr. ANDREW MCWILLIAM, a well-known metallurgist and formerly professor of metallurgy in Sheffield University, died at Sheffield on April 5. He had had 24 years' association with the city when, in 1911, he accepted the appointment of head metallurgical adviser to the Government of India. Before his departure for India he was given the degree of doctor of metallurgy for his researches into the metallurgy of steel. For many years he was a most familiar figure at the Iron and Steel Institute meetings, and his numerous papers were always of a practical and suggestive character, and most welcome contributions. He was born in 1867 and educated at Glasgow and the Royal School of Mines, London, where he obtained a first-class scholarship. At one time he was chemist to the Martino Steel Co., and then for 2 years lecturer in metallurgy to the Staffordshire County Council. His principal writings are a book on "General Foundry Practice" and technical papers on "Elimination of Silicon in Acid Open Hearth," "Heat-Treatment of Bessemer Steels" and several on the properties of heat-treated alloy steels.

Prof. EMIL HEYN died at his home in Berlin-Dahlem, March 1. He was born at Annaberg, Erzgebirge, Saxony, in 1867, and was educated at Freiberg. After his college days he spent some time with the Krupp works in Essen, and with the Hoerder Verein (now the Phœnix Co.) of Hoerde, Westphalia. Later he became a member of the faculty of the Royal Machine Construction and Foundry School in Gleiwitz, Silesia, and in 1898 he was called to the Royal Institute for Testing Materials at Lichterfelde, acting as assistant director from 1904 to 1914. Since 1901 he had been professor of mechanical engineering, foundry practice and strength of materials at Charlottenburg Technical Hochschule. He had been president of the German Metallurgical Society since 1918, and in 1921 also assumed the position of director of the Kaiser Wilhelm Institute for Metallurgical Research at Neubabelsberg, near Berlin. Prof. Heyn's published studies have naturally followed the lines of strength of metallic materials as affected by their composition and structure. He was early attracted by the possibilities of metallography, and much of his work was done along these lines. He developed an etching reagent for macroscopic examination of steel; he upheld the idea that there were two iron: carbon equilibrium diagrams, stable and metastable; he called attention to the peculiar physical properties of steel midway between troostite and sorbite, and proposed the name Osmondite for this structure; and he was a stout opponent of the amorphous metal hypothesis. In the non-ferrous field his work was no less important, resulting in many papers on copper and aluminum alloy systems and bearing metals. He also gave much attention to the problem of corrosion. A short elementary book on metallography is from his pen; he also edited the monumental Marten's Handbook of Materials. For several years, however, almost his entire attention had been devoted to the direction of the institutions of which he was the head.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

The Rise in Wholesale Prices

Wholesale prices since the beginning of 1922 have shown a steady and appreciable increase. The index numbers of the Bureau of Labor Statistics, recently announced for the month of March, indicate a net rise of 1 point, or approximately two-thirds of 1 per cent, since Feb. 28. Of the 327 commodities, or price series, for which data were obtained, increases were found to have occurred for 104 commodities and decreases for 83 commodities. In the case of 140 no change in the average prices was reported.

The index numbers of wholesale prices by groups of commodities have been as follows during the last 4 months:

INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES
(1913=100)

	1921 December	1922 January	1922 February	1922 March
Farm products	113	116	126	128
Foodstuffs	139	134	138	138
Cloths and clothing	185	183	183	182
Fuel and lighting	187	183	183	183
Metals and metal products	119	117	115	114
Building materials	203	202	202	202
Chemicals and drugs	161	159	159	159
Housefurnishing goods	218	214	213	213
Miscellaneous	148	146	150	153
All commodities	149	148	151	152

Farm products again showed an increase, due to advances in grain, hay, cattle, hogs, sheep and poultry. The increase in this group over the February level was approximately 1½ per cent. Food, fuel, building materials, chemicals and housefurnishing goods showed no change in the general price level. In the two groups of cloths and clothing and metals and metal products prices in March averaged somewhat lower than in February. On the other hand, the group of miscellaneous commodities, including, among others, such important articles as cottonseed meal and oil, linseed meal, slaughterhouse tankage, and a number of vegetable oils largely used for industrial purposes showed an increase of 2 per cent.

Specifications for Petroleum Products

The interdepartmental petroleum specifications committee has adopted a set of specifications for the use of the various government departments and independent establishments. These specifications, corrected to March 1, 1922, are now available as Technical Paper 305 of the Bureau of Mines. This publication supersedes the earlier publications of the committee, which has worked on the subject during the war period and since that time. Specifications are given for gasoline, naphthas, illuminating oils, fuel oils, lubricants, greases and a wide variety of similar petroleum products. The methods for testing which are to be observed under these specifications will be available shortly as Technical Paper 298 of the bureau. This latter paper, is, however, not yet printed.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	158.27
Last week	158.81
April, 1917	207
April, 1918 (high)	286
April, 1920	261
April, 1921 (low)	140

Practically no change was noted in the index number during the past week. Of the six commodities for which price changes were noted, four—viz., caustic soda, caustic potash, barium chloride and linseed oil—showed slightly higher prices and two—viz., crude potassium carbonate and cottonseed oil— showed decreases. The importance of the weighting for cottonseed oil was sufficient to more than compensate for the small increases in the other commodities.

The Effect of Tariff Protection on British Chemical Prices

In order to demonstrate any possible effect on British chemical prices of the so-called safeguarding of industries act, the *Times Trade Supplement* of London has taken a dozen chemicals which are entirely or chiefly manufactured in Great Britain and compared them with a similar number which are solely or largely imported.

These compilations, in shillings and pence, and the author's conclusions were as follows:

Chemicals (British)	Value Oct. 1, 1921	Value April 1, 1922
Acetone	85/0 cwt	75/0 cwt.
Aspirin	3/2 lb.	2/10 lb.
Benzoic acid	2/5 lb.	1/6 lb.
Beta naphthol	3/6 lb.	2/6 lb.
Calcium lactate	2/6 lb.	2/0 lb.
Formaldehyde	95/0 cwt.	74/0 cwt.
Formic acid	65/0 cwt.	60/0 cwt.
Methyl salicylate	2/9 lb.	2/4 lb.
Salicylic acid	1/6 lb.	1/4 lb.
Sodium hyposulphite	25/0 cwt.	19/6 cwt.
Salol	2/8 lb.	2/0 lb.

Chemicals (imported)	Value Oct. 1, 1921	Value April 1, 1922
Amidopyrin	21/0 lb.	18/0 lb.
Barbitone	12/0 lb.	11/0 lb.
Chloral hydrate	5/6 lb.	5/0 lb.
Guaiacol carbonate	12/6 lb.	9/6 lb.
Hexamethylenetetramine	4/3 lb.	3/0 lb.
Lithium carbonate	12/0 lb.	10/6 lb.
Paraldehyde	2/0 lb.	1/4 lb.
Phenacetine	6/6 lb.	5/3 lb.
Phenazone	8/0 lb.	7/6 lb.
Phenolphthalein	4/6 lb.	3/3 lb.
Potassium permanganate	1/0 lb.	–/9 lb.
Resorcin	8/3 lb.	7/3 lb.

"In order to arrive at a definite ratio of values it is convenient to consider each item as a unit and total the four columns. Thus treated, the British chemicals show values of £14 10s. 10d. (in October) and £12 5s. (in April), and the imported chemicals £4 17s. 6d. (in October) and £4 2s. 4d. (in April). By coincidence the percentage of difference is almost identical, and the average decrease in value of all the chemicals included is over 15 per cent. In other words, the act has not led to a general increase in price to the consumer of either British or foreign chemicals, despite the 33⅓ per cent duty and the prophecies to the contrary."

German Dye Prices and Dividends

According to a recent dispatch from Frankfort-on-the-Main to the New York *Journal of Commerce*, German manufacturers have announced a general increase in the prices of their products. The new quotations are said to be 40 to 50 per cent higher than the price schedule which is now superseded.

A later radio dispatch from the same source reports that the great dye combine (Interessen Gemeinschaft) earned a dividend of 30 per cent on its capital stock during the fiscal year 1921, as compared with 20 per cent in the preceding year.

Allied Chemical & Dye Corporation Reports Better Business Conditions

Although there was a marked fall in the earnings of the Allied Chemical & Dye Corporation in 1921, the recent annual report indicates that the corporation is in a stronger financial position and since the beginning of 1922 has enjoyed a much improved demand for its products.

The reduction in business due to the general depression is shown by the considerably lower income. After charges, inventory adjustments, federal taxes and preferred dividends, the net income was $7,646,909, equivalent to $2.27 a share on the outstanding common stock. In 1920 the income was $16,179,939, or $6.33 a share. Inventory adjustments in 1921 were $3,940,557, as compared with $10,226,688 for the previous year. However, the inventory on Dec. 31, 1921, stood at $33,434,653 and on the corresponding date in 1920 was $45,602,875.

Dr. W. H. Nichols, chairman of the board, pointed out in his letter to stockholders that the most important technical development in 1921 was the successful production on a commercial scale of synthetic ammonia at the nitrogen-fixation plant, Syracuse, N. Y. This plant, the only one of its kind in the United States, has been running at full capacity since it was completed last fall.

U. S. Industrial Alcohol Reports Deficit

The U. S. Industrial Alcohol Co., for the first time in its history, showed a net loss in 1921. This amounted to $572,047, after charges, depreciation and inventory adjustment. During the previous year the company had a net income of $3,339,499 and paid a dividend of $11.63 on its common stock.

The record of the company's earnings and dividends for the past 11 years is given in the following table:

Year Ended Dec. 31	Operating Income	Net Income	Amount Earned on Common Stock
1911	$1,308,399	$ 902,745	$2.01
1912	1,437,522	1,021,751	2.51
1913	1,006,774	652,358	0.97
1914	1,069,602	653,264	0.97
1915	2,724,607	2,172,013	7.30
1916	6,727,043	4,756,025	18.06
1917	12,511,277	6,980,420	27.33
1918	14,073,102	6,621,309	25.83
1919	4,426,265	2,834,858	10.06
1920	5,102,831	3,339,499	11.63
1921	82,638*	572,047*	.....

*Loss.

The New York Market

New York, April 24, 1922.

Leading producers report a steady call for the more important commodities, and shipment prices have maintained their former strength throughout the week. The most important feature of the market was the continued rise of barium chloride and yellow prussiate of potash. Inquiries from Italy and other European countries for solid caustic soda are keeping the export market for that commodity in a very firm position and the present tendency of alkali prices is upward. The recent rise in citric acid has been firmly maintained. Cyanide of soda has been somewhat neglected and prices showed a slight decline both for foreign and domestic material. Cream of tartar has displayed a stronger tone and the market recorded an advance for the week. The general list of products so far this month has shown every tendency to remain firm and leading factors have interpreted this as an approach to better business conditions.

General Chemicals

Acetic Acid.—There has been a better demand since the first of the month for this material. Producers offer the 28 per cent at $2.35 per 100 lb. in barrels. Large orders could probably be purchased down to $2.25. The 56 per cent has sold at 5c. per lb., and the glacial 99½ per cent sold at 9c. per lb.

Barium Chloride.—This material continued exceptionally strong throughout the entire week and quotations were around $100 per ton for spot goods in very limited quantities. This product has recorded a 100 per cent advance within the past few months. May-June shipment was held at $90 per ton. All other barium products have shown additional strength in sympathy with the chloride.

Bleaching Powder.—Domestic bleach is moving quietly at $1.60 per 100 lb. in large drums, f.o.b. works. The imported is quoted at $1.70 per 100 lb. dock. The demand is rather slow, with real competition for any passing business.

Borax.—Contracts for large quantities are held at 5¼c. per lb. in bags, 5½@5¾c. in barrels and 6c. per lb. in kegs. Small lots on the spot market command higher prices.

Boric Acid.—Round lots in bags are moving at 11c. per lb. and at 11½c. in barrels. Kegs are held around 12c. per lb. Small lots command a premium of ¼@½c. per lb. above these prices.

Caustic Potash.—Large importers report a moderate demand for the 88-92 per cent and reported several transactions at 5¾@6c. per lb. Shipment material is not attracting very much attention, as prices are in most cases above spot material.

Caustic Soda.—Export inquiries continue to reach the market and additional sales to Italy were recorded at $3.65 @$3.70 per 100 lb. Dealers are holding resale lots at $3.75 per 100 lb.

Cyanide of Soda.—Imported and domestic goods are a shade easier under a somewhat neglected buying condition. Sellers of imported offer spot goods at 22@24c. per lb., depending on strength. Domestic material is held at 25c. per lb.

Nitrite of Soda.—The market appears rather firm and several transactions were recorded at 8¾@9c. per lb. The general range is 8¾@9¼c. per lb., depending upon seller and quantity. Consumers are not buying any more than actual wants.

Prussiate of Potash.—There has been a pronounced scarcity in the yellow material. Spot offerings were exceedingly limited and dealers were asking 28c. per lb. The red variety still continues very scarce, with sellers asking 75c. per lb. for shipment.

Coal-Tar Products

The only outstanding feature in this market during the past week was the strength displayed by phenol. Resale lots are very scarce and firmly maintained. Benzene still continues in a very strong condition and little is obtainable on spot because of the steady absorption of deliveries on contracts to consumers. The recent reduction in the price of phthalic anhydride is bringing out a better demand and business has shown a noticeable improvement. Cresylic acid is firm at the recent advance.

Aniline Oil.—First hands were quoting 16c. per lb. and reported sales consumated at this figure. The demand has not been any too brisk and it was intimated that shading could be done on firm business.

Beta Naphthol.—There has been a better inquiry noted for this product and producers stated that they were getting 26@27c. per lb., depending on quantity. The sublimed is unchanged at 60c. per lb.

Acid.—Some small lot orders have been recorded among first hands. The lowest price heard was 85c. per lb., with the range up to $1, depending upon quantity. Demand is not very encouraging.

Phenol.—There has been no departure from the firm position of this crude. Second hands stated that it is doubtful if better than 12½c. per lb. could be done, while 13c. was being asked in several directions. Leading producers quoted the prime white crystals, U.S.P., at 15@17c. per lb.

Sulphanilic Acid.—Leading sellers are holding the market at 24@26c. per lb., but might shade these figures on firm business, owing to the slow movement. Sales are only of a light routine nature.

Naphthaline.—There were still a few consuming inquiries recorded during the week, but the general movement is rather quiet and large sellers are very much disappointed with the results of the season. Leading producers are unchanged in their recent prices.

The Chicago Market

CHICAGO, Ill., April 20, 1922.

Little change was to be noted in the general chemical market during the past week. Business continued fairly active and factors reported a satisfactory volume of small or medium-sized orders. Large buyers are still apparently holding off and are taking supplies for immediate consumption only. Practically all prices were firm and first hands were in control of the market, which is generally regarded as a healthy sign. Imported chemicals continue to advance in price and are becoming scarce.

General Chemicals

The alkali market was firm and stocks were reported to be moving fairly well in small lots. Solid *caustic soda* was quoted at $3.75@$4 per 100 lb. and the ground at $4.35@$4.50. *Caustic potash* is very firm and most sellers have advanced their price on the 88-92 per cent material to 7c., although it was reported that a few small lots could be had at 6¾c. *Soda ash* continued to move in the regular channels at $2.30 per 100 lb. for small lots in cooperage.

Alums were apparently in a firm position, but no transactions of consequence were reported. *Ammonia alum* was quiet at 4½@5c. per lb. for the ground. *Potash alum* was in some demand and the lumps could be bought at 5½c. for the U.S.P. or 4½c. for the technical. *Powdered potash alum* was in fair demand from the photographic trade and supplies were available at 5½@6½c., according to the quantity and the seller. Barium compounds were in an exceptionally firm position and prices showed a considerable advance. *Barium chloride* was very difficult to locate and the best offer noted was for shipment from the East at $90 per ton. *Copper sulphate* was in active demand and prices were firm at 6@6¼c. per lb. With warm weather in sight there was some pressure to sell *bleach*, which could be had at 2¾@3c. per lb. White *arsenic* is a little easier and supplies could be had at around 7½c. per lb. *Furfural* is still available at 50c. per lb. in single-drum lots. *Carbon tetrachloride* moved in a routine way and was unchanged at 10½@11c. per lb. Nothing new developed in the *glycerine* market and refiners continued to offer c.p. material at 16½c. per lb. bulk basis.

Potash bichromate was quiet and unchanged at 11¾@13c. per lb. *Soda bichromate* was in a similar position and was available at 9@9½c. per lb. A small sale of *red prussiate of potash* at 90c. per lb. was reported early in the week. *Yellow prussiate of potash* continued to move well at 32@35c. per lb. *Hypo* was in a somewhat better demand and was unchanged at $3.95 per 100 lb. for the pea crystals in barrels.

Linseed Oil—Naval Stores

Prominent factors in *linseed oil* reported a good movement in consuming channels. Prices were a little higher, with today's market on the boiled oil in 5-drum lots at 88c. per gal. and similar quantities of the raw at 86c.

Turpentine, like linseed oil, was reported to be moving in a satisfactory volume to the paint trade. Today's market on 5-drum lots was 83c. per gal., which represented a small decline. *Rosin* was in fair demand, and the "G" grade in less than carlots could be had at $6.35 per 280 lb.

The Iron and Steel Market

PITTSBURGH, April 21, 1922.

Strikes in the Connellsville and Lower Connellsville region have spread somewhat farther in the past week, but the tide appears now to have become stationary. Production of coal in the region as a whole is probably at not over one-third the rate in March, shipments of coal being decreased in greater ratio and production of coke in the region in somewhat less ratio. Of the strikes produced in non-union coal fields by the United Mine Workers, those in the Connellsville region are by far the most important. In many districts, according to the latest report of the Geological Survey, the demand for coal is insufficient to give the mines as full employment as labor conditions would admit.

By various means the iron and steel producers have tempered the effects of the Connellsville strikes, so that production is not restricted in full proportion to the amount of striking. There has been some additional drawing upon coal districts in position to produce freely, while there is some drawing upon stocks of coal.

Even to this date the influence of the Connellsville strikes has been more marked in preventing resumption of mills and furnaces than in restricting operations that were in progress April 1, whereby the production of steel is probably at a somewhat greater rate this week than on the last day of March, when steel ingot production was proceeding at the rate of 35,000,000 or 36,000 000 tons a year, against a rate of about 30,000,000 tons March 1 and an average rate of slightly under 20,000,000 tons in December.

Changed Character of Buying

The whole steel market is largely under the influence of the coal strike, in a double manner. Conservative and far-sighted buyers purchased liberally in February and March and undoubtedly accumulated stocks. Such buyers are not so conspicuous in the market now, while another class of buying has developed, on the part of consumers and distributors who appear decidedly frightened. The producers do not look with much favor upon buying of this sort, having some doubt whether the material will be entirely acceptable to the inquirers when delivered. The mills have learned to distinguish between the buyer who is attracted by a low price and the buyer who is attracted by an advanced price.

Inasmuch as the coal strike was expected for a year or so and serious efforts were made to insure against its possible effects, a quite erroneous view of the situation would be obtained by assuming that the strike, now that it has begun, has produced really important consequences. It is quite possible that serious consequences in markets generally would have followed had the strike suddenly been called off March 31. The steel situation appears stronger by reason of the strike, but perhaps it had need of some stiffening influence at this time.

Finished steel prices are being quite firmly maintained. This situation may be due to the coal strike, as is assumed in many quarters, or it may be due to mills having had fairly large sales and being disposed to stand their ground simply because they are fortified by back-log business. If so, the phenomenon is a familiar one.

Bars, shapes and plates are quite rigidly maintained at 1.50c., concessions from this figure being unusual if not entirely absent. Regular list prices on tubular goods are very well maintained, concessions having been dwindling for about 6 weeks past. Tin plate is reported quite firm at the official or regular price of $4.75. Sheets are held at prices as recently advanced $3 a ton. Hoops and bands are up $2 a ton, to 2c. In nails the independents maintain their recent advance to $2.50, while the Steel Corporation's price remains $2.40.

Pig Iron Higher

While the merchant furnaces may not have been definitely withdrawing as sellers, they have presented much the appearance of doing so, and quotable prices have advanced by an average of fully $2 a ton in the past fortnight. The valley market now stands at $21 for bessemer, $20 for basic and $21 for foundry, these being minimum prices, with some doubt as to whether any large purchases could be made at these figures. In bessemer the advance over the price April 1 is $1.50, while basic and foundry are up $2. Prices may work up still farther, as they are even now hardly up to what merchant furnaces assert is their cost. If Lake Superior ore prices for the 1922 season are developed in the near future, they will doubtless be in relation to these new prices for pig iron, in which case there would not be the reduction of about $1 a ton from the 1921 schedule that was being predicted 3 months and more ago.

Connellsville coke is not quotable as presenting regular market prices. The furnaces state they could not afford to pay advanced prices, while the offerings are only of extremely small lots, not enough to be worth while to a blast furnace even if the price were satisfactory. In foundry coke the demand is largely withdrawn, foundries generally having stocked in the past couple of months.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 38 – $0 40
Acetone	lb.	$0 09 – $0 09½	09¾ – 11
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	11 – 11½	11¾ – 12
Boric, powder	lb.	11– 11½	11¾ – 12½
Citric	lb.	..... –	45½ – 46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	11 – 11½	11¾ – 12
Lactic, 44 per cent tech	lb.	09½ – 10	10¾ – 12
Lactic, 22 per cent tech	lb.	04 – 04½	04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	06 – 06½	06¾ – 07
Nitric, 42 deg.	lb.	06½ – 06¾	07 – 07¼
Oxalic, crystals	lb.	11½ – 12	12½ – 13
Phosphoric, 50 per cent solution	lb.	08 – 08½	08¾ – 09½
Picric	lb.	22 – 24	24½ – 30
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	11 00 – 12 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	..... – .....
Sulphuric, 66 deg., drums	ton	20 00 – 20.50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	..... –	60 – 75
Tannic (tech.)	lb.	40 – 45	46 – 50
Tartaric, imported crystals	lb.	..... –	26½ – 28
Tartaric acid, imported, powdered	lb.	..... –	27½ – 30
Tartaric acid, domestic	lb.	..... –	..... – 30
Tungstic, per lb. of WO	lb.	..... –	1 00 – 1 10
Alcohol, ethyl	gal.	..... –	4 75 – 5 50
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	32 – 34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	32 – 34
Alum, ammonia, lump	lb.	03½ – 03¾	04 – 04¼
Alum, potash, lump	lb.	03¾ – 04	04¼ – 05
Alum, chrome lump	lb.	07½ – 08	08¼ – 08½
Aluminum sulphate, commercial	100 lb.	1 50 – 1 65	1 70 – 2.25
Aluminum sulphate, iron free	lb.	02½ – 02¾	03 – 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ – 07¾	08 – 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30 – 30½	31 – 33
Ammonium carbonate, powder	lb.	07 – 07½	08 – 09
Ammonium nitrate	lb.	06 – 06½	06¾ – 07½
Amylacetate tech	gal.	..... –	2.00 – 2.25
Arsenic, white, powdered	lb.	07 – 07¼	07½ – 08
Arsenic, red, powdered	lb.	12 – 12¼	12½ – 13
Barium chloride	ton	100 00 –105 00	105 00 –110 00
Barium dioxide (peroxide)	lb.	20 – 21	21½ – 22
Barium nitrate	lb.	06½ – 07	07¼ – 08½
Barium sulphate (precip.) (blanc fixe)	lb.	03¾ – 04	04¼ – 04½
Blanc fixe, dry	lb.	04 – 04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55 00	..... – .....
Bleaching powder	100 lb.	1 60 – 1.75	1.80 – 2 75
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	05¼ – 05¾	06 – 06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	27 – 28	28½ – 35
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	04½ – 04¾	05 – 05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24.75 – 27 00
Calcium chloride, granulated	lb.	01½ – 01¾	02 – 02¼
Calcium peroxide	lb.	..... –	1.40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	15 – 16
Camphor	lb.	..... –	80 – 82
Carbon bisulphide	lb.	06 – 06½	06¾ – 07½
Carbon tetrachloride, drums	lb.	09½ – 10	10½ – 12
Carbonyl chloride, (phosgene)	lb.	..... –	60 – 75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	04¼ – 04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	03½ – 03¾	..... – .....
Chalk, precip.—imported, light	lb.	04½ – 05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	05 – 05½	05¾ – 06
Chloroform	lb.	..... –	37 – 40
Cobalt oxide	lb.	..... –	2 00 – 2.10
Copperas	ton	15 00 – 16 00	16.50 – 30.00
Copper carbonate, green precipitate	lb.	19 – 20	20½ – 21
Copper cyanide	lb.	..... –	58 – 60
Copper sulphate, crystals	100 lb.	5.50 – 5 60	5 65 – 6.15
Cream of tartar	lb.	..... –	24 – 26
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	93 – 1 00
Formaldehyde, 40 per cent	lb.	08½ – 09	09¼ – 10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32 00	..... – .....
Fusel oil, ref.	gal.	..... –	2 15 – 2 50
Fusel oil, crude	gal.	..... –	1 25 – 1 50
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	15 – 15½
Iodine, resublimed	lb.	..... –	4 05 – 4 15
Iron oxide, red	lb.	..... –	12 – 18
Lead acetate	lb.	..... –	09½ – 12
Lead arsenate, powd.	lb.	14 – 14½	14½ – 15½
Lead nitrate	lb.	..... –	15 – 20
Litharge	lb.	07½ – 07¾	08 – 08½
Magnesium carbonate, technical	lb.	06 – 06½	06½ – 08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1 00 – 1 80
Methanol, 95%	gal.	..... –	57 – 58
Methanol, 97%	gal.	..... –	59 – 60
Nickel salt, double	lb.	..... –	11 – 11½
Nickel salt, single	lb.	..... –	11 – 11½
Phosgene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	45 – 46	47 – 50
Phosphorus, yellow	lb.	..... –	30 – 35
Potassium bichromate	lb.	.10⅜ – .10½	.10½ – .10¾
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04¾ – .05	.05½ – .06
Potassium chlorate, crystals	lb.	.06 – .06¼	.06½ – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.90 – 6.00	6.10 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07¾ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.28 – .28½	.28¾ – .29
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .07¾	.08 – .08¼
Salsoda	100 lb.	1.45 – 1.55	1.60 – 1.85
Salt cake (bulk)	ton	18.00 –20.00	..... – .....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04½ – .04½	.04¾ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07¾	.08 – .08¾
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.75	3.80 – 4.25
Sodium hyposulphite	lb.	.03 – .03¼	.03½ – .03¾
Sodium nitrite	lb.	.08¾ – .09	.09½ – .09¼
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¾ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.16½ – .16¾	.17 – .17¼
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.15
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.85 – 1.00	1.10 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¼ – .04½	.04¾ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18.00 –25 00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06¼ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16 — .16½
Aniline salts	lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .9
Benzidine sulphate	lb.	.75 — .8
Benzoic acid, U.S.P.	lb.	.60 — .6
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.60 — .65
Beta-naphthol, tech	lb.	.26 — .28
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.80 — .85
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.23 — .25
Dinitroclorbenzene	lb.	.23 — .25
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Dipnenylamne	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.10 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06¾
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.60 — 2.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.15 — .18
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.65 — .70
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.05 — 1.15
Phthalic anhydride	lb.	.36 — .38

Phenol, U. S. P., drums	lb.	.12½	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls	lb.	.24 —	.24½
Salicylic acid, U. S. P	lb.	.25 —	.26
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices same as previous report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.25 —	5.30
Rosin E-I	280 lb.	5.35 —	5.40
Rosin K-N	280 lb.	5.45 —	6.55
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.85 —	.....
Wood turpentine, steam dist	gal.	.85 —	.....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.38 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Quotations remain unchanged.

Crude Rubber

All prices same as report of April 19.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls	lb.	.13½ —	.13¾
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.09½ —	.09¾
Corn oil, crude, in bbls	lb.	.11 —	.11¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.09¾ —	.10
Cottonseed oil, summer yellow	lb.	.12 —	.12½
Cottonseed oil, winter yellow	lb.	.13¼ —	.13
Linseed oil, raw, car lots (domestic)	gal.	.85 —	.86
Linseed oil, raw, tank cars (domestic)	gal.	.81 —	.82
Linseed oil, in 5-bbl lots (domestic)	gal.	.88 —	.89
Olive oil, denatured	gal.	1.12 —	1.15¼
Palm, Lagos	lb.	.07¾ —	.08
Palm, Niger	lb.	.05¾ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09½ —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.86 —	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.10¾ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¾ —	....

FISH

Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

Prices remain quotably unchanged.

Refractories

Quotations remain same as previous report.

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.11½ —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	67.00 —	69.00
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	54.00 —	55.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.37 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	3.55 —	3.75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19.00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.75
Coke, furnace, f.o.b. ovens	net ton	3.50 —	3.75
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.26½ —	27
Manganese ore, chemical (MnO_2)	net ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	40 —	.42
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2.50 —	2.75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	5.00
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	30.75
Lead, New York, spot	5.00–5.25
Lead, E. St. Louis, spot	4.95–4.975
Zinc, spot, New York	5.40
Zinc, spot, E. St. Louis	4.90

OTHER METALS

Silver (commercial)	oz.	$0.70
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.15
Platinum	oz.	85.00@ 90.00
Iridium	oz.	160.00@170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	51.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10.50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.60@ 3.85
Lead, tea	3.00@ 3.25
Brass, heavy	4.50@ 4.75
Brass, light	4.00@ 4.25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.25@ 2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.48	$2.38
Soft steel bars	2.38	2.28
Soft steel bar shapes	2.38	2.28
Soft steel bands	2.98	2.88
Plates, ¼ to 1 in. thick	2.48	2.38

*Add 15c per 100 lb for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

EUFAULA—The City Council will soon call for bids for the installation of a filtration plant in connection with the waterworks system. The Ludlow Engineering Co., Winston-Salem, N. C., is engineer.

Arkansas

FORT SMITH—The Twin City Glass Co., recently organized with a capital of $100,000, has acquired local property comprising about 4 acres of land and will commence the immediate erection of a new plant for the manufacture of bottles, jars and other glass products. The main building will be about 50 x 100 ft., and will be supplemented by a number of smaller structures. A 15-ton glass tank will be installed. Harry Hart is president.

California

SAN FRANCISCO—The Magnolia Metal Co., Pacific Bldg., has taken bids for the erection of a new 1-story plant at Bryant and Sterling Sts., to cost about $15,000. Work will be commenced at an early date. Dodge A. Reidy, Pacific Bldg., is architect.

ANTIOCH—The Paraffin Paper Box Co. is considering plans for the rebuilding of the portion of its plant destroyed by fire, April 5, with loss estimated at about $30,000.

Florida

BAGDAD—The Bagdad Land & Lumber Co. has acquired property in Escambia County, Ala., and has preliminary plans under way for the erection of a new pine tar and turpentine extraction plant.

Georgia

CONCORD—Fire, April 8, destroyed a portion of the fertilizer works of R. H. Strickland, with loss estimated at about $75,000, including section of feed milling plant and machinery in both structures.

Idaho

COEUR D'ALENE—Idaho Clays, Inc., recently organized, will hold in temporary abeyance the construction of its proposed new plant on property acquired on Twelfth St., between Indiana and Pennsylvania Aves., Hayden Lake district, to be used for the manufacture of pottery, tile and other burned clay products. It will be built at a later date. L. A. Spear is president.

Illinois

CHICAGO—The Globe Varnish Co., 5338 Justine St., has filed plans for the erection of a new 2-story plant, 75 x 100 ft., at 750-58 Loomis St., estimated to cost about $35,000.

Indiana

NEW ALBANY—The Interstate Public Service Co., Indianapolis, will commence the immediate enlargement of its gas plant here, to include the construction of a new 300,000 cu.ft. gas holder. It is expected to double the present capacity.

WHITING—Fire, April 14, destroyed a portion of the plant of the Standard Oil Co., with loss estimated at about $150,000, including a battery of stills, and other equipment.

INDIANAPOLIS—The Scoria Mfg. Co., operating at the former works of the Broad Ripple Fuel & Supply Co., has acquired a site at 63rd St. and the Monon Railroad for the erection of a new plant for the manufacture of hollow wall tile, cement blocks and kindred products. Plans will be prepared at an early date. The factory will be equipped for a daily output of 20,000 ft. of material, and is estimated to cost approximately $50,000. E. L. Selvage is president, and Charles T. Hornaday, vice-president and treasurer.

SEYMOUR—The Buhner Fertilizer Co. has tentative plans under consideration for the rebuilding of its plant, destroyed by fire, April 12, with loss estimated at $50,000, including equipment.

Kentucky

ASHLAND—The Ashland Fire Brick Co., Winchester Ave. and 7th St., will make a number of improvements in its plant, including the remodeling of certain departments. Additional equipment will be installed. E. H. Gartrell is general manager.

LOUISVILLE—The Peaslee-Gaulbert Co., 413 West Main St., manufacturer of varnishes, wood finishes, etc., has plans under way for extensions and additions in its plant on 15th St., to cost about $100,000. D. X. Murphy & Bro., Louisville Trust Bldg., are architects.

Louisiana

HAYNESVILLE—The Standard Oil Co. will make extensions in its local tankage and distributing plant, including seventy 55,000-bbl. capacity storage tanks and auxiliary equipment. Work will be commenced at once.

WASHINGTON — The Louisiana Concrete Products Co., recently organized with a capital of $60,000, has acquired a local site and has plans in preparation for the erection of a plant for the manufacture of cement roofing tile and kindred products. Extensions will be made in the initial works at a later date for departments for the manufacture of bricks, blocks and other specialties. A. D. Alderson, Alexandria, La., is president; H. H. Holloway, Amite, La., is engineer.

Maryland

EASTON—The New Brick & Tile Co., recently formed with a capital of $50,000, is completing plans and will soon break ground for the erection of a new local plant for the manufacture of brick, drain tile and other burned clay products. It is expected to have the works equipped and ready for operation some time in June. The company is headed by U. G. Ross, J. Fletcher Clark and Robert L. Kemp, all of Easton.

BALTIMORE—The Brooks Mexican Petroleum Co., 7 St. Paul St., has preliminary plans under way for the construction of a new oil storage and distributing plant on site in the Curtis Bay section, recently acquired. It will comprise a pier, tankage works, storage facilities for about 300,000 bbl., and auxiliary equipment, and is estimated to cost close to $500,000. The company has been organized lately under state laws. W. B. Brooks is vice-president and general manager.

BALTIMORE—The Lasco Co., 206 South Sharp St., manufacturer of shellac and kindred products, is planning for extensions in its plant at 1117 Bush St., and will install equipment to more than double the present capacity. L. A. Stabler is president.

BALTIMORE—The Baltimore Brick Co., Maryland Trust Bldg., is completing the rebuilding of its plant No. 13 at East Baltimore, recently destroyed by fire, and will install machinery at an early date.

BALTIMORE—The Miller-Nelson Co., Belair Road, near Park Ave., will construct a new addition, 50 x 50 ft., at its cement products plant, to be equipped for molding and other service, estimated to cost about $25,000.

Michigan

KALAMAZOO — The Kalamazoo Sanitary Mfg. Co., Factory St., has rejected all bids recently received for the erection of its proposed 2-story addition, 120 x 400 ft., and will hold the project in temporary abeyance. If is estimated to cost about $200,000, including equipment.

MARYSVILLE—The Morton Salt Co. is rushing work on the three new factory buildings now in course of erection, and plans to have the structures equipped and ready for operation at an early date.

ESSEXVILLE—The Aetna Portland Cement Co., 412 Union Trust Bldg., Detroit, will commence foundation work at once for the different buildings to comprise its new plant at Essexville. The main building will be 375 x 900 ft., to include grinding departments, coolers, etc.; three kilns will be constructed. The plant will have an initial output of about 3,000 bbl. of cement per day, and is estimated to cost in excess of $750,000. Franklin R. Johnson is president; and O. J. Lingeman, secretary.

IONIA—The Michigan Porcelain Tile Co., recently organized, has taken bids on a general contract and will soon break ground for the erection of its proposed local plant, 1-story, 120 x 160 ft., estimated to cost about $45,000. It will be equipped for the manufacture of tile and other burned clay products. Harry E. Kidder is general manager.

Mississippi

LUCEDALE—Allman Clark & Co. have plans under way for the erection of a new plant on local site, recently acquired, for the production of turpentine and other distilled products.

New York

RETSOF—The Retsof Mining Co. has plans nearing completion and will soon take bids for the construction of a local salt mining and manufacturing plant, to be 1- and 2-story, estimated to cost in excess of $500,000, including equipment.

OAKFIELD—The extensions to be erected at the local plant of the United States Gypsum Co., 1170 Broadway, New York, will consist of two new buildings, 50 x 600 ft., and 50 x 100 ft. The first noted will be equipped for the production of gypsum wallboard products and the other structure for the manufacture of roofing tile and kindred specialties. Work will be commenced at an early date.

Oklahoma

SAPULPA—The Sapulpa Refining Co. is planning for the rebuilding of the tankage department and other portions of its local plant, destroyed by fire, April 4, with loss reported in excess of $300,000, including equipment.

Pennsylvania

PHILADELPHIA—John Harrison, Jr., 21st and Race Sts., manufacturer of oil products, has awarded a contract to Barclay, White & Co., 1713 Sansom St., for the erection of a 1-story addition to his plant. Work will be commenced at once.

South Carolina

GAFFNEY—The McGraw Brick Co. is perfecting plans for the installation of new equipment at its plant for the manufacture of building tile and other burned clay products. The work will include the construction of a number of new kilns. It is proposed to develop an output of about 125 tons of tile per day, while the brick department will be arranged on a basis of 100,000 bricks per day. C. D. Meadows is secretary and general manager.

Tennessee

HARRIMAN—The Poland Mining Co., recently organized, has leased a portion of the local W. N. Poland, and will install a plant for the production of precious metals. Work will be commenced at an early date. Charles C. Jarvis heads the company; J. C. Williams is engineer.

Texas

MEXIA—The Texas-Mexia Refining Co., lately organized, will soon break ground for the construction of a new oil-refining plant on local site, with daily output of about 3,000 bbl. It is estimated to cost approximately $500,000, including machinery.

COLEMAN—The City Council will soon commence the installation of a new filtration plant at the municipal waterworks. R. V. Wood is secretary.

ROCKDALE—The Empire Fuel Corporation, Dallas, operating lignite properties near Rockdale, is planning for the erection of a fuel carbonization and briquetting plant, with byproduct works for the manufacture of chemicals, dyes and kindred products from raw lignite. The company has recently increased its capital from $1,000,000 to $5,000,000, to provide funds for the plant. Adam H. Davidson is chairman of the board and treasurer; Roy R. McKee is secretary.

West Virginia

CHARLESTON—The Libbey-Owens Sheet Glass Co., Nicholas Bldg., Toledo, O., will soon commence the erection of additions to its local plant, including improvements in the present structures, estimated to cost close to $200,000, including equipment.

Capital Increases, Etc.

THE NATIONAL PORTLAND CEMENT CO., Mount Pleasant, Mich., has filed notice of increase in capital from $2,000,000 to $61,400,000.

THE BROWN CO., Berlin, N. H., manufacturer of bleached sulphite pulp and paper, has arranged for a bond issue of $3,000,000, the proceeds to be used for general operations and financing.

THE HUDSON OIL CO. OF DELAWARE, 135 Broadway, New York, N. Y., has filed notice of increase in capital from $1,000,000 to $3,000,000.

THE LITTLE FALLS PAPER CO., Little Falls, N. Y., has filed notice of dissolution under state laws.

THE RED BIRD OIL CO., Barboursville, Ky., has filed notice of increase in capital to $50,000.

THE STANDARD MINING & CHEMICAL WORKS, 42 Broadway, New York, N. Y., has filed notice of increase in capital from $75,000 to $100,000.

A receiver has been appointed for the WESTERN PENNSYLVANIA OIL CO., Butler, Pa.

A petition in bankruptcy has been filed against the MURCOTT STEEL PRODUCTS CO., 776 Jamaica Ave., Brooklyn, N. Y.

THE UNION BAG & PAPER CO., Woolworth Bldg., New York, N. Y., has perfected plans for a bond issue to total $3,000,000, to be used for general operations, financing, etc.

Louis B. Wehle has been appointed receiver in bankruptcy for the ABORN STEEL CO., 22 Clark St., New York. The liabilities are said to be $100,000, and assets $75,000.

New Companies

THE NUDRO CO., Bayonne, N. J., has been incorporated with a capital of $500,000, to manufacture chemicals and chemical by-products. The incorporators are G. F. and Robert L. Eaton, 115 East 5th St., Bayonne.

THE LINCOLN OIL CO., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture oil products. Joseph B. Shrago is president, and Charles Shrago, 51 McLellan St., Roxbury, Mass., treasurer.

H. C. COLLIER & SONS, INC., Binghamton, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, paints and kindred products. The incorporators are H. C., C. E. and C. R. Collier, all of Binghamton. The company is represented by Merchants, Waite & Waite, Binghamton.

THE DAWHOO CHEMICAL CO., Charleston, S. C., has been chartered under state laws to manufacture chemicals and chemical by-products. The incorporators are J. P. Matthews and E. Risher, both of Charleston.

THE UNITED CHEMICAL CO., Dallas, Tex., has been incorporated with a capital of $30,000, to manufacture chemicals and affiliated products. The incorporators are William G. Carroll, G. T. and E. O. Cobb, both of Dallas.

THE EASTON FOUNDRY & MFG. CO., Easton, Pa., has been incorporated with a capital of $75,000, to manufacture iron, steel and other metal castings. Raymond Kiser, Easton, is treasurer.

THE STEVENS ZODIPHRENT PRODUCTS CO., New York, has been incorporated with a capital of $50,000, to manufacture soaps and kindred products. The incorporators are R. D. Elder, C. J. Wood and B. Clark, Jr. The company is represented by Fitch & Grant, 32 Nassau St., New York.

THE OKLAHOMA OIL CO., Columbus, O., has been incorporated under Delaware laws, with capital of $8,100,000, to manufacture petroleum products. The incorporators are J. M. Lee, H. A. Evans and M. C. McShane, all of Columbus. The company is represented by Boyce & Magee, Dover, Del.

ROBERT W. LINTON, INC., Pawtucket, R. I., has been incorporated with a capital of $60,000, to manufacture paper products. The incorporators are Walter C. Newell, Henry L. Burdick and Robert W. Linton, 750 York Ave., Pawtucket.

THE INDEPENDENT SHOPE BRICK CO., Waco, Tex., has been incorporated with a capital of $60,000, to manufacture brick, tile and other burned clay products. The incorporators are B. W., G. V. and George Willig, all of Waco.

THE ANNABELLE MFG. CO., Syracuse, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, rubber products, etc. The incorporators are N. Vaeth, L. and G. Kallfelz, Syracuse. The company is represented by Shea & Crimmins, University Block, Syracuse.

THE AMERICAN SUPPLY CO., Miami, Fla., has been chartered under state laws to manufacture fertilizer products. Frederick C. Gomer, Miami, is president; Charles R. Graham, Goulds, Fla., vice-president; and W. K. Walton, Homestead, Fla., secretary.

THE ISCOLITE CORP., East Orange, N. J., has been incorporated with a capital of $200,000, to manufacture waterproofing materials. The incorporators are Albert R. Palmer, Leslie Reid and William H. O'Neill. The company is represented by the New Jersey Registration & Trust Co., 525 Main St., East Orange.

THE DU-RA ALUMINUM CO., Oklahoma City, Okla., has been incorporated with a capital of $5,000, to manufacture aluminum and other metal products. The incorporators are J. F. and D. B. Boettcher, and O. J. Logan, Oklahoma City.

THE LITTLE FALLS PAPER CO., New Windsor, Orange County, N. Y., has been incorporated with a capital of $250,000, to manufacture paper products. The incorporators are R. W. Spencer, S. L. Holden and L. J. White. The company is represented by Scott & Sneed, Newburgh, N. Y.

THE WILCO ASBESTOS MFG. CO., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture asbestos products. The incorporators are I. Wilkes, J. and B. Cohen, Brooklyn. The company is represented by H. D. Levy, 808 Broadway, Brooklyn.

THE MEADE RUBBER CO., Stoughton, Mass., has been incorporated with a capital of $150,000, to manufacture rubber products. James Meade, Stoughton, is president and treasurer; Patrick H. Mahoney is vice-president.

THE SOUTHWEST CHEMICAL CO., Dallas, Tex., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are J. William Morrow, M. C. Harris and J. F. Harrington, all of Dallas.

THE PEERLESS CONCRETE BRICK MFG. CO., INC., Philadelphia, Pa., has been incorporated with a capital of $10,000, to manufacture cement brick and kindred products. J. B. McDevitt, 2004 North 25th St., Philadelphia, is treasurer.

THE SOUTHERN STATES OIL CORP., Dover, Del., has been incorporated under state laws with a capital of $20,000,000, to manufacture petroleum products. The company is represented by Boyce & Magee, Dover.

THE HIGH TENSION INSULATOR CORP., Ballston Spa, N. Y., has been incorporated with a capital of $50,000, to manufacture porcelain and other insulating products. The incorporators are R. H. Davidson, W. H. Namack and C. Branda. The company is represented by E. D. Eddy, Saratoga Springs, N. Y.

THE FORT DEARBORN DRUG & CHEMICAL CO., 225 North Michigan Ave., Chicago, Ill., has been incorporated with a capital of $5,000, to manufacture chemicals and by-products, drugs, etc. The incorporators are Leonard Kaufman, Victor P. Houston and M. S. Greenbaum.

THE UNITED STATES CHEMICAL TEST CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are F. Johnson, J. T. Fitzgerald and M. M. Klein. The company is represented by M. Eichner, 1545 Broadway, New York.

SANNER BROS., INC., Philadelphia, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture oil products. The incorporators are Celestin Sanner, Jules A. Rominger and M. L. O'Neill, Philadephia. The company is represented by Amos A. Watson, Dover, Del.

THE NEILAN OIL & REFINING CO., Houston, Tex., has been incorporated with a capital of $150,000, to manufacture refined petroleum products. The incorporators are P. A. Neilan, M. H. Gubbels and J. J. Chadll, all of Houston.

THE WHALEBACK PRODUCTION CO., New York, N. Y., has been incorporated under Delaware laws with a capital of $500,000, to manufacture oil products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE NITRAM PRODUCTS CO., Paterson, N. J., has been incorporated with a capital of $200,000, to manufacture ferro-alloys. The incorporators are James S. Cudlipp, Carl C. and Ernest Greiner, 230 East 18th St., Paterson.

THE BLAYNE LABORATORIES, INC., 1442 Majestic Bldg., Detroit, Mich., has been incorporated with a capital of $5,000, to manufacture chemical specialties. The incorporators are Walter H. Blome, Franklin S. Payne and E. H. Frye.

THE SAN MARCOS OIL CORP., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are L. J. Lynch, F. A. Gill and D. T. Almond. The company is represented by W. F. Clare, 135 Broadway, New York.

THE CHAUTAUQUA PRODUCTS CO., Jamestown, N. Y., has been incorporated with a capital of $10,000, to manufacture rubber specialties. The incorporators are A. W. Jackson, F. M. Garfield and W. A. Stoeltzing. The company is represented by Mott & Ottaway, Jamestown.

THE MID-STATES TANNING CO., 2417 Smith Ave., Detroit, Mich., has been incorporated with a capital of $15,000, to manufacture leather products. The incorporators are James McAdoo, Jacob M. Feldstein and James D. May.

THE ORTEX OIL CO., Beaumont, Tex., has been incorporated with a capital of $50,000, to manufacture petroleum products. The incorporators are H. M. Higgins, E. L. Hall and O. H. Maschek, all of Beaumont.

THE PLASTIC PRODUCTS CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture composition paper products. The incorporators are M. Baumann, L. Rothbart and M. Symington. The company is represented by E. L. Brooks, 176 Broadway, New York.

THE PAINT SPECIALTIES CORP. OF NEW JERSEY, Jersey City, N. J., has been incorporated with a capital of $15,000, to manufacture paints, varnishes, etc. The incorporators are John D. Craven, Walter J. Freund and George A. Wardell. The company is represented by Alfred K. Moe, 15 Exchange Place, Jersey City.

THE WOODISON-KELLEY CO., 7415 St. Aubin Ave., Detroit, Mich., has been incorporated with a capital of $20,000, to manufacture chemical compounds, pastes, and kindred specialties. The incorporators are E. J. and J. C. Woodison, and Alfred D. Kelley.

THE NEW YORK GUMMED PAPER CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture paper products. The incorporators are E. D. and I. W. Ehrler, and A. F. Mayo. The company is represented by M. F. Miller, 350 Fulton St.

THE WOLVERINE CASTINGS CO., 405 East Ransom St., Kalamazoo, Mich., has been incorporated with a capital of $10,000, to manufacture iron and other metal castings. The incorporators are William and Edward Korman, and Joseph W. Stohrer, Kalamazoo.

Industrial Developments

OIL—The Vacuum Oil Co. has adopted a full-time operating schedule at its plant at Olean, N. Y., replacing a half-time basis operative for a number of weeks past. About 400 men are affected.

The India-Burma Oilfields Co., Rangoon, Burma, has opened its new oil-refining plant, recently completed, located about 15 miles from the city. The new refinery will run on a capacity basis for an indefinite period, using crude oil from the Yana and Padaupkin fields.

GLASS—The Hemingway Glass Co., Muncie, Ind., is increasing production at its plant, and expects to be on a close to normal basis at an early date.

The Owens Bottle Co., Toledo, O., has advanced production at its plants to about 80 per cent of capacity, and expects to increase the schedule at an early date. This same time a year ago the plants were running on a 25 per cent basis.

RUBBER — The Hydro-United Tire Co., Pottstown, Pa., has adopted a night shift at its plant, in addition to regular day production, under capacity operations.

The Miller Rubber Co., Akron, O., manufacturer of automobile tires, is planning to make further increases in production at an early date.

The Mason Tire & Rubber Co., Akron, O., is developing an expansion program providing for tire manufacture at practically double the regular output. It will be made effective at an early date.

CERAMIC— The Gill Clay Pot Co., Muncie, Ind., is increasing operations at its plant, giving employment to additional workers.

The Star Clay Co., Mertztown, Pa., has resumed production at its works, following a shut-down for some time past.

PAPER—The American Writing Paper Co., Holyoke, Mass., has advanced production about 20 per cent at its different mills in Connecticut and Massachusetts since the first of the year.

According to an official statement of the American Paper & Pulp Association, mills in the industry throughout the country are

now running on an average total of 75 per cent of capacity, following the worst conditions, for 24 months past, experienced in this line for a generation.

METALS—The Anaconda Copper Co. has placed its High Ore and Anaconda properties, two of the largest producers in the Butte, Mont., district, in service, following an extended shut-down. The company is increasing production at its plants to a point nearer normal far exceeding earlier estimates.

The Utah Copper Co., Salt Lake City, Utah, has reopened a portion of its properties, the largest in this section, following a shut-down for about a year past. The company has also resumed active production at its Magna, Utah, plant.

The Phelps-Dodge Co., New York, is operating at its Copper Queen smelting plant, Arizona, after a shut-down of about 10 months.

The Utah-Apex Mining Co., Salt Lake City, Utah, has resumed operations at its plant, following a curtailment for about a year past.

The Calumet & Hecla Co., Inc., has resumed operations at a portion of its copper properties at Calumet, Mich., following an extended shut-down. It is proposed to develop production to a point of about 2,000 tons a day by May 1, with the resumption of the reclamation plant not later than this date, providing a monthly output of about 1,500,000 lb. of refined copper.

CEMENT—The Kansas City Cement Co., Cement City, Mo., is increasing production at its local plant and has added about 150 men to the working force.

The Atlas Portland Cement Co. is increasing the output at its plant at Northampton, Pa., and is placing subsidiary departments in operation after period of curtailment, including the local bag factory.

Cement shipments from the Lehigh Valley district of Pennsylvania are now exceeding 100 cars a day. The mills have been stocking up with bituminous coal for a number of weeks past, and now have close to a 3 months' supply on hand.

TIN PLATE—The N. & G. Taylor Co. has resumed operations at the open-hearth and bar mill departments at its plant at Cumberland, Md. The black plate and tinning departments are now running at about 90 per cent of normal.

IRON AND STEEL—The Easton Steel Co. has resumed operations at full capacity at one of the blast furnaces at its mills at Pottstown, Pa.

The Otis Steel Co., Cleveland, O., has advanced production to a full capacity, 100 per cent basis, at its steel mills.

The Republic Iron & Steel Co. is making repairs to a second furnace at its Thomas, Ala., plant, and will place the unit in service about May 1.

The Sloss-Sheffield Steel & Iron Co. has blown in another furnace at its North Birmingham, Ala., works, and will soon blow in the furnace at its Philadelphia mill at Florence, Ala.

The United States Steel Corp. has blown in another blast furnace at its Gary, Ind., plant, making 17 furnaces in active production at this works.

New Publications

BAKING TECHNOLOGY is the title of "a journal of applied science in baking," published monthly by the American Bakers' Association, 1135 Fullerton Ave., Chicago. The first number was issued in January. It sets a high editorial and professional standard and will undoubtedly prove to be a strong factor in raising the technology of the baking industry.

THE NATIONAL RESEARCH COUNCIL has published Bull. 16, dated December, 1921, on "Research Laboratories in Industrial Establishments of the United States," including consulting research laboratories.

U. S. GEOLOGICAL SURVEY PUBLICATIONS: I: 14, Gold, Silver, Copper, Lead and Zinc in Montana in 1920, by C. N. Gerry (Mineral Resources of the U. S., 1920, Part I), published Dec. 17, 1921; I: 18, Gold, Silver, Copper, Lead and Zinc in Utah in 1920, by V. C. Heikes (Mineral Resources of the U. S., 1920, Part I), published Jan. 18, 1922; I: 19, Gold, Silver, Copper, Lead and Zinc in Nevada in 1920, by V. C. Heikes (Mineral Resources of the U. S., 1920, Part I), published Jan. 13, 1922; I: 20, Gold, Silver, Copper, Lead and Zinc in Arizona in 1920, by V. C. Heikes (Mineral Resources of the U. S., 1920, Part I), published Jan. 19, 1922; I: 21, Iron Ore, Pig Iron and Steel in 1920, by Ernest F. Burchard and Hubert W. Davis (Mineral Resources of the U. S., 1920, Part I), published Jan. 23, 1922; I: 22, Cobalt, Molybdenum, Nickel, Tantalum, Titanium, Tungsten, Radium, Uranium and Vanadium in 1920, by Frank L. Hess (Mineral Resources of the U. S., 1920, Part I), published Feb. 20, 1922; I: 28, Tin in 1919, by Adolph Knopf and Bertrand L. Johnson (Mineral Resources of the U. S., 1919, Part I), published Jan. 26, 1922; II: 2, Salt, Bromine and Calcium Chloride in 1920, by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published Feb. 21, 1922; II: 24, Talc and Soapstone in 1920, by Edward Sampson (Mineral Resources of the U. S., 1920, Part II), published Jan. 20, 1922; II: 25, Gems and Precious Stones in 1920, by B. H. Stoddard (Mineral Resources of the U. S., 1920, Part II), published Dec. 29, 1921; II: 26, Concrete Stone and Concrete Blocks in 1920, by R. W. Stone (Mineral Resources of the U. S., 1920, Part II), published Jan. 12, 1922; II: 27, Stone in 1920, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1920, Part II), published March 6, 1922; II: 28, Cement in 1920, by Ernest F. Burchard (Mineral Resources of the U. S., 1920, Part II), published March 7, 1922.

NEW BUREAU OF STANDARDS PUBLICATIONS: Sci. Paper 425, Characteristic Soft X-Rays From Arcs in Gases and Vapors, by F. L. Mohler and Paul D. Foote; Sci. Paper 426, Thermal Expansion of Nickel, Monel Metal, Stellite, Stainless Steel and Aluminum, by Wilmer H. Souder and Peter Hidnert; Sci. Paper 429, Note on the Preparation of Mannose, by E. P. Clark; Tech. Paper 200, An Investigation of Oxyacetylene Welding and Cutting Blow-Pipes, With Especial Reference to Their Design, Safety and Economy in Operation, by Robert S. Johnston; Tech. Paper 203, Influence of Phosphorus Upon the Microstructure and Hardness of Low-Carbon, Open-Hearth Steels, by Edward C. Groesbeck; Tech. Paper 294, Cutting Fluids, by Eugene C. Bingham; Tech. Paper 205, Tensile Properties of Some Structural Alloy Steels at High Temperatures, by H. J. French; Tech. Paper 296, Effect of Heat-Treatment on the Mechanical Properties of 1 per Cent Carbon Steel, by H. J. French and W. George Johnson; Tech. Paper 207, Manufacture and Properties of Steel Plates Containing Zirconium and Other Elements, by George K. Burgess and Raymond W. Woodward; Tech. Paper 208, Weighing by Substitution, by C. A. Briggs and E. D. Gordon.

NEW BUREAU OF MINES PUBLICATIONS: Schedule 18, on "Procedure for Establishing a List of Permissible Carbon Monoxide Indicators." Tech. Paper 278, The Sugar-Tube Method of Determining Rock Dust in Air, by A. C. Fieldner, S. H. Katz and E. S. Longfellow; Tech. Paper 281. The Use of Electrolytes in the Purification and Preparation of Clays, by H. G. Schurecht; Tech. Paper 282, Analysis of Detonating and Priming Mixtures, by C. A. Taylor and W. H. Rinkenbach.

THE DIVISION OF THE STATE GEOLOGICAL SURVEY, State of Illinois, has issued Bull. 26 on "Coal Resources of District IV," by Gilbert H. Cady.

IN THE MODERN EXECUTIVE'S LIBRARY the H. E. Wilson Co., New York City, is entering into the field of business and industrial administration with a series of books similar in plan to its Handbook Series on current topics that are known in the educational field. This new series will include books of immediate practical value in every line of importance to business and industrial executives. Daniel Bloomfield, under whose general editorship the Modern Executive's Library will be built up, is a member of Bloomfield & Bloomfield, the Boston firm of lawyers and consultants in industrial relations. The Modern Executive's Library will be divided into Management Series and Industrial Relations Series. In the Management Series the following books are in preparation: Financial Incentives for Employees and Executives, by Daniel Bloomfield; Practical Psychology for Business Executives, by Lionel C. Edie; Personnel Problems, by Daniel Bloomfield. The following titles in the same series have been published to date: Employees' Magazines, by Peter F. O'Shea; Standard Practice in Personnel Work, by Eugene J. Benge, with an introduction by Daniel Bloomfield. In the Industrial Relations Series the following volumes have been published: Employment Management, by Daniel Bloomfield, with introduction by Meyer Bloomfield; Problems of Labor, by Daniel Bloomfield, with introduction by Meyer Bloomfield; Modern Industrial Movements, by Daniel Bloomfield with introduction by Meyer Bloomfield.

SANITATION AND SEWAGE DISPOSAL FOR FARMSTEADS AND COUNTRY ESTATES. By William Paul Gerhard. Price 30 cents. Copies can be obtained at 17 West 42d St., New York City.

THE UNIVERSITY OF ILLINOIS has issued Bull. 127, on "Sound-Proof Partitions," by F. R. Watson, and Bull. 126, on "A Study of the Effect of Moisture Content Upon the Expansion and Contraction of Plain and Reinforced Concrete," by Torata Matsumoto.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922. Headquarters will be at the Emerson Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at Atlanta, Ga., May 8-11.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

AMERICAN WELDING SOCIETY will hold its annual meeting April 26-29 at the Engineering Societies' Building, New York City.

ANNUAL SAFETY CONGRESS of the NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15 to 22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its national convention in Detroit, Mich., April 26-28.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting: June 9—American Chemical Society, regular meeting.

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The Persistent Relativity of Things

THERE is something that everybody knows in a kind of a sleepy, half-awake, dull way; that he carries along rather beside than within his consciousness; as though he had the information stowed away in some compartment of his brain to which the door is closed. This something is the fact that Society does not stop when any of us dies, and that the world does not stop when we come to the custom house, and that even if we mind our own business we are not always sure to tread the path of wisdom.

It was not many years ago when the last thing on earth that any government would give up was the issuance and coinage of its own money. Today everybody is looking for some kind of international currency with which to trade, and we are beginning to realize that if nations would merely live on the same earth with one another and without even attempting to make a show of comity, they must have tokens and conventions over and above their respective boundaries.

We have no international propaganda to offer, and we are wholly out of sympathy with our lately naturalized fellow citizens of the soapboxes who prefer a Soviet government to that of the United States. But we must learn to think across the borders of our own bailiwicks, our own language, our own interests and our own lives.

With increased means of communication and transportation this earth is growing smaller every day, so that our lives and activities, even at great distances apart, overlap each other in increasing measure. Indeed, if we are not mindful of our potentialities of nuisance and of destruction we may be sure others will discover them for us—and they will call a halt if we haven't sense enough to stop of our own accord.

We have suffered a great deal in this country from the stripping of transportation systems and of industries to make profit for temporary stockholders. We are still pretty sleepy and drowsy while this unconscionable chicanery is going on and we seldom wake up until the damage is done. We must, for the sake of safety, get a bigger vision of things than most of us enjoy, and to those of us to whom this is impossible—to the 12-year-olds in mind who are willing to try anything because they cannot co-ordinate cause with effect—the only safety is to get the light from those who can see. We must have trade with Europe, we must conserve our industries, and we must provide for decent lives for all the people who work for us. We must look beyond our own interests and see what harm our good may do. A year ago we were all talking about relativity. Have we forgotten that there is such a thing? Has the sense of relativity departed from the world just as the nature of it was made manifest?

On Writing Technical English

THE other day a very kindly and appreciative letter came in from one of our subscribers who is eminent in chemistry. It commended some writings about a subject that is difficult of exposition, and was just the sort of a letter that encourages an editor to do his best. It contained also a word of gentle criticism. The writer regretted that at times the language fell below the dignity of the subject, as when the author spoke of the periodic table as "the blamed thing," and again when he says that he "once attended Sunday School."

"De gustibus non est disputandum." And yet, the next time we are born in this vale of tears, if we have our own way about it, we propose to promulgate a Gospel of Good Taste and to establish tests to determine who may be admitted to the shrine as adepts and who shall be cast into outer darkness. That will keep out all those who try to be funny in the wrong place along with those who are without a proper sense of the things we like best. We propose to do this even if, in the end, we ourselves land in the outer darkness. We confess it does give us a pain when reading something serious to find a poor joke languishing alone, like the last rose of summer, to liven the text. But there is the new-Sunday-go-to-meeting-suit-of-clothes style of scientific literature that bothers us also. This is practiced by many distinguished men who do not hesitate to use as ugly a word as specificity without a thought that a sound like that is an offence against good taste.

Science suffers from the ugliness of its language. Any old word to express the meaning has been seized upon, irrespective of its artistic faults. That is because the language of science is young and has not had the time to grow civilized. We can't even agree about spelling or pronunciation. In English some of us are disposed to worry about the vowel "i," and to shorten it as often as we can. By right of custom it often holds its place in iodine, but the other halogens become "bromeen," "chlorinn," etc. Germans grow nervous over the vowel "y" and usually pronounce it falsetto. Some of us say catalyst, but others use catalyzer—which does not seem to be an improvement.

The late WILLIAM JAMES introduced slang into philosophy—and he did so to the advantage of philosophy and psychology. But he was such a master of letters that he decorated diction with slang, just as the profanity of the late Mayor LIVINGSTON MIMS of Atlanta had its own quality of elegance. It is hard to introduce these subtleties into scientific writing, for it is in the lighter steps that we are bound to show our leaden feet. The main thing in writing is to get the idea across, and we constantly urge our contributors and try ourselves to write as though we were talking to the reader, and as if both reader and writer were engaged in a pleasant

effort with all their electrons, to reach a common understanding. Bring in the Sunday School or chewing gum or mothers-in-law or goats or flappers or the Volstead act or anything else, if it will only help. But if such things serve only as unrelated contributions to the humors of science, then our friend is justified in his criticism, and they should be avoided.

Ghosh

All Hemlock

IT DOES BEAT ALL what difficulties we find in the search for the solution of solutions. When we old fellows were young, solutions were about the simplest things in chemistry: you dissolved the solute in the solvent, and there you had it. That was all there was to it. It worked perfectly so long as you didn't worry about it. Of course, as soon as people began to call for investigations as to the behavior of bodies in solution the troubles began, and a promising young fellow named ARRHENIUS, who couldn't sleep because of his questing, conceived the idea of electrolytic dissociation. In the course of time we accepted the idea, but we might as well admit that it was unwillingly done and that if it had not been for OSTWALD and VAN'T HOFF we might still be discussing the subject in the manner of Kentucky theologians and WILLIAM JENNINGS BRYAN.

But really, our thinking (which we had learned) had to do principally with dilute solutions. When ROLLO'S uncle advised him how to study chemistry the old gentleman said:

I used to think theology
Was rather rough on doubt,
But chemistry with ions beats
Theology all out.

You'd better join the church before
Your course is well begun
Because you'll need to exercise
The art of faith, my son.

Solutions you'll discuss at length,
Provided always they
Contain solute to solvent as
The needle in the hay!

There was the trouble. As long as we had a substance in solution in the relation of one small needle to one large haystack, everything went well. Concentrated solutions were a nuisance; they were solutions, all right, but they did not behave according to the rules that we had learned.

Then along came a gentleman with the most picturesque name in chemistry—so far as any one with New England affiliations is concerned. His name is GHOSH, JNANENDRA CHANDRA GHOSH, from far-away Calcutta.

Now "Gosh" is a word that has probably wandered over into colloquial English use through the medium of Sanskrit, and when we say, "Gosh all hemlock!" we indicate surprise, amazement and sometimes despair. In this solution business Dr. J. C. GHOSH became a very present help in time of trouble. While the subject was getting pretty hard for some of us, he came forward from the banks of the Hoogly with everything explained. No matter how strong the solution, said he, any dissolved salt is completely ionized, and the little ions are all arranged in orderly rows in the solution, just the same as the atoms of the same salt are arranged in the crystalline state, as recently expounded by the modest BRAGGS, father and son. That is, we were told that the ions arranged themselves in a kind of a submarine lattice formation. They are like children, we were to understand, sitting on their benches at school; at a co-educational school, in fact, because they tend to form "completely saturated electrical doublets" with their oppositely charged neighbors. But even as the course of true love never does run smooth, so some of the ions have energy enough to break away from their mates, according, by GHOSH, to Maxwell's law of the distribution of velocities. These more venturesome ones thus become the "free ions," which conduct the current, whereas the more tranquil pairs, being bound, hold fast to that which is good, refuse to be parted from one another, and so do not conduct.

Isn't that a pretty theory? And it explains everything. The trouble begins for some of us when we want to prove it, and, digging back into the storehouses of our scholarship, we find ourselves lacking in the needful familiarity with differential equations and thermodynamics and those other enticing studies which seemed too theoretical for such eminently practical men as we were resolved to be when we were young. But Dr. GHOSH, he knows mathematics backward and forward, and he adds a little to the postulates we have outlined above and digs down into the depths of his learning and brings up the expression "virial" and the formula $e^{-\frac{A}{nRT}}$ and emerges with some beautiful equations which demonstrate that everything is just as he said it was. They show perfect agreement with all the experimental results on conducting solutions that ever found their way into print. Then we admire those long and involved equations and formulas, and, like the boards of directors of some chemical works when they get a report of the progress of research, we approve, accept and place them on file. We can't follow "very well," as we admit, but we applaud. Why, not long ago the learned Faraday Society in London held a symposium on ionization, and one gentleman present declared that the theory of GHOSH marked the greatest advance in physical chemistry since the revelation of the Ostwald-Planck dilution law.

But now is our complacency sore troubled and the waves of doubt encompass us about. In the April number of the *Journal of the American Chemical Society* Prof. JAMES KENDALL of Columbia University contributes an article which attacks our faith and harasses our spirit with all manner of uncertainty. The work of GHOSH has been done after him and checked up in detail with disastrous results. The postulates prove to be inconsistent with each other. The equations do not follow from the postulates, in spite of "virial," $e^{-\frac{A}{nRT}}$ and their companions in obscurity. Worse than ever, many of the calculated results do not follow from the equations. And finally, Ghosh all hemlock, an astounding proportion of the observed results of previous investigators have suffered transmutation in the process of transcription. We know the wonderful work which the veteran KOHLRAUSCH did, and when GHOSH says his theory agrees with KOHLRAUSCH'S data, and gives tables to prove it, what room is there for doubt? None, until we are put wise to the fact that 39 out of 75 of KOHLRAUSCH'S values, as given by GHOSH, are not the same as in the original.

And so we are sent out to wander in the wilderness again! Solutions have not yet been solved after all! Ghosh all hemlock!

The Ignorant Forge Shackles for Progress

UNDER the mistaken idea that democracy consists in letting everybody decide everything for himself whether he knows anything about it or not, we have struck the severest blow to representative government that it has ever received. We have made party leadership irresponsible. Senators are now both nominated and elected by popular vote, and the quality of the Senate has gone off. And as representative government weakens under government by harangue, the always-ready oligarchy steps in and takes the reins in the disorder which follows. We have lost the checking system of government that the founders were thoughtful to provide when we let ourselves be carried away by direct nominations and threw the obligation and responsibilities of representation on the people.

The more we encourage government by speech-making the more we give up our rights and privileges as citizens and our liberties. Utterly irresponsible legislators, nominated and elected by grown-up children, and a curious group of leaders who are constantly engaged in doing battle against intelligence propose measures that take from us that which we hold most precious: our liberty of thought and of speech. The statute lately proposed in the State of Kentucky and which failed of adoption by a single vote sounds like a joke; but it is not. It isn't even funny. It proposed under severe penalties to prohibit the teaching of the principle of evolution. WILLIAM JENNINGS BRYAN has a new speech about it and he is making a profitable journey through the country, appealing to the ignorant, to deny the right of freedom in the study and teaching of geology, biology, comparative anatomy, anthropology and the whole gamut of science wherever it interferes with the exact letter of the first chapter of Genesis. The reason for this is that it does not accord with the bias of a limited number of persons in regard to what they think is religious teaching, but which is not religion at all. It does not accord with their particular dogma. That is all.

The opponents of evolution of this generation are principally those who for lack of mental capacity cannot comprehend the nature of progress. They cannot see beyond tradition. And the theory of human evolution does not include them in its workings.

The anti-evolution propaganda is no less than an effort to forbid all teaching that is not approved by a board of ecclesiastical censors drawn from the most ignorant. Objection to these amazing restrictions on freedom of thought is as common among enlightened churchmen of all denominations as it is among men of science.

Where then is the danger? It consists in our good-humored listening till BRYAN and his ilk get a following. Soon such a following will make noise enough for the weaklings nominated to legislative office to hear the sound and think it represents votes. Then, before we know it, by threats of the minority that hold these views, we find the statutes enacted, the Constitution amended—and our liberties gone.

It is time now to tell those who constantly offend against intelligence that we purpose to retain our liberties and to put ourselves to the discomfort of showing that we mean it. It is an unpleasant, noisy job, but the situation demands it. It is time for men of science to speak.

New Lines of Production Needed

ONE of the difficulties in appraising the economic needs of the present time is the distant mental vision of pre-war times. We are apt to feel, now that the war is over, that we ought to begin where we left off. We have economic problems, and those that seem to result from the war receive much attention, while little attention is given to the fact that just before the war we also had economic problems, and the war did not settle those problems.

No one wishes to start an argument as to who or what caused the war, but it is permissible to recall, merely as a convenient aid to memory, that early in the war there were cited many economic facts such as would tend to produce war. Prominent among these was what is called "overproduction," wherefor "new markets" were being sought.

It is very curious that reference to "overproduction" so frequently produces a mental concept in terms of aggregate instead of individual industries. While we have learned something in this respect in recent years, even today the thought in many minds is that the United States possesses too much productive capacity, from which some men seem to deduce that we should encourage all exports and discourage all imports.

In the early stages of any industry progress is usually slow. Then, as technique is developed, production per unit of equipment increases and costs decrease, whereby demand increases through the increasing cheapness. The owners, who are merely human beings, acquire a slightly exaggerated idea of their product's importance to mankind, and give little thought to the possibility of a saturation point. The natural result is that there is what is called "overproduction" of this commodity, which means simply that development along that line has gone too far and others that could be developed are being neglected.

In the latter part of the nineteenth century there was what was called "overproduction" in the United States and elsewhere, and the condition continued in the new century up to the beginning of the war. We should now remember that the condition, however erroneously described or misunderstood, existed before 1914—not all of our present difficulties are the product of the war.

On the contrary, the war accentuated some of the undesirable conditions that already existed, causing, for instance, the further expansion of industries that had already reached or passed the point of full development to meet the desires of the people, and furthermore the period since the beginning of the war has been singularly bare of discoveries and inventions giving men opportunity to work in producing new things that the public may want.

It would be ludicrous, if it were not tragic, how widespread is the notion that our industries are here and simply must be kept. Continually references are being made to this industry or that industry operating at such and such a percentage of its "capacity," plainly with an inference that conditions will be right and conducive to our complete and continued welfare when each industry is "operating at 100 per cent." That is altogether too easy for this world. Instead, we are lined up for more changes than ever, not merely to correct distortions produced by the war, but to correct many that had developed long before the war.

Electric Cast Iron

Symposium by American Electrochemical Society Considers Manufacture of Pig Iron in Electric Furnaces, Manufacture of "Synthetic Cast Iron" From Steel Scrap or Iron Turnings, Melting of Pig Iron by Electricity, and Desulphurizing Cupola-Melted Gray Iron

A DAY-LONG DISCUSSION on all phases of electric cast iron was held in Baltimore, Thursday, April 27, by the American Electrochemical Society. Starting with Heroult's experiments at Sault Ste. Marie, papers and contributed remarks carried the subject into nearly all corners of the field which have been explored or occupied since that time.

Smelting Furnaces

A very good case for the open-top furnace, for the production of pig iron from ore, was made out by R. C. Gosrow in a paper entitled "Shaft vs. Open-Top Electric Furnaces." Disregarding at least one intermediate type, there are two practicable ore-smelting furnaces. Shaft furnaces, either with closed or open top, are useful for drying and calcining the charge before it reaches the reduction zone. Gosrow doubts whether any reduction of ore by ascending hot gases occurs, a doubt voiced by many auditors, but it is difficult to see why this should not occur, if, as said by the author, "the stacks were constantly frozen up with the charge, which fused [sintered?] by contact with the hot exit gases." Sticky charges are associated with slips, broken electrodes and superheated and smashed linings. Variable operating conditions are furthermore caused by segregation of even a carefully prepared charge during a descent down a tall shaft, and the variable electrical conduction by irregular settlement of the charge and after molten metal is tapped from the furnace.

While F. Hodson was sure he had seen gray iron tapped from a Swedish shaft furnace, several other speakers, notably Dorsey A. Lyon, said that the product was not a pig iron, as this was known to the foundry trade, but a hybrid metal, a white iron for steel making containing 2 to 2¼ per cent C. Swedish furnaces seldom met predictions as to cost of operations, but many of their early troubles have been successfully overcome. Roof failures, near the electrodes, have been controlled by gas circulation (really the main value of this operating feature except perhaps in the larger furnaces, where a little pre-reduction may be effected thereby) and the Soderburg self-baking electrode has solved many troubles originating at the carbons. From the standpoint of comfort to the workmen, there could be no comparison—to a casual observer the Swedish furnaces do not appear to be smelting, while an open-top furnace is a good imitation of hell. This term is purely relative, however, as demonstrated by Robert Turnbull, who offered to exhibit a 20,000-kw. open-top furnace which was no more uncomfortable than a crucible melting shop. He also insisted that "hand stoking and the correcting of the position of the electrode in the charge is more than half the battle, and such work is impossible in the shaft furnace."

Turning to the merits of a rectangular open-top furnace with a shallow ore bed and of at least 7,000 kw. capacity, Mr. Gosrow pointed out that the operation could be much more closely controlled because variations in smelting rate quickly show in the conditions at the top of the charge, and the necessary correctives can be got down to the smelting zone—or for that matter, if charging is stopped the charge works down so that wall accretions can be barred off or proper flux charged alongside, or in bad cases the furnace can be drained completely in a few hours. Much stress was laid on the advantage of placing the charge just where it is wanted, with the assurance that it will not be badly segregated by the time it reaches the smelting zone, or the charcoal crushed and the charge compacted by the excessive overburden. "The initial cost of construction is lowest and the cost of maintenance is also the lowest." A detailed estimate of the smelting cost totals $40 per net ton of iron in a proposed Western plant to produce 20,000 tons a year, a cost which apparently is liberal, since Messrs. Fitzgerald and Turnbull noted that the current consumption and the electrode charges were very liberal, not to say extravagant, whereas the plant itself could probably be built for half the estimated $750,000.

Robert Turnbull noted that there was no question that the open-top furnace was economical, despite the fact that none are now in operation making pig iron. Heroult's experimental runs at Sault Ste. Marie have never been bettered, if approached[1]. The operators at Heroult, Cal., were never able to produce gray foundry iron consistently, but no trouble was experienced at the Sault, where all tappings were of gray iron with 3 to 4 per cent C.

Carburization of Iron

Whether or not the necessary balance between carbon and silicon could be attained so that gray foundry iron could be produced in a pit furnace depends to a large extent on the rate of absorption of solid carbon into molten iron, since the zone of reduction and carburization by CO gas is practically non-existent. It has also been very difficult to get more than 3 per cent C into "synthetic pig iron" made by melting iron sponge or steel scrap in an electric furnace. Furthermore, it has been found impossible to melt iron sponge in the open hearth and carburize it without melting down the roof, although it is reported that heats containing 80 per cent of "purple blocks" (briquetted sponge iron) are being melted in Sweden with the introduction of 3 per cent carbon.

Therefore, "A Study of Carburization in the Manufacture of Synthetic Cast Iron," by Clyde E. Williams and C. E. Sims, was given particular attention. Most of their experiments were made in a small tilting furnace, holding 300 lb. of metal. Mild steel punchings and clippings were mixed with about 20 lb. of carburizer (crushed through 10 mesh), melted, necessary

[1]Certain ores were smelted with 2,000 kw.-hr. per ton, whereas the best Swedish furnace uses 2,500 kw.-hr.

ferro-alloys added, and sampled periodically. Temperatures varied not more than 50 deg. during a single run, and seldom mounted higher than 1,450 deg. C.

Table I shows the results of a series of runs on various carburizers. Practically all of the carbon contained at the end of the melting stage was picked up immediately upon melting, for if steel clippings were melted before the carburizer were added, samples would analyze 2.7 per cent carbon after a few pounds of graphite was thrown in. Graphite is a better carburizer than charcoal, because it is much easier to keep it in contact with the iron. Its commercial use would be restricted by the limited amount of electrode butts available. The table also shows the advantage of using low-ash coke.

TABLE I—ABSORPTION OF CARBON IN IRON CONTAINING 2 PER CENT Si

Carburizer	At End of Melting Stage Time (Min.)	Carbon Content	At End of Experiment Time (Min.)	Carbon Content
Acheson granular resistor graphite	190	3.0	260	4.1
Coal tar coke, 4 per cent ash	150	2.5	230	3.8
Coke, 12 per cent ash	160	2.3	270	3.6
Coke, 25 per cent ash	110	2.1	300	3.0
Charcoal	130	2.2	270	3.3

Robert Turnbull made a considerable quantity of electric pig iron during the war, and found that 2½ per cent carbon was about the maximum he could introduce with lump charcoal; crushing the charcoal for better contact boosted the carbon to 3 per cent; finally, by using silicon carbide (carborundum fire sand), he was able to increase the carbon to 3½ per cent, introducing 1 per cent silicon at the same time. The present authors also find that if silicon carbide is added after high-ash coke has been used, the carbon is increased from 3.1 to 3.9 and silicon increased 1.55 in 8 minutes.

Silicon in iron up to 7 per cent and phosphorus up to 0.8 per cent apparently makes no difference in the amount of carbon dissolved, but 1.75 per cent manganese iron carburizes a little more rapidly than one containing 0.40. Sulphur uniformly retards the rate and total amount of carburization.

Slags would be expected to retard carburization by preventing physical contact, iron to carbon. This indeed occurs, except when working under a desulphurizing slag, when the iron is carburized rapidly, possibly because calcium carbide in the slag transfers its carbon to the iron more easily. George K. Elliott said that this was possibly also due to the simultaneous lowering of sulphur. At Aniston, Ala., it is the practice to "pole" the charge, or stir it with a green pole, when making electric furnace wash metal. In this way sulphur is reduced to 0.03 and carbon up to 3.9 to 4.0 is absorbed from low-ash coke with no trouble. Low-sulphur frees manganese from the sulphide and allows it to form a corresponding amount of carbide.

Carburization in the Cupola

If straight steel charges are melted in the cupola with the proper coke, the resulting iron could ordinarily be expected to contain 2¼ to 2½ per cent carbon. Six times as much coke would probably have to be burned in order to boost cupola melted steel to 3½ per cent carbon, although a mixture of scrap steel, plus a small quantity of cast iron, plus a little high-grade ferrosilicon has been used to make low-phosphorus bessemer pig containing 2½ to 3 per cent C. Richard Moldenke mentioned some recent German practice of interest in this connection, where synthetic pig iron for malleable and low-carbon (2¼ to 2½ per cent) castings are made in a cupola. The charge consists of two kinds of briquets: First, steel clippings or borings heated to redness in a rotary furnace by a strongly reducing flame, a certain quantity placed in the lower, box-like die of a forging hammer, and welded into a pancake of high density by two or three vigorous blows; second, pig-iron shot and ferrosilicon cemented into small bricks.

Synthetic Cast Iron

James L. Cawthon, in a paper on "Synthetic Cast Iron," discussed methods of applying these principles to the actual production of cast iron from machine shop scrap (steel turnings). When this is melted in either an acid or basic electric furnace with 75 lb. good coke per ton, it will come down with about 2.5 per cent carbon, and well deoxidized. Melting under a carbide slag in a basic furnace will not change this carbon analysis nor affect the manganese or phosphorus, but silicon will be reduced practically to zero, and sulphur cut in half. Acid furnace melting without slag brings down metal unchanged in S and P; about 50 per cent of the Mn has slagged, while a little silicon has probably been picked up from the furnace. If desulphurizing is unnecessary, the acid process will prove cheaper and simpler, and give less trouble with slag when pouring the iron.

More carbon can be added only by stirring carbon into hot clean metal. Cawthon recommends skimming the bath carefully, adding 50 lb. fresh coke, raising the temperature as far as the furnace will safely stand, and stirring the bath with a green pole. Ten minutes poling will increase the carbon 0.50; another equal portion can be absorbed by repeating the operation. Some silicon can be reduced from an acid slag, but ordinarily it will be cheaper to add 50 per cent ferrosilicon just before tapping. Provided two or three times as much Mn is present as is necessary to form MnS, and C is 3.25 or over, a further fractional percentage of manganese does not affect the physical properties of the cast iron materially. Ferromanganese will be absorbed by the metal quantitatively if added to a basic heat at any time; at least 15 per cent is lost when adding at the very end of an acid heat; none is lost when adding the alloy to hot metal in the ladle.

Since phosphorus is eliminated at a fairly low temperature and under highly oxidizing conditions, it will remain practically constant in a high temperature carburizing operation. If phosphorus under 0.03 per cent (washed metal) is desired, it can be had by melting steel scrap in a basic furnace, with additions of lime and iron oxide. After melting, the phosphorus slag is removed, leaving behind "wild metal," which will violently boil when the first shovel of carbon is thrown in. This boil should be checked by 3 lb. of ferrosilicon fines, whereupon carburizing can proceed in the usual way.

A useful furnace test is described by Mr. Cawthon. He casts a test bar, 1 in. diameter, 6 in. long, in a dry sand core block, it is shaken out after 3 minutes, and quenched after 7 minutes further air cooling. A fracture is studied; one break is ground and tested for Brinell hardness. If the metal is harder than experience indicates is desirable to match the specification, carbon or silicon should be raised by additions, depend-

ing upon the indications of the fracture; if the hardness is too low, more low-carbon steel scrap is added.

Field for Process

In a paper entitled "Synthetic and Electric Pig Iron Sanely Considered" Robert Turnbull expressed the opinion that notwithstanding the fact that little or no synthetic pig iron is now being made anywhere, it is a logical operation for iron foundries having electric furnaces making either gray iron or steel castings, of both; the same furnace serving for both. Indeed this exact condition at Treadwell, Alaska, was described in a paper by W. E. Cahill, entitled "Electric Furnace Iron and Steel. Intermittent and Alternating Operations."

Synthetic iron is also the best solution for the problem of producing pig iron in countries far removed from coke and producing furnaces. Iron from scrap in an electric furnace will in most cases prove far cheaper than electric furnace production of iron from ore. Despite the difficulty in charging, and in getting high carbon into a low-carbon bath, the steel furnace is to be recommended over the open-top smelting furnace, because the closed furnace is more flexible and can be operated with refining slags. Refined iron, as a matter of fact, does not need as high carbon as ordinary cupola metal.

A supply of cheap iron or steel borings is a very attractive raw material for excellent castings at a price which may compare favorably with cupola melting from expensive pig.

Melting Cast-Iron Borings

Just how cheap the electric furnace and how dear the cupola iron will be depends to a certain extent upon who makes the estimates. Disregarding some evidently erroneous figures submitted in one of the papers, E. L. Crosby told of a foundry in Detroit which could buy borings at $8 per ton and used them for 100 per cent of the charge. Their current consumption was 600 kw.-hr. per ton under 8-hour operation, or 500 to 525 kw.-hr. per ton for 16-hour operation. Paying 1.8 cents per kw.-hr., they were able to produce molten iron from borings for $23.60 per ton, whereas cupola iron, made right alongside, cost $25 per ton. This tells only part of the story, for the rejections, both in foundry and in machine shop, were sharply reduced. Consequently it would probably be cheaper to use electric iron even if the borings cost 50 per cent more.

F. W. Brooke pointed out that one feature often overlooked by furnace estimators was that material absorbed heat at different rates, and that the same material varied with its physical condition. Cast-iron borings melted particularly slowly, and were quite liable to melt from the top; whereupon the arc would melt about as much furnace as metal. This trouble is largely obviated by methods described by H. M. Williams and T. B. Terry in their paper entitled "The Melting of Cast Iron in the Booth Rotating Electric Furnace." Using a very small furnace, holding from 250 to 280 lb. metal, it is actually easier to melt turnings than a mixture of pig and scrap, possibly due to the washing action of the molten charge on the finely divided solid.

No refining is attempted; additions are made with a small spoon thrust through an electrode hole. Temperatures are regulated by watching the current input; operations having been standardized so that the furnace may be poured by wattmeter. Melting losses amount to 4 per cent on pig and scrap, and 7 per cent on clean borings. No material change in chemical analysis is noted, except sulphur goes up about 0.01 per cent, either from a habit which sulphur has, errors in sampling, or dirt or cutting oils adhering to the scrap.

Duplex Foundry Iron

George K. Elliott reviewed the foundry practice of duplexing with cupola and basic electric hearth. Small heats of special iron may advantageously be melted in the electric furnace, but since the cupola is able to melt 8 tons of iron with 1 ton of coke, there are few locations where electric energy can compete. A cupola is a wonderful melter, but it introduces 0.03 S into iron on each melting, and in careless hands will deliver highly oxidized and gassy metal. Whenever these limitations of the cupola, or the cost of available raw materials, or the shifting from price per pound to quality per piece, or all of these factors together, become of considerable importance, a basic electric furnace should be introduced to refine the molten iron delivered by the cupola. Cast iron can be deoxidized and sulphur reduced from 0.18 per cent to under 0.07 in about 30 minutes, changing poor castings into uniformly good ones. Some 0.15 S irons, even some 0.25 S irons, produce acceptable test-bars, especially in England, but at the Lunkenheimer plant in Cincinnati it has been found that an important machining operation invariably uncovers "dirty" iron whenever S exceeds 0.09 per cent. Mr. Elliott was of the opinion that impact testing should be used to determine quality on apparently similar irons; a certain obsolete casting was scrapped, and several made of duplex metal and several of cupola metal of substantially the same composition and tensile properties were broken under the drop hammer. Cupola iron broke in two drops; electric iron required four or five drops.

Foundries serving machine shops where intensive production programs are installed should be particularly interested in electric duplexing, since it will enable them to produce unfailingly material of uniform machinability and strength. In figuring the value of the process, one should not reglect the important saving effected through a very much smaller proportion of rejected pieces, especially partially machined pieces. Very hot electric iron means sounder iron, because fluid iron in gates and sinkheads can more effectively "feed" the casting, and the ferrostatic head more effectually prevents liberation of the small amount of residual gas in refined metal. One important point is this—that hotter iron requires more refractory molding sand. While there is little information on the effect of O,N,CO,CO_2 and other gases in cast iron, the influence of oxygen and oxides on the whole is bad, since a certain well-defined kind of bad iron from cupolas is doubtless the result of highly oxidized conditions. Some of these gases may have an indirect effect in causing coarse crystallization and copious deposition of graphite in large flakes; micrographically electric iron is finer grained, the graphite comes down in smaller and more advantageously dispersed particles. Hence the iron may carry more silicon without the usual softening and loss of strength. It has already been noted that desulphurized steel is relatively easy to carburize into synthetic pig; possibly this is more truly due to the previous degasification which is essential before desulphurization is possible, and of which desulphurization is the only indication now furnished by chemical analysis.

Handling the Finished Products of Industry—I

The Necessity for Keeping the Cost of Handling Finished Products at a Minimum—Other Factors Causing the Adoption of Mechanical Equipment for Handling Finished Products—Classification of Handling for Finished Products—Types of Equipment Available and How Used

By G. L. MONTGOMERY

THAT the cost of most products is almost directly proportional to the cost of handling the materials of their manufacture into the works, through the process, and out of the works again, as recently stated by Herbert Blyth,[1] is a fact too evident to require much proof. Over any reasonable period of time, the reductions in cost possible of attainment through reduction in the cost of raw materials, of productive labor, of office and sales overhead, or of fixed charges will be relatively small as compared to reductions in cost possible through the elimination of non-productive labor. In almost any process industry, the greater part of the non-productive labor is entailed in handling the materials. The obvious and true conclusion to be reached in seeking to reduce costs is that the handling routine must be made as nearly automatic as possible so that the costs for this work are at a minimum. This solution is well worthy of adoption and should be put into effect wherever possible. Putting it into effect means the use of material-handling machinery and of other automatic machinery in the process and elsewhere.

Where Automatic Equipment Will Give the Quickest Results

Accepting the statements in the preceding paragraph as a basis for a study looking to the reduction of the costs of producing a commodity and getting it into the hands of the primary consumer, let us survey the present use of automatic equipment for handling and other purposes in the process industries, and determine where in these industries such equipment can be made to give the quickest and most satisfactory results for the least expenditure of capital.

As stated above, this automatic equipment is concerned with getting the materials into, through and out of the plant. In this series of papers equipment is considered as handling equipment whenever it is employed to further the physical movement of the material from the start of the process toward the close. Hence such machines as are commonly called automatics—i.e., cutting, wrapping, bagging, filling and packing machines, etc.—are here included as handling machines, together with the conventionally so-called conveyors, trucks, cranes and so on. Consideration of the three steps—in, through and out—will show where an industry can best start to realize the savings possible if there is no handling equipment employed or where perhaps, if some handling equipment is used, an extension can best be made to give quick results in reducing costs.

The application of automatic machinery to the movement of the raw materials of industry has had a more extended development and has been more widely accepted by the process industries than any other type of handling. Types of conveyors for this purpose such as scraper, drag, apron, belt and bucket, bucket-elevators, and cranes and hoists have reached a state of workability almost approaching perfection, having had their development many years ago in mine and power house. From the ancient mine car drawn by a pony the electric industrial railway and the storage battery or gasoline-motored industrial truck have grown. Locomotive cranes, bridge cranes and similar devices were early used in mines, coal-storage yards and such places. From these uses this equipment has spread to industry in general. At the present time its acceptance and use is on the road to universality.

Of course there are a number of cases where the raw materials are not handled by automatic equipment. Generally it will be found that these cases are where the total amount to be handled is small, or where, while the aggregate may be large, it is made up of a number of diverse materials which for some reason must not be mixed or contaminated one by another. In these cases study has generally proved that the saving incident on the use of handling machinery would not offset the relatively high fixed charges on the installation necessary.

The Status of Inter- and Intra-Process Handling

Mechanically handling materials while they are in process of manufacture is of great importance. No one other thing can have as great an effect in reducing costs of production, increasing production efficiency and lessening the problems of management. Without question, in cases where a new plant is to be erected, new machinery is to be purchased or existing machinery is to be re-arranged, the most complete system of inter- and intra-process handling and the fullest use of automatic process machinery that sound engineering judgment and practical designing and operating experience can recommend will be found a highly paying investment.

But the efficient use of such equipment almost invariably requires an arrangement of process machinery differing from that used with man-power handling and often requires the development of new machines or appliances. These considerations put a necessary brake on any sudden and universal realization of increased production efficiency through extensions of this type of handling. Such a growth will come—but come slowly—as new processes are developed, new plants are erected and existing equipment, through obsolescence, requires replacement.

The Finished Products Present the Best Field for Immediate Savings

Taking the product out of the plant includes all operations which must be performed with a product after the last true manufacturing process is completed, until it

[1] *Chemical Age* (London), Feb. 25, 1922, abstracted in Chem. & Met. Eng., April 5, 1922.

passes out of the ownership of the maker. These operations are really incidental to the distribution and sale of the product, including such items as wrapping, storing, packing, labeling and shipping. Often the cost of this work more than equals all the other charges which the product must bear. It is obvious that any savings that can be made here have a direct result in reducing the price at which the products can be sold and hence enable the sales force to do more effective work. If these savings are made in many industries, the consequent price reductions possible, covering a broad field, cannot fail to stimulate trade—domestic and foreign.

The cost of handling finished products is generally regarded as a necessary evil. Part of this cost is necessary. But the effort to reduce it to its irreducible minimum has just started. Everywhere one sees work of this nature being done by hand, utilizing the labor of hordes of workers, workers who could be and should be trained to real productive labor if it were possible to spare them from their present non-productive tasks.

And it is possible so to spare most of them; but not until the automatic equipment has been installed to take their places. Packing and shipping rooms, distributing warehouses, storehouses, piers, railroad freight terminals and all kindred places in which this non-productive work is performed can get along with fewer workers and do their work in a more efficient, quicker and cheaper way by the use of machines and equipment which has already been thoroughly tried. As an illustration of the difference which the use of such equipment makes, the writer was recently on the freight pier of the Hudson Navigation Co. in Albany, N. Y. The tractors usually employed in loading and unloading the boat from New York City were undergoing their annual overhauling and as a result it had been found necessary to hire more than fifty additional men to handle the work usually done by the tractors and their trailers. This meant that the force on the pier had been more than doubled, conditions being back to the same state as before the tractors had been purchased. The agent of the company stated that the equipment had more than paid for itself in a year and had been a great help to the company in getting its work handled expeditiously.

This equipment is all susceptible of improvement and is constantly being improved. But as it exists today, the results obtained by those who use it warrant full investigation on the part of those who are still using hand methods and justify the statement that the use of automatic equipment for handling finished products is a necessity for those who wish to keep costs low for competitive reasons and still to make a fair profit.

Other Reasons for Using Automatic Methods

Aside from the direct economies to be realized in the use of automatic handling methods for the finished products, there are several additional reasons which make the use of these methods at least advisable. Among these we might mention the elimination of delays obtained by having a continuous flow of product to the desired point at the desired time. Confusion is also eliminated in packing, warehouse and shipping rooms because of the smaller number of workers and the direct pathway which the products take. And also there is a speeding up of the workers without increase in fatigue, made possible by the greater ease of accomplishing the work and the natural human inclination to keep the pace of the machine.

These three factors all have a direct and an indirect effect in lowering costs and increasing efficiency of production, which may be decisive factors in causing the adoption of mechanical equipment. In addition, one result of eliminating delays and confusion, of speeding up the workers and reducing the working force is to do away with much of the burden of management. The first result of this is to make it less difficult to keep the work going smoothly. Following this, ways will be found for economies in the office overhead, and the ultimate result is a further reduction in the price at which the product can be marketed.

Hygiene and Cleanliness as Factors Causing the Use of Automatic Equipment

Often the product of a process industry is one where the conditions of manufacture must be kept at the highest attainable point of sanitation, as for instance with a drug or a food product. This naturally means that the surroundings must be as clean as possible, and all contact between the product and the workers reduced to zero or thereabout. There is only one way in which this can be done—by the fullest use of automatic machinery and mechanical handling equipment that can be reached. This consideration of cleanliness applies more to the finished products than to other phases of the industry, for there is no further possibility of sterilization or purification after the process is completed. Any contamination which may occur in wrapping, packing or shipping or other operation which the finished product undergoes has a direct effect in lowering the sale value of the product and hence increasing the relative cost of production.

Psychological Effects of Automatic Machinery

Two other effects of installing mechanical handling for finished products, which are largely psychological, are worthy of note. These are, first, the improvement in the morale of the employees resulting from easier working conditions, lack of confusion, and cleaner, pleasanter surroundings. And, second, the fact that a completely mechanized plant can be made a showplace, and for the public to see a food product or similar article packed and handled in a spotless plant without contact of human hands has a distinct reflection on sales.

Classification of Handling for Finished Products

Handling performed on finished products can be divided into three general classes. First, where the product is in a bulk or unpacked state. In this condition it is least convenient for manual handling; and for cleanliness and many other reasons, it is most necessary to have the handling done by machine. Second, after the product has been wrapped, boxed or crated, or otherwise prepared for shipment and has reached the point where it must be moved through various storing and shipping operations. And third, an intermediate class of handling, coming between the first and second classes, where the bulk or unwrapped product is put into the final container or form in which it is to reach the consumer.

Of the above, the second class presents the place in which handling equipment can most easily be installed and in which the cost of the installation will be least. It is often possible, by the application of a small gravity or belt loader or a storage conveyor or an industrial

truck, without any great change in existing conditions, to effect a revolution in this second class of handling. In most industries, and in the small plants of these industries in particular, this is the place in which the installation of modern handling methods should be started.

In the first class mentioned, handling equipment may be effective in reducing labor and always produces good results by feeding the wrapping or packing operations in a properly continuous manner and eliminating confusion and easing the task of keeping the plant clean. By doing away with the necessity of keeping a large working margin of bulk or unpacked material at the packing room, this type of handling is valuable as a space saver. The equipment used here is often much more costly and heavier than that used in the second class, but its use pays dividends and is absolutely necessary to make a well-rounded system that will give satisfactory results.

In the third or intermediate class, the machinery consists of what is usually known as automatic machinery. This is as truly handling equipment as any other class of handling machinery, for by it the product is moved through a series of operations, and the moving element of the machine is always some true conveyor element as a chain, roll or belt. Such machines are usually a combination of several operations and the movements between them—all in one machine.

This machinery is not applicable to every industry, not being needed in some—as in the brick industry, where a common red building brick after it is burned undergoes no operation to which an automatic machine could be applied. But the use of these machines has not yet been extended to many of the industries where they could effect marked savings, while in those industries where this machinery is already developed its use has not yet fully spread through the industry.

Standard Types of Equipment and Where Used

Class 1. Handling equipment for finished products in bulk or unpacked form:

(*a*) Flat belt conveyors.
(*b*) Troughed belt conveyors.
(*c*) Bucket elevators—various types.
(*d*) Screw conveyors.
(*e*) Apron and pan conveyers.
(*f*) Slat conveyors.
(*g*) Scraper and flight conveyors.
(*h*) Drag chain conveyors.
(*i*) V-bucket and pivoted bucket elevator conveyors.
(*j*) Cranes, hoists and monorails.
(*k*) Storage-battery or gasoline-motor driven industrial trucks and tractors.
(*l*) Lift trucks—hand or power propelled.
(*m*) Compressed air conveyors.
(*n*) Pumps—all types.
(*o*) Industrial railways.

Class 2. Handling equipment for finished products in various kinds of containers, or on platforms or palettes:

(*a*) Gravity roller conveyors.
(*b*) Spiral chutes.
(*c*) Straight slides.
(*d*) Apron conveyors.
(*e*) Slat conveyors.
(*f*) Bar conveyors.
(*g*) Chain conveyors.
(*h*) Flat belt conveyors.
(*i*) Inclined package or barrel elevators—bar, slat or apron type.
(*j*) Vertical package elevators and lowerators.
(*k*) Storage-battery or gasoline-motor driven industrial trucks and tractors.
(*l*) Lift trucks—hand and power propelled.
(*m*) Tiering machines—self-propelled and hand-propelled.
(*n*) Cranes, hoists and monorails.
(*o*) Industrial railways.

Class 3. The automatic machines which handle the product in such operations as cutting, filling, wrapping and packing vary with every case and are impossible to name. They are generally the result of design growing out of special studies and experiments with the particular product and process to which they are to be adapted.

These automatic machines, however, well repay the money, time and effort which their development demands. Often the labor force necessary to wrap a certain number of packages is cut two-thirds by the introduction of such equipment, while the cost of the operation is cut in half. Also, where freedom from contact with the workers is a desideratum for hygienic and sanitary reasons, these machines are a necessity. Other industries have a product that is of a form extremely difficult to pack by hand, as for instance a fine dust or a sticky, gluey mass. In these cases the automatic machine is also of great use. And where the product is dangerous or injurious to the workers, the automatic machine is a necessity for safety's sake.

Illustrations of the Use of This Equipment

In succeeding articles of this series various commercially successful installations of different types of handling equipment used in handling the finished products of industry—such as are mentioned above—will be described. The facts governing the selection of the particular type of equipment used will be pointed out. In all cases where such information is available, the savings effected in costs and the improvements made in the efficiency of the operations due to the use of the equipment will be brought out. By this means it is hoped to point the way to those wishing to realize the economies which have been obtained by others through the use of proper handling equipment, and to establish some criteria by which a handling installation can be judged.

Copper Salts Improve Casein Glue

It has been found that copper salts added to casein glues greatly increase their resistance to moisture and also make them more durable when exposed to the action of molds and fungi.

In the preparation of copper-casein glue at the Forest Products Laboratory, Madison, Wis., 2 to 3 parts by weight of copper chloride or copper sulphate are dissolved in about 30 parts of water and are added to every 500 parts of the ordinary casein, lime and water-glass glue. Copper added to the casein before the lime and water-glass is ineffective.

Glues containing little lime are especially improved by the addition of copper. A low-lime glue with copper may be as resistant to moisture as a glue with more lime in it, and copper does not shorten the "life" or period of workability of the glue so much as more lime would.

Some Facts About Residual Alum in Filtered Water

Graphic Representation of Chemistry of Alum Coagulation Process Emphasizes Interdependence of Various Equilibria and Importance of Hydrogen-Ion Concentration—Use in Explaining Discrepancies in Data on Alkalinity Changes and Residual Alum

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VARIOUS material (references 1-13 inclusive) is available in the literature which indicates certain wide limits within which aluminum will be more or less completely precipitated and beyond which it will be partly or completely dissolved. The work of Hildebrand[1] long ago indicated the importance of using the hydrogen electrode for the investigation of certain types of chemical reactions. Later Blum[2] applied this method to the study of determination of aluminum in quantitative analysis. He showed that if the p_H were adjusted to from 6.5 to 7.5 and the reaction mixture then boiled, he obtained complete precipitation—i.e., less than 0.1 mg. in 100 c.c. of the original solution. Since NH_4OH was used as the alkali, heating must have affected the final p_H. Altogether it is evident that Blum's conclusions do not necessarily apply to the precipitation of $Al(OH)_3$ in small quantities in the cold.

In September, 1920, this laboratory undertook an investigation of the various reactions involved in water purification, using the hydrogen electrode as the principal means of carrying out the investigation. The results[3] of this investigation showed among other things that p_H determinations alone were not sufficient for determining the optimum conditions for precipitation of aluminum hydroxide. A different laboratory method of attacking this problem was therefore decided upon.

Since the laboratory procedure chosen was one which involved considerable labor, it seemed advisable to make a field survey of various filter plants in the state in order to estimate the possible practical value of more exact information concerning the conditions for the precipitation of $Al(OH)_3$. It is this field survey which constitutes the subject of the present paper.

Since the completion of the first stage of the investigation two articles have appeared by Wolman and Hannan[14, 15] which furnish a very complete review of the current scientific literature having a bearing on the alum-precipitation question. These authors in their experimental part confirmed the statements of Blum, Mahin and others to the effect that aluminum hydroxide is appreciably soluble at a p_H of 8 or more, probably existing as the acid ion. They further showed that by acidifying their reaction mixture as Blum did to a p_H of about 7 a more complete precipitation was effected. Pirnie[16] has discussed the colloid chemistry of water purification and the relation between alkalinity and coagulation, and Eddy[17] has presented the possible applications of the p_H determinations to filter plant control.

Experimental

The data described in this paper were collected by visiting over twenty filter plants in different parts of Illinois. Due to irregularities in operation at the time of the visit some of the results had to be discarded. The data on twenty-one plants are given. The determination of alkalinity, free CO_2 and p_H were made in the field, while at the same time samples were collected and shipped to the laboratory for the determination of aluminum and iron.

Methods

The determinations of alkalinity and free carbon dioxide were made according to standard methods. Hydrogen-ion concentrations were determined with the use of Clark's indicators and buffer solutions. The analysis of aluminum, iron and phosphorus was made on the residue from a 2-liter sample, which was taken up in hydrochloric acid, separated from silica by filtration and precipitated with NH_4OH according to Blum's method.[2] The ignited precipitate was Al_2O_3, Fe_2O_3 and P_2O_5. Iron was determined colorimetrically according to U.S.P.H. Standard Methods of Water Analysis[18] and phosphorus was estimated colorimetrically by a method given by Deniges,[19] which is briefly as follows: If an acid solution of $SnCl_2$ and an acid solution of $(NH_4)_2MoO_4$ are added to water containing small amounts of phosphorus, a blue color is produced, the intensity of which varies with the amount of phosphate present. These colors may be compared with standard phosphate solutions.

Aluminum was calculated from the difference between the iron and phosphorus and the aluminum, iron and phosphorus.

Reference to such authorities as Aberhalden,[20] Richter[21] and Prideaux[22] indicates that hæmatoxylin is an indicator changing color with the p_H. Hence its use in the aluminum determination would be possible only in a buffered solution. This is accomplished in a measure by blowing breath (CO_2) into the solution or acidifying with acetic acid as recommended by Richards.[23] In addition hæmatoxylin gives various colors with most of the heavy metals. Morison[24] states that "using pure hæmatoxylin a red color was given by the raw water and by a water completely clarified by a dose of alum just sufficient," and Wolman and Hannan[14] state that treated water "showed the usual alumina blue changing to brown with acetic acid." Richards states, however, that the test may be made only in an acid solution in order to avoid the color produced by the alkaline earths. In view of these considerations, the "logwood" or hæmatoxylin test was not used.

Treatment Changes in Alkalinity and p_H

The chemical reactions taking place during coagulation have from time to time been represented in text books and technical articles by various styles of chemical equations. All of these show in the main that 8 mg. per liter of alkalinity will react with 1 grain per gal. of filter alum, forming $Al(OH)_3$. Now, as is very well

known, none of these reactions go to completion, but we have instead a number of reversible reactions each of which depends for its final equilibrium upon all the others. Such complex systems seem to be best represented graphically by the method used by Smith[25] as shown in Fig. 1.

The heavy arrows indicate the direction of the predominating reaction. The substances toward which the light arrows point will be present in relatively small amounts. It should be recalled in this connection that

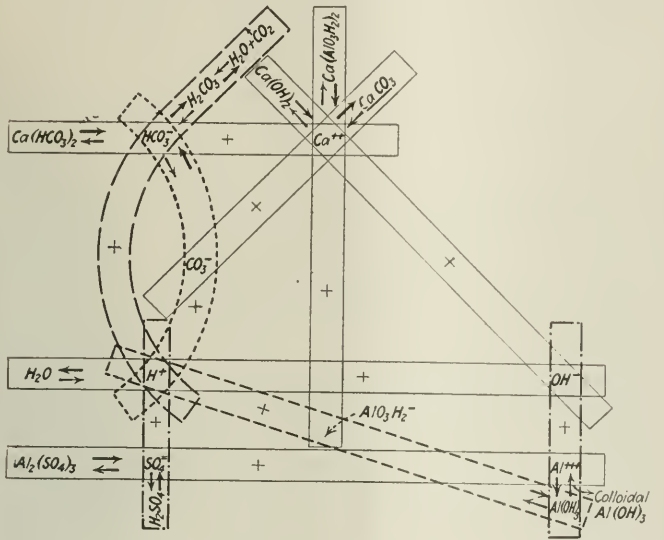

FIG. 1—GRAPHIC REPRESENTATION OF REACTIONS TAKING PLACE DURING COAGULATION

any secondary reaction which tends to remove a product of a primary reaction will increase the amount of the primary reaction in the direction of the formation of the removed product. Numerical coefficients such as are used in "balancing" ordinary chemical equations have been omitted to avoid complicating the diagram. This formulation shows the interdependence of these reactions. It also emphasizes that in each of these equilibria the hydrogen ion plays a part either directly or through its reciprocal relation to the hydroxyl ion. The relation between alum and alkalinity is shown here as in other representations, but it also appears that the loss of CO_2 with the precipitation of $CaCO_3$ may cause a decrease in the alkalinity, and that the addition of lime may cause a net decrease in the alkalinity due to this same precipitation of $CaCO_3$. On the other hand, the formation of colloidal alumina instead of the precipitate would tend to offset the decrease in alkalinity.

TABLE I—ALKALINITY AND $_1$H CHANGES IN FILTRATION

	Alkalinity		Decrease		$_1$H	
Town	Raw	Filtered	Found	Calculated	Raw	Filtered
1	56	62	−6	−12	7.8	8.1
2	116	110	6	5.6	8.3	7.7
3	178	170	8	11 2	8.3	7.5
4	192	186	6	8.0	8.0	7.5
5	180	176	4	8.8	7.6	7.5
6	79	84	−5	2.96	7.5	7.5
7	134	116	18	14.80	8.0	7.4
8	...	124	..	.....	...	...
9	126	112	14	−1.4	7.9	7.3
10	130	108	22	22.4	7.9	7.3
11	160	154	6	21.6	7.3	7.2
12	68	58	10	7.2	7.5	7.1
13	82	71	11	12.0	8.1	7.0
14	58	54	4	3.68	7.5	6.9
15	132	94	38	24	7.9	6 8
16	48	42	6	16	7.2	6.8
17	54	24	30	16	8.4	6.2
18	46	24	22	12.0	8.5	6 2
19	60	16	44	0.8	7.2	6.1
20	24	2	22	16.8	6.8	6.0
21	...	6	..	.....	...	...

An inspection of Table I shows examples of all three of the above-mentioned cases. At four out of nineteen of the plants studied (2, 10, 13, 14) the decrease in alkalinity corresponded to 8 mg. per liter per grain per gal. alum used. At nine plants (1, 7, 9, 12, 15, 17, 18, 19, 20) the decrease in alkalinity was greater than the calculated. This group includes, as would be expected, the three plants at which lime as well as alum was added. At six plants the decrease was less than the calculated.

In addition to those already mentioned we submit the following list of factors which would tend in a measure at least to produce the deviations cited above. Decrease in alkalinity would be caused by: Removal of colloidal iron and aluminum hydroxide and carbonates; removal of alkaline turbidity; titration error caused by adsorption of acid on colloids during titration (Pirnie[16]); excessively acid alum. Factors tending to offset the decrease in alkalinity are: Use of basic alum; precipitation of basic aluminum sulphate instead of aluminum hydroxide; resolution of $CaCO_3$ previously deposited on the sand.

Residual Alum

Reference is made by Wolman and Hannan,[14] Pirnie,[16] Eddy[17] and others to "residual alum" in filtered waters without any statement as to the comparative amounts in the raw and filtered water nor any indication as to what may be a safe limit for this residual alum. The incrustation of sand and distribution mains and the possible adsorption on bacteria (Pirnie[16]) thereby protecting them from subsequent chlorination seem to be the chief objections to "residual alum." Unprecipitated alum has presumably done no work and the inference is that residual alum is an indicator of faulty operation and poor clarification.

TABLE II—R_2O_3 IN RAW AND FILTERED WATER, MG. PER LITER

	Al_2O_3			Fe_2O_3		
Town	Raw	Filtered	Decrease	Raw	Filtered	Decrease
1	1.36	1.86	−0.50	0.14	0.14	0.00
2	20.56	1.5	19.06	0.00	0.0	0.00
3	3.19	2.15	1.04	0.14	0.0	0.14
4	1.81	2.1	−0.30	0.14	0.0	0.14
5	1.36	1.72	−0.36	0.14	0.28	−0.14
6	1.75	1.39	0.36	0.00	1.96	−1.96
7	1.21	1.51	−0.30	0.14	0.14	0.00
8	....	1.86	....	....	....	....
9	2.23	1.25	0.98	0.00	0.00	0.00
10	1.56	1.12	0.44	0.14	0.28	−0.14
11	2.95	1.38	1.57	0.00	0.42	−0.42
12	0.97	12.1	−11.13	0.28	0.00	0.28
13	1.6	1.35	0.25	0.00	0.00	0.00
14	0.76	1.26	−0.50	0.14	0.14	0.00
15	0.82	0.71	0.11	0.28	0.14	0.14
16	2.30	0.71	1.59	0.85	0.14	0.71
17	0.40	3.16	−2.76	0.28	0.994	−0.714
18	0.71	0.17	0.54	0.14	0.28	−0.14
19	3.22	0.66	2.56	1.43	0.14	1.29
20	0.15	0.55	−0.40	1.68	0.71	0.97
21	....	0.16	.....	....	.....	....

Table II furnishes a notion of the extent to which alumina is present in the effluent of twenty-one filter plants in Illinois. In addition to the description of methods given above it should be stated that in all cases except No. 2 the raw water was filtered through Whatman No. 50 filter paper before making the aluminum determinations. Since a comparison of the aluminum in solution or in a fine colloidal state in the raw and treated waters was to be made, it seemed best to exclude the filterable turbidity. The data on No. 2 indicate what the results might have been without the adoption of this procedure. Nos. 12 and 17 are excluded from consideration, since they showed a turbidity in the filtered water of 30 and 25 respectively. Column 2 shows that in only the two abnormal cases, Nos. 12 and 17, does the alumina in the filter plant effluent exceed 2.15

mg. per liter (approximately $\frac{1}{8}$ of a grain per gallon), and further that in thirteen out of nineteen cases the aluminum is distinctly less in the effluent than in the raw water after filtering through filter paper. It should also be noted that although a fairly wide range in p_H value is exhibited by these waters, in no case does the alumina in the effluent reach zero. From our knowledge of the individual plants and their operators we do not feel that this last result can be laid to faulty operation.

From the above data it appears that with reasonably good operation the amounts of "residual alum" occurring in filter plant effluent in Illinois are not such as to be the cause for alarm. Whether or not the condition of the "residual alum" is such that it is more subject to subsequent deposition or adsorption is a question for further study.

Relation of p_H to "Residual Alum"

In the diagrammatic representation of the chemical reactions given above it will be observed that the substances H^+, $AlO_3H_2^-$, $Al(OH)_3$, Al^{+++} and OH^- form a cycle. The reactions may be made to take place in either direction around this cycle depending upon the concentrations employed. Suppose, starting with the substances in the cycle in equilibrium, we take away hydrogen ions; more water will be ionized by the reaction from H_2O in the direction of the light arrow. But this will increase the amount of OH^- present, thereby causing the reaction to go in the direction of $Al(OH)_3$ and removing some of the Al^{+++} from the solution. If the hydrogen-ion concentration is depressed low enough, reaction will take place counter-clockwise in the direction of the light arrow from $Al(OH)_3$ to an appreciable extent, forming some aluminate ion with the side reaction forming some $Ca(AlO_3H_2)_2$. (The aluminate is written in the hydrated form.) If now the hydrogen-ion concentration is increased, the reaction will be turned in a clockwise direction, aluminum will be reprecipitated and later dissolved as Al^{+++}. The exact hydrogen-ion concentration at which the maximum amount of $Al(OH)_3$ is precipitated has not yet been determined. We believe, however, that we are approaching it by slow degrees.

Table III presents a summary of the data collected, the filter plants being arranged in the decreasing order of the effluent p_H values. From column 3 it is seen that with exceptions of Nos. 12 and 17 they also fall in the decreasing order of the residual alum values. To illustrate this point more clearly, the residual alum and p_H values are shown plotted as co-ordinates of points in Fig. 2. Though the points do not lie on a smooth curve, they show a distinct trend toward a minimum of Al_2O_3 at a p_H of about 6. This is much more acid than any value heretofore reported. It is, however, the first value to be determined under operating conditions and with a gravimetric estimation of the Al_2O_3.

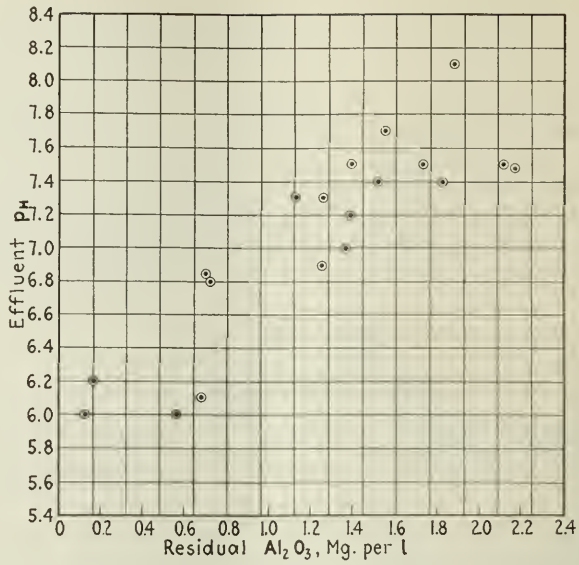

FIG. 2—RELATION OF HYDROGEN-ION CONCENTRATION TO RESIDUAL ALUM

TABLE III—SUMMARY OF DATA

Town	Turb.	Filtered Fe_2O_3	Filtered Al_2O_3	Filtered p_H	Filtered CO_2	Filtered Alkalinity M.O.	Filtered Alkalinity Ph'th	Pre-treatment Chemicals	Pre-treatment Gr. per Gal.	Pre-treatment Time Hr.	Raw Fe_2O_3	Raw Al_2O_3	Raw p_H	Raw CO_2	Raw Alkalinity M.O.	Raw Alkalinity Ph'th
1	5	0.14	1.86	8.1	0.0	62	2	alum lime	0.75 0.75	1	0.14	1.36	7.8	2.0	56	0.0
2	0	0.0	1.5	7.7	2.8	110	0	alum	0.7	2	0.00	20.56	8.3	0.0	116	5.00
3	3	0.0	2.15	7.5	6.8	170	0	alum	1.4	3½	0.14	3.19	8.3	0.0	178	16.0
4	5	0.0	2.1	7.5	7.6	186	0	alum	1.0	3	0.14	1.81	8.0	2.0	192	0.0
5	3	0.28	1.72	7.5	7.2	176	0	alum	1.1	¼–½	0.14	5.9	7.6	4.8	180	0.0
6	10	1.96	1.39	7.5	4.0	84	0	alum	0.37	3	0.00	1.75	7.5	4.4	79	0.0
7	10	0.14	1.51	7.4	8.8	116	0	alum	1.85	1½–2	0.14	1.21	8.0	2.0	134	0.0
8	3	0.14	1.86	7.4	6.0	124	0	alum	0.7	6	....	....	....	....	....	....
9	3	0.00	1.25	7.3	7.2	112	0	alum lime	2.8 1.0	4½	0.00	2.23	7.9	2.4	126	0.0
10	0	0.28	1.12	7.3	8.8	108	0	alum	2.8	6–24	0.14	1.56	7.9	2.8	130	0.0
11	10	0.42	1.38	7.2	13.6	154	0	alum	2.7	4–5	0.00	2.95	7.3	12.0	160	0.0
12	30	0.00	12.1	7.1	6.4	58	0	alum	0.9	4	0.28	0.97	7.5	2.4	68	0.0
13	5	0.00	1.35	7.0	9.2	71	0	alum	1.5	½	0.00	1.6	8.1	0.00	82	0.0
14	20	0.14	1.26	6.9	10.4	54	0	alum	0.46	none	0.14	0.76	7.5	4.0	58	0.0
15	3	0.14	0.71	6.8	15.2	94	0	alum	3	8–24	0.28	0.82	7.9	3.6	132	0.0
16	3	0.14	0.71	6.8	10 0	42	0	alum	2	none	0.85	2.30	7.2	4.0	48	0.0
17	25	0.994	3.16	6.2	23.6	24	0	alum	2	3½	0.28	0.40	8.4	0.0	54	
18	3	0.28	0.17	6.2	19.6	24	0	alum	1.5	4	0.14	0.71	8.5	0.0	46	5
19	3	0.14	0.66	6.1	33.2	16	0	alum lime	0.4 0.5	3 3	1.43	3.22	7.2	6.8	60	0.0
20	5	0 71	0.55	6.0	23.2	2	0	alum	2.1	6–7	1.68	0.15	6.8	6.8	24	0.0
21	3	0.14	0.16	6.0	37.2	6	0	alum	4.5	2						

Summary

The chemistry of the alum-coagulation process is represented by a diagram which emphasizes both the interdependence of the various equilibria involved and the importance of the hydrogen ion.

Data on the alkalinity changes during treatment do not check with expected changes as ordinarily calculated. Various reasons for these discrepancies are discussed.

Data presented indicate in general less dissolved alumina in the effluent than in the influent. The amount of alumina in the effluents did not in general exceed 2 mg. per liter.

Points plotted with "residual alum" and p_H values

as co-ordinates indicate a minimum alumina at a p_H of 6, which was the lowest value reached in this series.

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Motor Fuel Should Be Basis of Evaluation of Shale Oil

Attempts to evaluate shale oils, even for comparative purposes in the laboratory, involve both technical and economic considerations. From a technical standpoint one must consider and determine what possible products can be reasonably expected from shale oils. From the economic side there must be considered which of these possible products will be in greatest demand and how cheaply they can be placed on the market. Possibly in some sections of the country certain products will be in greater demand than in others; and a discussion of how cheaply these products can be produced and marketed leads to a consideration of plant location, transportation, labor supply and similar economic factors, which each plant must individually solve.

Inasmuch as the chief problem in the oil-shale work of the U. S. Bureau of Mines is to determine the conditions most favorable for the production from different shales of highest yields of best products, it must first consider what these products are likely to be; second, determine the amount of these products in the oils under consideration; and finally, determine the relative qualities of these products from different shales.

During the past several years the petroleum products in the greatest demand have been motor fuels, illuminating oils, lubricants and fuel oils. The demand for illuminating oils is increasing very slowly, and no immediate appreciable increase can reasonably be expected. Lubricants will probably be supplied from petroleum for a great many years, since much of the petroleum and petroleum residuums now burned as fuel can be worked into lubricants when the demand for lubricants increases. Oil will continue to be used as fuel until its price exceeds that of an equivalent amount of coal. The demand for motor fuel is, however, likely to grow at an increasing rate. This being the case, it seems likely that, first of all, shale oil will be used as a source of motor fuel, and secondly, possibly as a source of fuel oil. Other products will probably be of secondary importance, and it has been finally decided that shale oils may reasonably be evaluated on the basis of the amount and quality of motor fuel they will produce.

Determining Penetration of Wood Preservatives

The effectiveness of any wood-preservation treatment is measured very largely by the depth to which the preservative penetrates. This can be determined by the following tests, which are used by the Forest Products Laboratory, Madison, Wis.

The presence of creosote oil is indicated by the dark discoloration, and the degree of penetration may readily be determined by taking a sample at a point free from checks and other imperfections and at a considerable distance from the end. This may be done either with an ordinary ½-in. bit or with an increment borer, which brings out a core of wood that shows in cross-section the depth of penetration and is easily examined. The observation should be made at once, because the oil spreads rapidly over the cut surface. In order to prevent infection, the hole in the treated piece should be tightly closed with a creosoted plug.

As zinc chloride is colorless, the depth of penetration of this preservative must be ascertained by chemical means. After cutting the stick in two or getting a sample with the increment borer, the freshly cut surface is dipped for not to exceed 10 seconds in a 1 per cent solution of potassium ferrocyanide, and the excess solution is removed by blotting paper. The sample is then dipped into a 1 per cent solution of uranium acetate and dried. The treated portions will be whiter than the natural wood, and those untreated will have a dark red or a maroon color. This method does not give very sharp contrasts on wood which is reddish in color, like red oak, but otherwise is very satisfactory.

Another method consists in spraying over the freshly cut surface a mixture of equal parts of 1 per cent potassium ferricyanide solution, a 1 per cent potassium iodide solution and a 5 per cent solution of soluble starch. This colors the treated portion a very dark blue, but does not affect the untreated wood.

Sodium fluoride is colorless and no satisfactory method of showing its presence in wood has been devised.

Mercuric chloride is shown by the blackening of the treated area when dipped in a solution of hydrogen sulphide.

Production of Domestic Graphite

There was a decrease of 88 per cent in the sales of domestic crystalline graphite in 1921 and a decrease of 61 per cent in the sales of amorphous graphite as compared with 1920. The following table shows the sales for the last 5 years:

DOMESTIC NATURAL GRAPHITE SOLD, 1917-1921

Year	Amorphous — Quantity (Short Tons)	Amorphous — Value	Crystalline — Quantity (Short Tons)	Crystalline — Value	Total — Quantity (Short Tons)	Total — Value
1917.....	8,301	$73,481	5,292	$1,094,398	13,593	$1,167,879
1918.....	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919.....	3,379	47,716	4,043	731,141	7,422	778,857
1920.....	4,694	49,758	4,816	576,444	9,510	626,202
1921.....	1,842	20,860	595	75,664	2,437	96,524

The Packed Cell Process for Sulphuric Acid

Description of the Construction and Operation of the 25-Ton Unit at Anaconda, Mont.— Comparison of Efficiencies, Operating and Construction Costs Between This Plant and Modern Chamber Installations

By E. L. LARISON

THE packed cell sulphuric acid process developed at Anaconda, Mont., has shown some unusual results which should be of interest to the industry. This process has been developing in increasing sizes since 1917, up to the present plant with a capacity of 25 tons per day. This last installation involves all the apparatus and construction features which will be required in a plant of any size and has given data for the precise designing of all future installations.

This process is one which, like the chamber process, makes use of the reactions between sulphur dioxide, oxygen, water and the oxides of nitrogen. It produces acid of the usual grades made by a chamber plant—namely, 50 to 60 deg. Bé.

The chief points of interest in the process from the standpoint of practical operation are:

1. Cost of plant for a given tonnage is about 50 to 60 per cent of that of an equally well-built chamber plant.
2. Cost of operation is no more and under some conditions is less than that of a chamber plant.
3. Ground area used is only 30 to 40 per cent of that required for a chamber plant of equal capacity.
4. Process is established much more rapidly than is the chamber process, a valuable quality when plants have to stop and start frequently.
5. The maintenance cost is probably lower than that of a chamber plant, although this point cannot be definitely stated, since the existing plant is only 2 years old.

The packed cell plant consists essentially of a source of SO_2, a Glover tower, packed cells, Gay-Lussac towers, acid coolers, pumps and fans. The chemistry of this process is the same as that of the chamber process. It is to the physical and mechanical conditions created in the packed cells that the remarkable acceleration of the acid-producing reactions is due.

Physical Conditions in the Ordinary Chamber Plant

It is interesting to contemplate what may be called the niter processes in use today. We may consider as one extreme those chamber plants consisting of a small number of enormous chambers and as the other, the process under discussion. It is not intended to convey the impression that from an economic standpoint the large chamber plants are poorest, for that is not the case. They do, however, represent the antithesis in reaction speed of the packed cell process.

In those plants consisting of a few very large chambers, the mixture of SO_2, O, N, water and oxides of nitrogen, coming from the Glover tower, moves in a very slow, tranquil way through the chambers. Mixing or agitation and impingement of liquid particles on solid surfaces are slow and infrequent. Some such plants use over 20 cu.ft. of chamber space per pound of sulphur converted to acid per 24 hours. In these plants, too, the ratio of radiation surface of chamber walls and top to volume is low, and the heat of reaction is dissipated slowly, thereby further limiting their acid-making capacity.

In units consisting of a large number of small chambers the movement of the gas mixture is more rapid, mixing and impingement are caused by frequent passage from chamber to chamber, ratio of radiation surface to volume is higher and in some cases only 10 or 12 cu.ft. of chamber space per pound of sulphur per 24 hours is used.

Devices in Use for Cutting Down Chamber Space

We next observe the many schemes in which devices are used before, between and following the ordinary chambers for mixing the reacting gases, cooling them and providing wet surfaces for them to impinge upon. Among the better known of this class of process are the Gilchrist column, the process of N. P. Pratt, the Lunge plate tower and the ordinary packed "intermediate" tower. All these are effective and in some plants using them we find the total reaction space reduced to 7 or 8 cu.ft. per pound of sulphur. In general these processes aim chiefly at producing a more thorough mixing of the reacting gases.

A process which obtains faster reaction by means of high ratio of surface to volume and also by better cooling is that of Mills and Packard, so far used almost entirely in England. This process uses rather small lead chambers built in the form of frustums of cones, over the surfaces of which water is circulated. These plants have been operated using only about 4 cu.ft. of chamber space per pound of sulphur per 24 hours.

The rapid reaction attained in these chambers is probably due to unusual mixing, to the large amount of surface presented to the reacting gases and to the ability to use an unusually large proportion of nitrogen oxides in the gas mixture without raising the temperature of the chambers excessively.

Factors Influencing Reaction Velocity

A consideration of the facts briefly stated above, together with other phenomena of the niter processes, leads to these conclusions:

1. The velocity of the cycle of reactions between SO_2, O, water and the oxides of nitrogen, to form sulphuric acid, is greatly increased by vigorous mixing of the reacting gases.
2. The velocity of the cycle of reactions between SO_2, O, water and the oxides of nitrogen, to form

sulphuric acid, is increased by causing the gas mixture to impinge frequently upon wet surfaces.

3. The velocity of the cycle of reactions between SO_2, O, water and the oxides of nitrogen, to form sulphuric acid, is increased as the proportion of the oxides of nitrogen to the other components increases up to some proportion not yet indicated in commercial work.

4. In using proportions of nitrogen oxides appreciably greater than those used in well-managed chamber plants, it is necessary to provide means for controlling the temperature of the reacting gases more effective than simple radiation from the chamber surfaces to the surrounding atmosphere.

It was with these ideas in mind that the packed cell process was developed.

Details of the Packed Cell Plant

As the most effective practical means of causing vigorous mixing of the gases and at the same time providing a large amount of wet surface for cooling impingement and condensation, a column of acid-resisting brick was adopted. This is incased in lead or masonry and the reacting gases are driven through it by fans. The brick packing is so laid and the cross-sectional area is such that no unreasonable resistance to the passage of the required gas volume is offered. On account of structural considerations this packed column is built as a series of cells or towers.

It has been possible to design and build a plant entirely without lead chambers and consisting simply of a Glover tower, a set of packed cells and Gay-Lussac towers, to make acid at a rate corresponding to 1 cu.ft. of gross packed cell volume per pound of sulphur per 24 hours. When operating with a 7 to 8 per cent SO_2 gas, about 10 minutes is occupied in the passage of any given portion of gas from the entrance of the Glover to the exit stack. The plant which has been built and operated at Anaconda is shown in Figs. 1 to 7.

This plant operates on gas derived from roasting copper concentrate in a Wedge furnace. The gas is drawn from the furnace dust chamber through a 24-in. asbestos-covered steel flue, by a No. 11 Buffalo Forge "B" volume blower, provided with overhung runner, water-cooled bearings and a water-cooled gland where the shaft enters the case. The fan case is cast iron and the runner is of steel plate on a cast hub.

The fan forces the gas into the Glover tower, which is of standard design and dimensions. It is sheathed with lead and packed with Anaconda brick of standard dimensions. Two 4 x 4 x 4 ft. coolers receive and cool the outflowing acid. This division of the plant is just as would be provided for any chamber plant of equal capacity.

From the top of the Glover tower the gases pass

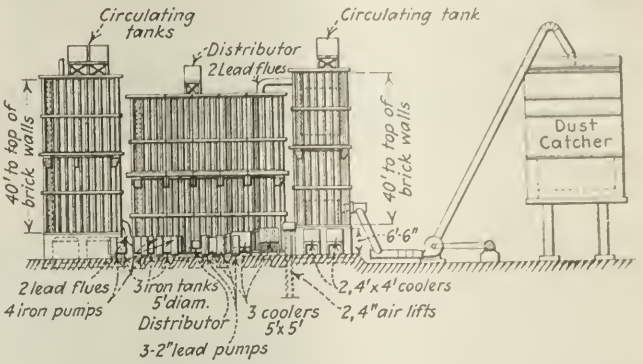


FIG. 2—ELEVATION OF 25-TON PACKED CELL PLANT AT ANACONDA

through a pair of flues to the packed cells. There are five of these packed cells built in one block and sheathed with lead. They are packed with acid-resisting brick of standard shape. The gas flow is down in No. 1, up in No. 2, down in No. 3, and so on. Experiment showed that there is no difference in efficiency whether the flow be up or down. Each cell is provided with its own acid-distribution system. The acid issues from the bottom of each cell into a launder and is conducted to the first of a set of three coolers in series. The cooled acid is pumped up to the distributing tank on top of the cells by a centrifugal pump. The gravity of the acid leaving the cells is maintained at such a point that it will take into solution neither SO_2 nor the oxides of nitrogen, that is 48 to 50 deg. Bé. This is accomplished by running water into the distributor boxes as needed. No water atomizers or steam are necessary. By varying the flows on the cells very close control of the gas temperatures can be maintained.

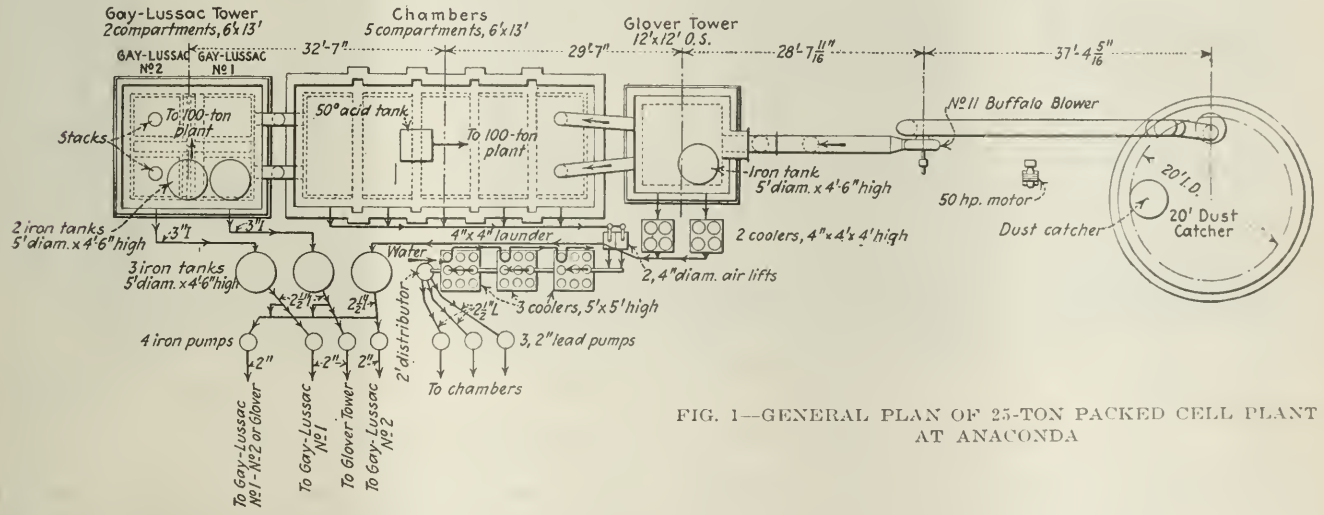


FIG. 1—GENERAL PLAN OF 25-TON PACKED CELL PLANT AT ANACONDA

Effect of Acid Concentration on Reaction Velocity

Some interesting data regarding reaction speed in towers using different acid concentrations were ob-

tained in the course of the experimental work. On account of conducting the burner gas a long distance, its temperature on entering the Glover tower was so low that it could not denitrate the nitrous vitriol fed, if the issuing acid was kept up to 60 deg. Bé. We ran for some time, therefore, with so large a quantity of 48 to 50 deg. Bé. acid and water going in with the nitrous vitriol that the issuing acid was only 50 deg. Bé. While this condition existed about 25 per cent of all the SO_2 entering the tower was converted to sulphuric acid. The Gay-Lussacs were meanwhile supplied with 60 deg. acid from the chamber plants. While operating in this way the plant was not, of course, an independent unit.

When the temperature of the gas entering the Glover was increased so that denitration could be accomplished with the issuing acid at 60 deg. Bé., the water was cut off and the flow of weak acid reduced. In other words, the conditions became normal Glover tower conditions. Running in this way, the tower converted to H_2SO_4 only 10 to 15 per cent of the SO_2 entering. This is the way in which the tower must be operated for the plant to be self-sustaining.

The experience indicates that the reactions progress more rapidly when the acid present is around 50 deg. Bé. than when it is around 60 deg. Bé., which is another way of saying when the nitrogen compounds will not exist in solution, but only in the gaseous condition.

There are two Gay-Lussac towers built in one block with an interior downtake flue between them, so that the gas flow is upward in both. These towers have masonry walls and are sheathed with lead. They are packed with standard brick.

The acid throughout the plant is pumped by Lewis vertical submerged centrifugal pumps with direct-connected motors. The pumps for the tower acid, which runs 60 to 61 deg. Bé., are of iron, and those for the weak acid are of hard lead and lead-lined iron.

A consideration of the principles of this process discloses the feasibility of using masonry walls instead of lead for the packed cells. This follows from the fact that the circulation acid in the cells provides for cooling so that radiation from the walls can be neglected.

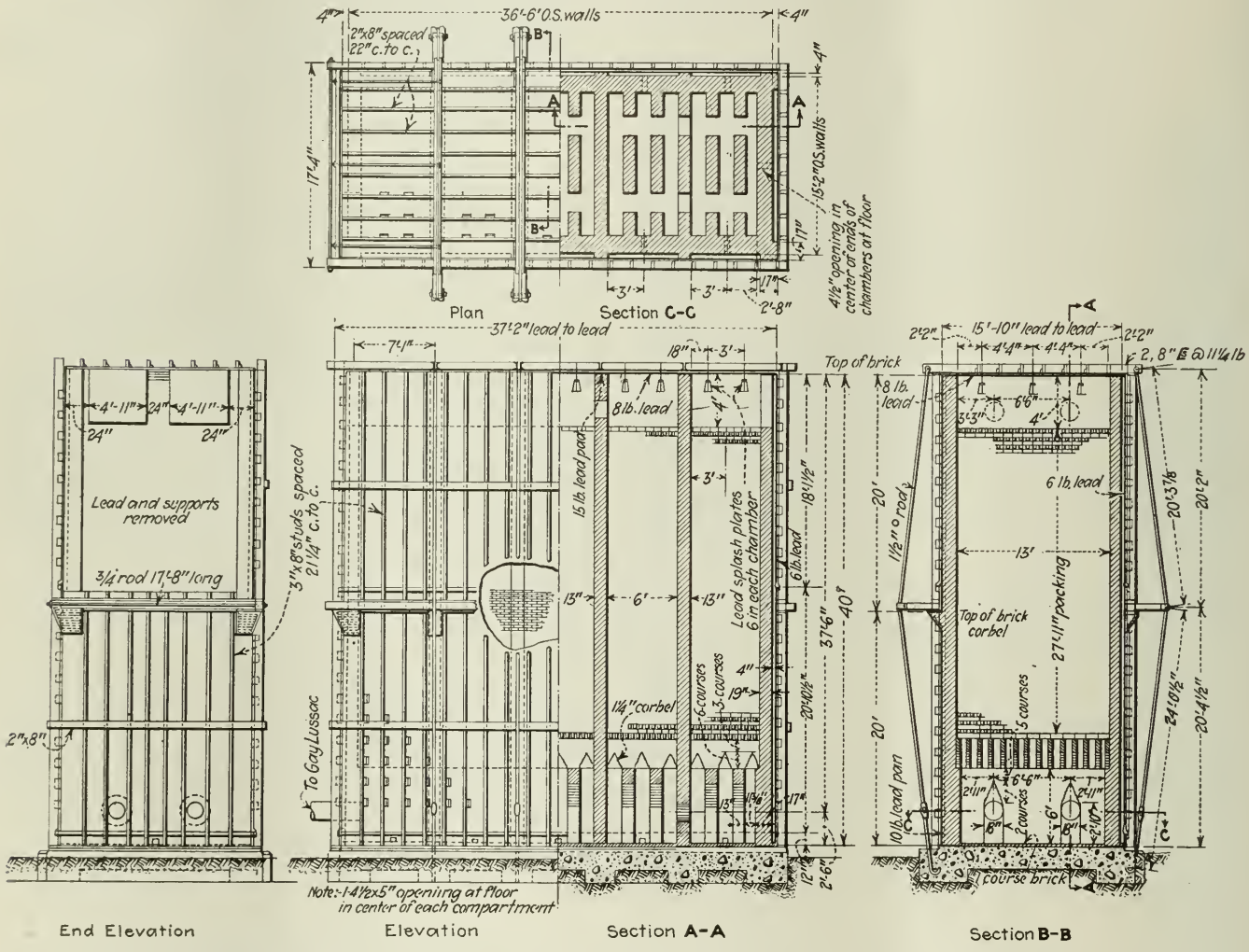


FIG. 3—DETAIL OF PACKED CELLS. 25-TON PACKED CELL PLANT AT ANACONDA

At the same time some rather contradictory reports and experiences as to acid-proof masonry being gas tight led to the decision to build, in the case of this pilot plant, the cells and the Gay-Lussac towers with masonry walls and to sheath them with light lead, thus assuring a tight plant with which to work out the operating details. After the plant had been operated for several months and satisfactory results and data had been obtained, a part of the lead sheathing was removed from the packed cell block. It was found that the masonry wall alone was quite tight and entirely satisfactory. A consideration of this structural aspect will be taken up later.

This plant was built in the winter of 1918-1919, upon

the basis of data obtained from experiments upon a smaller scale. It was put into operation about May 1, 1919, and operated without interruption until Oct. 1, at which time a lack of demand for acid necessitated shutting down. In the spring of 1920 the plant was run for about 6 weeks, when inability to dispose of the product again caused a shut-down. Since that time, conditions have not been favorable to a resumption of operation.

The source of SO_2 from which acid is made at Anaconda is three Wedge furnaces roasting copper cencentrate. This concentrate carries about 8 per cent copper and ranges from 32 to 40 per cent sulphur. The gas produced is somewhat irregular and ranges from 7 to 8 per cent SO_2. This set of furnaces furnishes gas for two chamber plants and for the packed cell plant. The niter consumption in the chamber plants is 4 per cent on the sulphur in the acid produced. In view of the irregularity of the gas and the fact that Anaconda is 5,300 ft. above sea level with a normal barometric pressure of 622 mm., a 4 per cent niter loss is not abnormal.

It is, in fact, comparable with 3 per cent niter loss in a plant burning brimstone and at a lower elevation. In considering the performance of the packed cell plant these conditions must be borne in mind and comparison in the matter of niter loss and production made with the chamber plants operating under the same conditions and not with a plant burning brimstone at sea level.

Performance of the Packed Cell Plant

The average daily production of the packed cell plant over a period of a little over 6 months was 20.3 tons of 60 deg. Bé. or 25.5 tons of 50 deg. Bé. acid. Direct figures on the yield in terms of acid produced per ton of sulphur burned could not be obtained because of the fact that all three plants were taking gas from the same battery of roasting furnaces. Very close control on the amount of SO_2 in the gas going to the Gay-Lussac towers was maintained, however, so that the yield was necessarily very high. The consistently low exit test is shown in the operating log, Table I.

The average daily niter consumption during the same period was 670 lb. of $NaNO_3$, or 6.6 per cent, figured on the sulphur in the acid produced. During the early part of the operation the niter consumption was around 8 per cent. This was consistently reduced as the operators became accustomed to the plant, and practice was improved so that during the last weeks of the run the niter loss was running about 4.4 to 4.5 per cent on the sulphur.

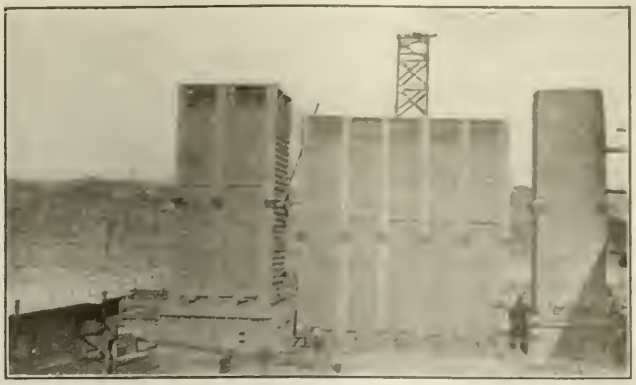


FIG. 4—25-TON PACKED CELL PLANT AT ANACONDA DURING CONSTRUCTION

Extensive tests were made to determine the character of the niter loss. These showed that about 55 per cent of the total niter in the stack gases could be absorbed by further contact with 60 deg. Bé. acid. It is quite certain, therefore, that by providing additional Gay-Lussac space, the niter loss in this process will be no more than that in a chamber plant operating under parallel conditions.

Comparison of Niter Rate in Chamber and Packed Cell Plants

A brief analysis of the niter recovery and loss figures of the packed cell process in comparison with the chamber process is in order. It has been mentioned that the unusual speed of reaction attained in the former is largely due to its ability to use higher than the ordinary proportions of the oxides of nitrogen.

In the usual chamber process the total amount of niter (nitrous vitriol plus fresh niter) introduced into the Glover tower, expressed in terms of $NaNO_3$, is 20 to 30 per cent of the amount of sulphur introduced in the same time. For example, if a plant makes 50 tons of 60 deg. acid in 24 hours, approximately 12.5 tons of sulphur as SO_2 is put in and there will be introduced as nitrous vitriol plus the gases from the pots, or fresh

TABLE I—SEVEN DAY LOG OF ANACONDA 25-TON PACKED CELL PLANT

	April 12	April 13	April 14	April 15	April 16	April 17	April 18
Tons 60 deg. Bé. produced	19.7	21.09	19.64	21.03	19.6	22.51	24.9
Lb. 96 per cent $NaNO_3$ used	516	388	387	513	424	400	465
Per cent $NaNO_3$ on S basis	5.2	3.7	3.9	4.9	4.3	3.5	3 9
Per cent SO_2 entering cell 1							
Shift 1	7.3	7.1	7.0	7.1	6.8	6.3	6.7
Shift 2	7.1	6.7	6.5	6.7	6.7	5.8	6 1
Shift 3	6.6	6.6	6.3	6.7	6.1	6.4	5 6
Per cent SO_2 entering cell 5							
Shift 1	0.025	0.015	0.01	0.015	0.022	0.027	0.01
Shift 2	0.01	0.01	0.01	0.01	0.01	0.01	0 01
Shift 3	0.01	0.01	0.008	0.009	0.009	0.011	0 011
Oz. $NaNO_3$ per cu.ft. in acid from Gay Lussac No. 1	1.79	81	77	77	74	68	70
Oz. $NaNO_3$ per cu.ft. in acid from Gay-Lussac No. 2	2.33	33	30	27	26	21	20
Temperature gas entering Glover, deg. F.	531	539	561	546	524	550	574
Temperature gas entering cell No. 1, deg. F.	172	170	169	174	166	167	171
Temperature gas entering cell No. 3, deg. F.	166	163	161	159	159	162	164
Temperature gas entering cell No. 5, deg. F.	118	121	120	125	123	115	124
Temperature gas entering Gay-Lussac No. 1, deg. F.	86	89	90	93	94	93	94
Deg. Bé. acid from Glover	60.6	60.2	60.1	60.0	60.1	60.1	60 1
Deg. Bé. acid from cells	48.5	48.5	48.5	48.6	48.6	48.6	48.3
Temperature acid to cell cooler No. 1, deg. F.	134	137	138	132	125	134	139
Temperature acid from cell cooler No. 1, deg. F.	94	91	91	90	89	90	94
Temperature acid from cell cooler No. 2, deg. F.	74	72	72	71	71	72	73
Temperature acid from cell cooler No. 3, deg. F.	62	61	62	60	60	62	61
Pressure difference cell No. 1 to exit stack, inches water	0.30	0.34	0.38	0.35	0.39	0.35	0.41

SO_2 entering cell No. 1 determined by caustic absorption in Orsat.
SO_2 entering cell No. 5 determined by Reich test using N/500 iodine with acetate mixture.
Nitrosity of Gay-Lussac acids determined by titration with permanganate solution.
Pressure difference determined with Ellison differential draft gage.
SO_2 figures represent averages of tests made every 30 minutes. All other tests made hourly.
SO_2 in gas entering Glover is about 15 per cent higher than in gas entering Cell No. 1. Tests were made at latter point because the location was more convenient.

nitric acid, the equivalent of 5,000 to 7,500 lb. of $NaNO_3$. It has been found that niter in this proportion range will react with SO_2, O and water to the extent of converting substantially all of the SO_2 to sulphuric acid in from 1 to 2 hours, depending upon the construction of the chamber set. Such a gas mixture will develop sufficient reaction heat, with the sensible heat already in it from the burners, to produce in the front chambers temperatures approaching 100 deg. C.

If we attempt to make this set of chambers produce 100 tons of acid instead of 50 tons, it will be necessary to put through it twice as much SO_2 as before—i.e.,

FIG. 5—SIDE VIEW OF 25-TON PACKED CELL PLANT AT ANACONDA

assuming the same volume per cent of SO_2 in the gas, a given portion of gas will pass through the chambers in one-half the time it took when the plant was making 50 tons. In order to convert completely the SO_2 to H_2SO_4 in this reduced time, it will be necessary to substantially double the proportion of the nitrogen oxides, or to introduce in a given time four times as much as when the plant was making 50 tons per day. If this were done, we would find that due to the limited radiating capacity of the chambers the temperatures in the leading chambers would be too high for the proper reaction cycle and the process would work badly, with low yield and excessive niter loss.

In the packed cell process the ratio of sulphur to total nitrogen oxides introduced, in terms of $NaNO_3$, is about 10 to 7. In other words, where the chamber plant can rarely handle niter to the extent of more than 30 per cent of the sulphur, the packed cell plant can readily use 70 per cent, the reason being, as mentioned, the control of temperature afforded.

It should be clearly understood that the above figures do not mean new niter introduced—i.e., niter loss—but total niter, including nitrous vitriol.

In the chamber process operating at Anaconda under the same conditions, the total niter circulation is about 25 per cent on the sulphur and the niter loss is about 4 per cent. In the 50-ton chamber plant, for example, the sulphur input is about 25,000 lb., the total niter introduced about 6,250 lb. and the niter loss about 1,000 lb. per 24 hours. The loss, therefore, is 16 per cent and the recovery 84 per cent.

It will be readily seen that in a process using 70 per cent niter circulation instead of the customary 20 to 30 per cent, a much higher percentage recovery is necessary. If, for example, in a 50-ton-per-day plant we introduce the equivalent of 17,500 lb. of $NaNO_3$, which is 70 per cent of 25,000 lb., and wish to sustain a loss of only 1,000 lb., we must make a Gay-Lussac recovery of 94 per cent.

It is customary in chamber plants to provide from 125 to 175 cu.ft. of gross packed Gay-Lussac volume per ton of 60 deg. acid made. This amount gives ordinarily about the 84 per cent recovery mentioned. In the 25-ton packed cell plant under discussion the Gay-Lussac space provided is 213 cu.ft. of gross packed volume per ton of 60 deg. acid made. Total niter introduced amounted to about 7,000 lb. per 24 hours. Using the average loss figure of 670 lb., the recovery was 90 per cent. During the latter part of the operation, when the loss was about 460 lb., the recovery was about 93 per cent.

Niter was introduced into this plant in the form of mixed nitric and sulphuric acid, the production of which was described in a previous article.[1]

The question naturally arises why is it not possible in this type of plant to increase still further the niter circulation, decrease the volume of the packed cells and increase the Gay-Lussac space to get the additional niter recovery necessary. Perhaps this can be done to a limited extent. However, acid makers generally agree that there will inevitably be some niter going out the stack which is not soluble in sulphuric acid. Whether this be nitrogen compounds in a state of oxidation below NO or what not, it seems that between 3 and 5 per cent of the total nitrogen oxides introduced is not recoverable in Gay-Lussac towers. Somewhere, then, not far above the proportion carried in the present operation, an economic balance arises in the matter of niter ciculation beyond which it is not well to go.

Suppose, for example, a 95 per cent recovery of total niter introduced is all that we can recover even with

[1] "Introduction of Niter Into Sulphuric Acid Processes as Mixed Acid," by E. L. Larison, CHEM. & MET. ENG., vol. 26, No. 14, April 5, 1922, p. 642.

FIG. 6—END VIEW OF 25-TON PACKED CELL PLANT AT ANACONDA

greatly increased Gay-Lussac space. Assume that a niter circulation double that mentioned, or 140 parts of $NaNO_3$ per 100 parts of sulphur, be used. If 5 per cent of the niter be lost, the niter rate as $NaNO_3$ on the basis of sulphur will be 7 per cent.

A plant to operate with such niter proportions would need less cell space and more Gay-Lussac space than one using the 70 to 100 proportion and its cost would be almost the same. It is obvious, therefore, that the economic limit of niter circulation lies near that used in the present operation.

Power

The power used is all electrical, no steam or air being required. For pumping acid to the Gay-Lussac and Glover towers three centrifugal pumps were run continuously. The amount of acid fed to each tower was about 75 tons per 24 hours, so the total amount pumped was about 225 tons. These pumps are equipped with 5-hp. motors. The full capacity of these pumps is about 250 tons per day, so they were less than one-third loaded.

The acid for the cells was circulated by one centrifugal pump running continuously. The amount of acid fed to the cells was 250 to 275 tons per day. This pump is equipped with a 5-hp. motor and was pumping to full capacity.

The motor driving the draft fan used 20 hp.

Water

Water used for cooling the acid amounted to 50,000 to 60,000 gal. per 24 hours. It was not necessary at Anaconda to re-use the cooling water, but in case such procedure were necessary it would present no difficulties.

Labor and Maintenance

The plant was operated by one operator with one helper per shift. The operator made hourly observations and records of the SO_2 percentages of the gas entering the first and fifth cells, the nitrosity of the Gay-Lussac acids, the gravity of the Glover and cell acids and the draft gages. Operation of the pumps was entirely automatic. The helper had very little to do.

On account of the very compact nature of the plant and the fact that there are no actual operations to be performed (assuming that SO_2 is available as a by-product of the smelter) but simply regulation of acid and gas flows, a plant of any size can be operated by two men per shift.

The plant has not been operated long enough to require repairs of any consequence. The centrifugal pumps are very satisfactory. One pump of this type has been in use in one of the chamber plants for 3 years without any repairs whatever. So far as the operation has gone it seems reasonable to expect the general repair and maintenance costs to be smaller than those of a chamber plant.

Comparison of Costs

A general consideration of operating and repair cost figures on chamber plants and the packed cell plant at Anaconda leads to the conclusion that with plants of the same tonnage capacity the costs mentioned over a period of years will be at least equal for the two types of plant and probably lower for the packed cell type. In the matter of interest and depreciation charges the packed cell plant shows a very great advantage, since its first cost is so much less than that of a chamber plant.

The 25-ton pilot plant at Anaconda described and illustrated herein cost $68,066. It has been mentioned that the cells and the Gay-Lussac towers were built with both masonry and lead walls in order to assure a tight plant. The cost of the lead sheathing and its supporting framework on these two structures was $14,000. The cost of the plant without this precautionary sheathing was $54,000.

It is only fair also to say that at the time this plant was constructed, 1918-1919, material and labor prices were at a very high point. Some unit costs of the chief items of this construction were as follows:

Leadwork in place, per ton	$305
Brick in place in mortar, per thousand	52
Brick in place, dry, per thousand	27
Concrete in place, per cubic yard	17
Woodwork in place, per thousand	167

A considerable part of the lumber used was Douglas fir, which cost at the time $75 per thousand feet.

The experience gained in the construction and operation of this plant has made it clear that the cell and Gay-Lussac portions of future plants may be built with either the conventional lead shells and without masonry interior walls, or with masonry walls unsheathed. This latter construction has been demonstrated to be entirely satisfactory here in the Anaconda plant and at many other places as well. In designing future plants, therefore, it is necessary to ascertain the respective costs of the two kinds of construction and to use that one which is least expensive. The relative costs will depend largely upon the market price of lead, the freight haul and the cost of suitable brick- and mortar-making materials.

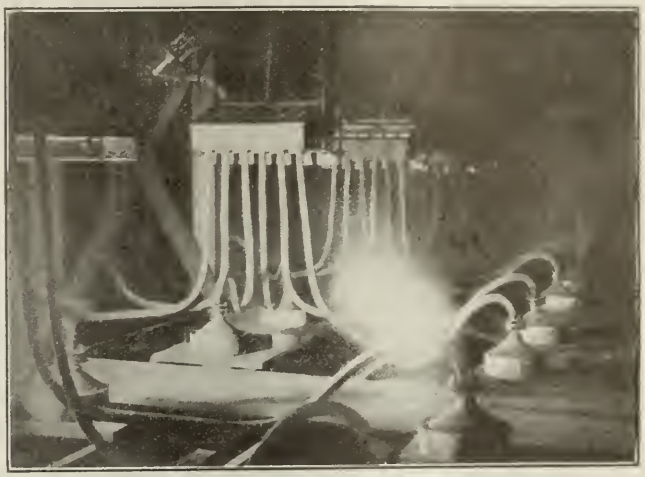


FIG. 7—ACID DISTRIBUTORS ON CELLS

At Anaconda the masonry construction is decidedly less expensive because bricks cost only $10 to $12 per thousand, and excellent ground silica costs about $3.50 per ton. Moreover, lead and steel are comparatively expensive because of the long freight haul. It may be said in general that when sheet lead and pipe can be laid down at the plant for 7c. and standard acid-proof brick for $25 to $30 per thousand, the cost of the two kinds of construction will be about equal.

Acid-Proof Brick Used at Anaconda

Some discussion of the brick suitable for this work is pertinent. For the past 5 or 6 years brick made from slime tailings produced in the concentration of the Butte ores have been used at Anaconda for tower walls and packing in the sulphuric acid plants here. This brick is entirely satisfactory for the purpose. The analysis of

the material is as follows: Silica, 74 per cent; iron, 1.6 per cent; lime, 1.1 per cent; alumina, 19.1 per cent; magnesia, 1.3 per cent.

The method of manufacture is simple. The slime is delivered to the brick plant containing varying amounts of moisture up to 22 per cent. It is fed into a rotary drier with a small percentage of sand, and the mixture is dried to about 15 per cent moisture. After being discharged from the drier the material passes through a set of conical rolls and thence into a pug mill. This machine, into which usually a little water is fed, thoroughly mixes the mass and delivers a homogeneous stiff mud. This mud is fed to an auger machine, which makes plain wire cut brick. After passing through a tunnel drier the brick are burned in an Oregon continuous kiln. No attempt is made to vitrify, and while the brick are hard and have a good ring there is no suggestion of a glaze.

Variations in Analysis of Satisfactory Brick

This Anaconda slime is, of course, of an excellent natural chemical composition. In order to show that considerable variations in analysis may exist between different grades of brick satisfactory for acid plant construction, analyses of two other bricks used in plants under the writer's observation are given herewith.

No. 1. A brick manufactured by an Eastern factory especially for acid work analyzes: Silica, 62.8 per cent; iron, 6.9 per cent; lime, 1 per cent; alumina, 23.7 per cent; magnesia, 1 per cent.

No. 2. A paving brick made on the Pacific coast analyzes: Silica, 64.8 per cent; iron, 4.6 per cent; lime, 3 per cent; alumina, 26.2 per cent; magnesia, 1.2 per cent.

With these analyses and several others in view, showing considerable ranges in the silica, iron, lime and alumina percentages, it seems fairly evident that in almost any locality satisfactory acid-resisting brick can be obtained at reasonable prices. It should not be assumed that any brick will do, because some brick, for chemical or mechanical reasons, disintegrated badly. Usually tests on crushing strength, weathering after saturation with acid, chemical analysis and general physical characteristics tell the acid engineer whether the brick is proper for the work.

The mortar used for laying acid-resisting masonry at Anaconda is made by mixing 30 deg. Bé. silicate of soda solution with finely ground Dillon rock, which is an almost pure natural silica. This mortar sets slowly, as the hardening is simply due to evaporation. It should be permitted to stand several weeks in an atmosphere as warm and dry as possible, in order that it may become thoroughly hard. After this set has taken place the masonry is sprayed or washed with sulphuric acid, which reacts with the silicate of soda to form silica and sulphate of soda. The mortar mass after this treatment consists of about 85 to 90 per cent of SiO_2 and 10 to 15 per cent $NaSO_4$ and water. In this condition it is practically unaffected by acid or water.

During the period of laying and hardening and up to the treatment with acid, acid-resisting masonry should be protected from rain or snow and kept as warm and dry as possible. This often means that during the construction of a packed cell plant of the masonry type a temporary shed must be constructed. In some cases when the climate and season are favorable only tarpaulin covers are required. In the case of the lead shell construction no such protection is necessary at any time.

Packed cell plants have been designed in 10, 25, 50, 100 and 250 ton capacities. In

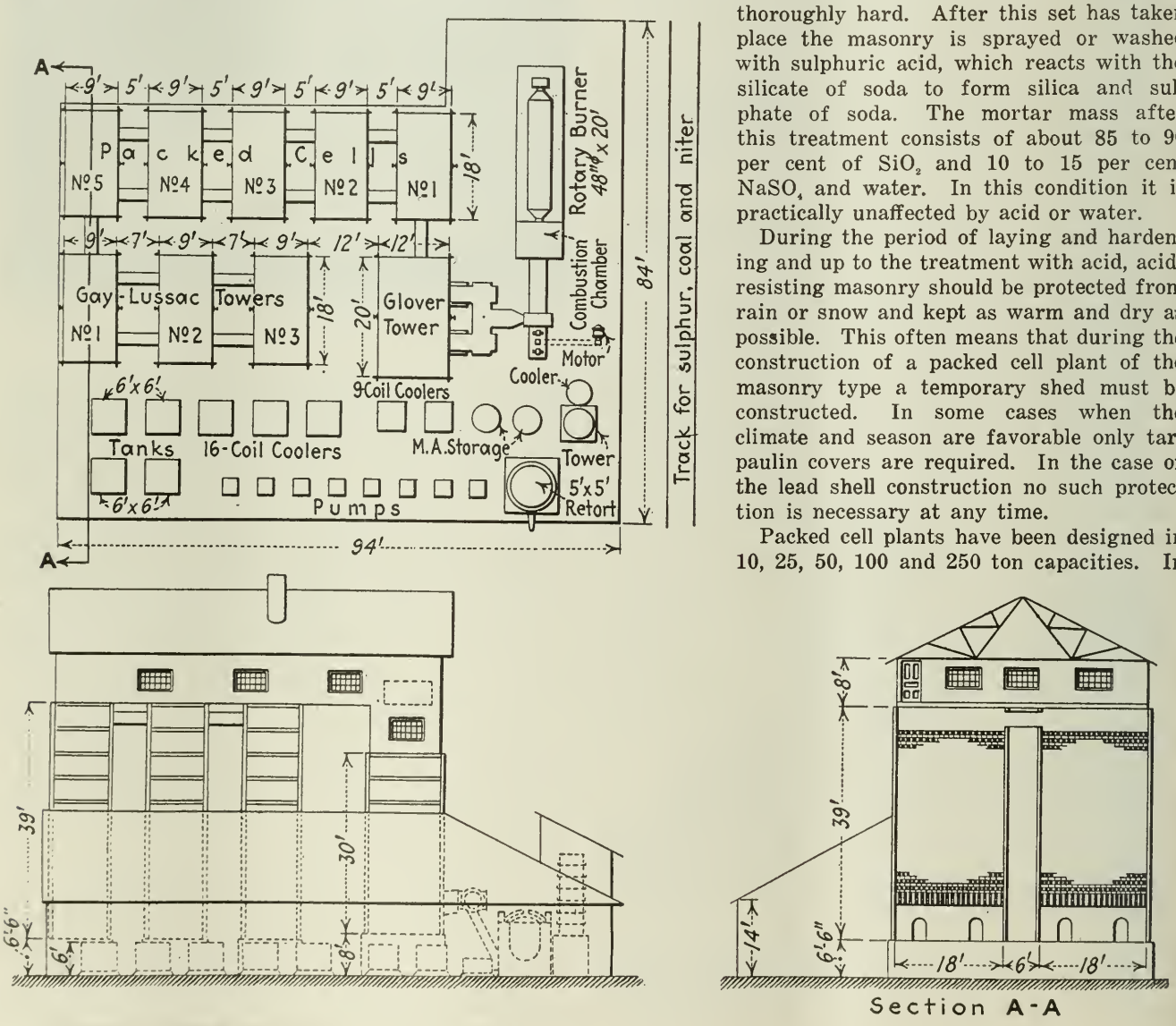


FIG. 8—GENERAL LAYOUT OF A COMPLETE 50-TON PACKED CELL UNIT OF THE LEAD SHELL TYPE

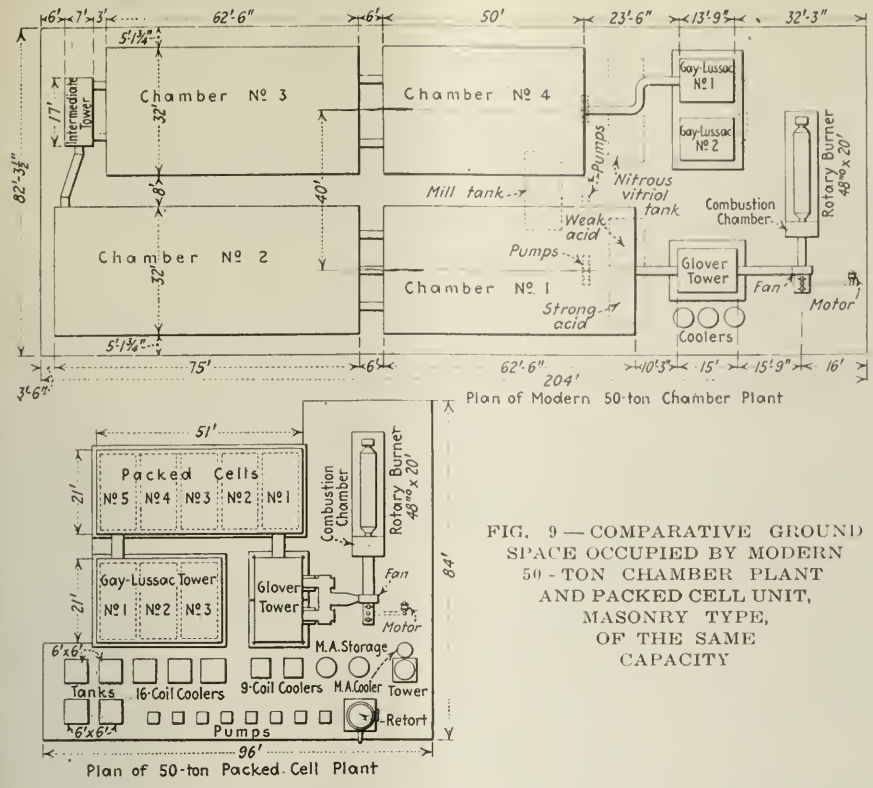


FIG. 9 — COMPARATIVE GROUND SPACE OCCUPIED BY MODERN 50-TON CHAMBER PLANT AND PACKED CELL UNIT, MASONRY TYPE, OF THE SAME CAPACITY

order to show the principal features of the plants as now designed Figs. 8 and 9 are shown of a 50-ton 60 deg. acid per day packed cell plant of brick construction and another of lead shell construction.

In Table II are given the relative costs of the two kinds of construction and the quantities of materials required for each.

Fig. 10 shows the relative ground space occupied by the packed cell plant of 50-tons-per-day capacity, and a modern chamber plant of the same capacity.

Comparative Costs of the Two Types of Packed Cell Construction

The chief advantage offered by the packed cell process is its low first cost. For example, a 50-ton 60 deg. Bé. acid per day plant can be built at present for something between $110,000 and $120,000, depending on local conditions. The cost of a chamber plant of this same capacity built in 1921 by one of the leading engineers in this country was approximately $220,000. This is a brimstone plant and the expenditure included the cost of the burner equipment. Another modern chamber plant completed in the early part of 1921 cost about $180,000 and has a rated capacity of 40 tons per day, which is in almost the same proportion.

If a chamber plant costs $220,000, produces 16,500 tons of acid per year, and is amortized at 12 years, the charge against the acid is $1.11 per ton. If the packed cell plant costs $120,000, produces 16,500 tons per year and is amortized at 12 years, the charge against the acid is $0.58 per ton.

With sulphur at $16 per ton, the cost of acid, including the amortization charge, is not far from $8.50 per ton of 60 deg. acid for the chamber plant of average size. For the packed cell plant this cost is about $8.

If the acid from each plant be disposed of to yield $10 per ton, the annual profit from the chamber plant on 16,500 tons is $24,750, which is 11.2 per cent on the $220,000 invested. The profit from the packed cell plant is $33,000 per annum, which is 27.5 per cent on the $120,000 invested.

This process is covered by Patent Specification 1,342,024.

TABLE II—COST ESTIMATES FOR 50-TON PACKED CELL PLANTS

	—Lead Sheathed—		— Masonry —	
	Amount Required	Cost	Amount Required	Cost
Excavation		1,000		1,000
Concrete @ $15	462 yd.	6,930	489 yd.	7,335
Brick in mortar @ $60	121 M.	7,260	346 M.	20,760
Brick dry @ $35	507 M.	17,745	507 M.	17,745
Lead in place @ $250	160 tons	40,000	85 tons	21,250
Steel erected @ $125	36 tons	4,500	12 tons	1,500
Woodwork @ $100	75 M.	7,500	75 M.	7,500
Roofing @ $25	160 sq.	4,000	160 sq.	4,000
Doors and windows		1,200		1,200
Pumps, 8 @ $500		4,000		4,000
Fans and flues		2,000		2,000
Lead valves		775		775
Painting		1,100		1,000
Electric wiring		1,200		1,200
Sulphur burner		4,000		4,000
Nitric plant		3,900		3,900
Water piping, sewers and miscellaneous, $5,000 to		10,000		10,000
		$117,110		$109,165
Temporary protection shed				5,000
Total		$117,110		$114,165

The Mica Industry in 1921

The mica industry in 1921 on the whole reflected the general depression of business all over the country, according to a preliminary report issued by the United States Geological Survey. The decrease in the domestic output, sales and prices is marked and is not balanced by an increase in the imports. Several mica companies, especially in the South, were idle the entire year, and one large company discontinued business entirely.

Preliminary figures showing the quantity and value of mica sold in the United States in 1921 give a total of 3,854 short tons, valued at $174,838. Of this quantity 371 tons (741,190 lb.), valued at $117,989, was sheet mica; the rest was scrap mica. These figures are obtained from reports received by the Geological Survey from 97 per cent of the producers and others engaged in the mica business.

The production was made by eight states—North Carolina, New Hampshire, Virginia, New Mexico, Georgia, South Dakota, Colorado and Wisconsin, named in order of total value of mica sold from greatest to least.

The total quantity of uncut sheet mica sold in 1921 shows a decrease of about 56 per cent, and the value a decrease of about 78 per cent; scrap mica showed decreases of about 39 per cent in quantity and of about 66 per cent in value, as compared with 1920. Comparisons cannot strictly be made with any year previous to 1920, as the figures for those years include cut mica, or mica that has been through several stages of preparation for the market and thereby commands a higher price than uncut mica.

The average price per pound of all sheet mica sold in the United States in 1921 was 16 cents, as compared with 32 cents in 1920, and the average value per ton of scrap mica fell from $29 in 1920 to $16 in 1921.

Electric Steel Plant at the Southern Pacific Shops

Six-Ton Heroult Furnace Produces All the Steel Castings for the Large Western Railways as a Side Line —For a Year It Produced Rivet Steel From Miscellaneous Scrap, and Now Is Working on an Order for One Million Tie Plates

By LARRY J. BARTON

ONE of the largest railroad systems in the world, the Southern Pacific company, located its general shops at Sacramento, Cal., where it maintains large and well-equipped manufacturing and repair facilities. These shops have been in existence since the late '80s, gradually expanding to handle current needs. They now include practically every branch of industry necessary for the complete manufacture of all classes of locomotives and cars, besides being able to attend to the necessary repairs for other branches of the service such as steamboats and electric trains. A late acquisition is a steel-making shop, comprising a 6-ton Heroult electric furnace, with the necessary equipment for the making of ingots and castings.

Previously it has been the practice to collect old scrap, pile it carefully in bundles, wire the bundles tightly and send it to a small merchant mill owned by the railway company. Here these bundles were put into an oil-heated furnace, and when up to a good welding heat, were put under a steam hammer and worked down into compact billets. These were then reheated and rolled into the finished product. All sizes of small iron bars were made, together with flats up to 6 in. in width and 1½ in. thick. However, the steel pieces would never form a solid billet, due to the layers of oxide surrounding each piece; the method resulted in a large waste of split unsound bars and a product suitable only for low-grade work. Such work could scarcely be called steel manufacturing, and all steel for rivets, forgings or important members had to be purchased on the open market.

There were many ways in which a steel mill would be advantageous to the company shops, situated as they were, far from a large producer. Every year the road scraps large tonnages of wrought iron and steel of which only a small part was used in "fagoting," the remainder being sold on the market at whatever price could be obtained. Eventually this fell into the hands of different commercial steel companies, which remelted it and often resold it to the railroad company in the form of desired products, one of the highest priced being steel castings. It seemed reasonable on the face of this to suppose that if a small steel company buying scrap could furnish certain products at a given price, a resourceful plant using its own scrap could furnish the same product at an equal price or even cheaper, figuring the handling of the scrap as a saving.

With the proposal to build a steel plant accepted, there yet remained the question as to what sort of a melting furnace to install. Cupolas and converters, open-hearth furnaces and the electric furnace were very carefully considered from all angles.

For many years the company had been running its own iron foundry, and it was an easy matter to determine the average cost of molten cast iron in the ladle. The cost of blowing this metal to steel in the converter was then estimated, giving a final cost of the metal by this method. The question of quality then arose, and it was concluded that while converter steel would be suitable for the majority of cases, it would not meet several of the specifications requiring higher quality.

A small open-hearth was next compared to a 6-ton electric furnace. The electric process was chosen for several reasons:

Quality.—It is generally accepted that well-made electric furnace steel is superior to that made by either of the two processes before considered. This was an important point in the decision, especially when anticipating high class forging work for such products as gears, driving rods, crank pins, shafts and small axles, where a failure would tie up a locomotive and cost several hundred dollars per day in delays.

Cost.—Cost of the finished steel was, of course, the main deciding factor and was given the greatest consideration. It was figured not only for present conditions but for reasonably anticipated developments on the Pacific Coast in the near future. When this matter had been finally computed, it was found that the difference in the costs of the three proposed methods were very small, but a slight advantage was shown in favor of the electric furnace. High freight cost of Eastern pig iron militated against the converter. Inability to obtain "hot metal" for the open-hearth furnace militated against this process. There is no blast-furnace coke manufactured on the coast; furthermore, on account of the refractory nature of California iron ores, the erection of a blast furnace in this region is a very distant possibility. The present cost of electric power is rather low in comparison to the rest of the United States; this is likely to continue, since further great developments are under construction. That these factors were well weighted has been amply proved, since the electric furnace installed has turned out the highest grade of steel at a lower cost than it could be procured from several competing open-hearth plants, and has even melted gray iron for castings cheaper than the cupola.

Adaptability.—This point was so much in favor of the electric furnace that it scarcely needs discussion. Suffice it to say that the same furnace, without change of any kind, can economically make the following: steel castings; manganese steel castings; any required analysis of alloy and carbon steel for rolling or forging; iron castings, gray, chilled or white, of any analysis desired; malleable cast iron castings; special products such as acid-, fire-, and fume-resisting castings; special steels for magnets, electrical apparatus and trans-

formers. Not only these products came from the same furnace, but from the same general scrap, with only minor changes in the charge ratio. Furthermore, the temperature of the metal is under easy control (depending upon the time it is held in the electric furnace), making the furnace an excellent melter for either small, medium or large sized castings.

These were the salient points. An electric furnace plant needs a smaller floor space and lighter accessory equipment than the open-hearth; it is very easy to control accurately the chemical analysis of the resulting steel. An electric furnace also possesses an unexampled refining ability when working on low-grade scrap.

Acid vs. Basic Process

When the furnace had been installed another point arose as to whether we should use the basic or the acid process. The advantages for the acid process were a hotter steel, with a greater tonnage in a given period. Against this were the disadvantages that selected scrap must be used to meet specifications, due to the inability of acid bottom to eliminate any material amount of sulphur and phosphorus; specifications and analyses are harder to meet with constant exactitude; alloy steels cannot be very satisfactorily made, and can never be remelted to save high-priced alloys such as chromium and manganese; and finally power surges give more trouble than in a basic furnace. As the scrap to be used was high in phosphorus and sulphur, due to large quantities of wrought iron mixed in it, it was really imperative to use the basic process. Against the disadvantage of higher cost for this process were the ability to make any analysis with ease; great refining possibilities; easier power control; elimination of power surges and high peak loads; reclamation of alloy steel scrap; and most important of all for quality stock, complete de-gasification of the hot metal.

The furnace is located in an ordinary wooden frame building 130 ft. long by 65 ft. crane span, with a 30-ft. side bay on each side. The building, which was constructed in 1919, is higher than most steel foundries, which permits a ready exit of smoke and gas and makes excellent working conditions. This height was necessitated by building the furnace on a 10-ft. concrete platform in order to protect the ladle pit from any seepage of water, the shop being built on filled-in ground, once a marsh adjacent to the Sacramento River. The building is of the latest glass-walled construction, giving excellent light for molding purposes.

From the floor plan (Fig. 1) a very good idea can be obtained as to the general layout. The center bay is served by a 15-ton Champion crane. The shop was put in operation early 1920, and several improvements are now needed, such as another crane, a stripper and more floor room, all of which are expected to be made in 1922.

On the side floors are the bench molding, coremaking and cleaning departments, together with all like miscellaneous equipment. Directly in front of the furnace are the ingot pits. All ingots are plate poured (Fig. 2). Scrap is brought into the foundry on a standard gage flat car in large round buckets, containing about 2,500 lb. of such metal as old track scrap, forge butts, borings and turnings, forge flashings and clippings, all of which furnishes good material for the desired products. The furnace is charged by hand.

Operation of the furnace follows the standard two-slag process: eliminating phosphorus in the first, and finishing under a heavy carbide slag. The furnace is operated continuously and the results for the first 2 years have averaged 565 kw.-hr. per ton of charge, 33 minutes per ton of charge with the ordinary charge 7 to 8 tons in the ladle. Electrode consumption has averaged 30 lb. on carbon electrodes and 12 on graphite

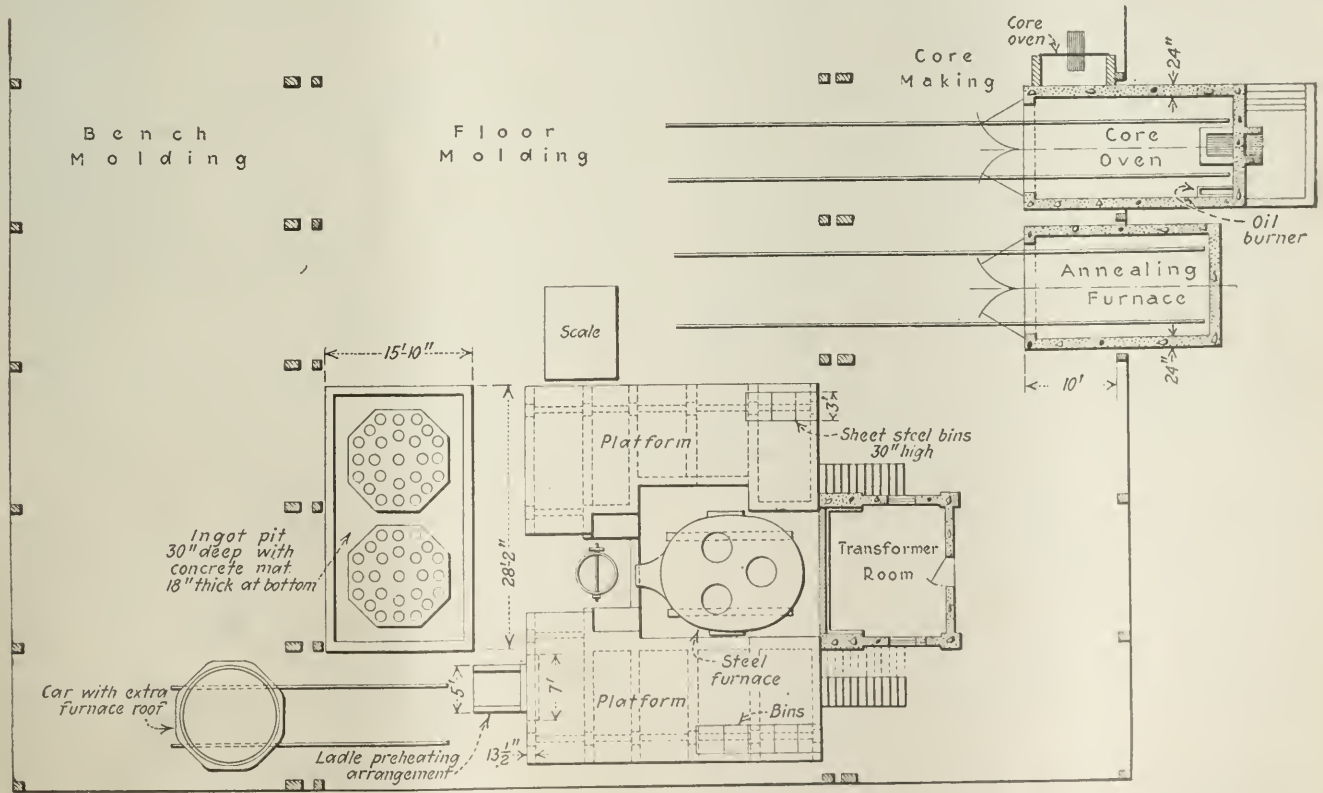


FIG. 1—GROUND PLAN OF STEEL FOUNDRY, SOUTHERN PACIFIC LINES

FIG. 2—TEEMING A NEST OF INGOTS. FURNACE IN BACKGROUND

per ton of product. The bottom was made of the highest grade of dead-burned magnesite and is still in good condition after 2 years of constant operation.

During the first year's operation the product went into rivet steel, plus about 30 tons of steel castings a month. Ingots cast were 6 x 6 in. in cross-section and 6 ft. in length, poured 20 to 26 on an octagonal plate, depending on the length desired. (A rectangular plate has now been installed so that the molds may be placed closer together and the combination be safer against runouts.) During this early period a large amount of forging ingots of varying sizes and composition were also made for stock, mostly 12 x 18 in. x 6 ft. ingots for main driving rods for locomotives. Crop ends and runners are rolled into bar iron for cheap material such as tie-rods or buckstays.

Early in 1921 several heats were made and cast in special ingot molds, rolled into tie plates and tested extensively to prove fitness and general adaptability. These proved so good that the shop was given an order to make 1,000,000 tie-plates, requiring about 9,000 tons of steel. Since that time we have specialized on this work and have made tie-plate steel and steel castings only. Tie-plate ingots are 9½ x 3½ in. at the bottom, 8½ x 2½ in. at the top, and 6 ft. in length, and weigh approximately 500 lb. As the small rolling mill owned by the company cannot handle pieces of this length, they must be cut in two, which is a costly operation, lacking heavy shears. To overcome this we are now experimenting with ingot molds 40 in. in length. So far the results are excellent.

Some physical tests made on the steel as rolled gave the following results:

Tensile Strength	Elongation Per Cent	Analysis C	Mn	Si	P	S	Cold Bend Test
77,840	25.0	0 25		0 34	0 066	0.041	1¼ in. round bent flat on itself, with no check
58,974	31.3	0.16	0.61	..	...	....	1¼ in. round bent flat on itself, with no check
112,000	12.5	0.48	0.96	0.25	0 057	.....	1¼ in. round bent flat on itself, no check
64,000	28.0	0 12	0 34	0.11	0.041	.....	1 in. rivet bent flat on itself, no check

The largest money maker for the foundry is steel castings. All steel castings used by the Southern Pacific Lines are made here, the foundry thus serving the territory from Portland to Los Angeles and as far east as Ogden. All classes of castings are made, including those for ferryboats, locomotives and cars, and those needed for general repair work on shop machinery. Their average size is about 150 lb., but sizes from 1 lb. to 16,000 lb. have been made. All small castings are stacked when poured, although an attempt is always made to get the small ones in a box with a large one, thus making an easier job for the ladleman and resulting in a superior product.

Due to lack of floor space and modern equipment the making of steel castings presents several difficulties. As many castings as possible are put into every flask, and it is interesting to shake out a locomotive frame with possibly twenty small-sized pieces sticking to it, like ornaments on a Christmas tree. All large cores are made at the iron foundry, several blocks away, and brought to the steel mill in small auto trucks, where they are set and dried by means of a gasoline torch. All dry sand molds are dried by small wood or charcoal fires, and are given finishing touches with the torch before closing. Most of the smaller sized work is made in green sand molds made of heap sand properly tempered with molasses water. The core sand mixture used is silica sand, one wheelbarrow; fireclay, two shovels; sawdust, two shovels; molasses water, one pint; molasses with water to suit. Dry sand molds are made of silica sand, one barrel; heap sand, one barrel; fireclay, five medium shovels; molasses with water to suit. Several brands of sand have been tried, but our present stock sand is made up of equal parts of Ottawa and Monterey beach sand and is excellent for all general classes of work.

Special Blank for Locomotive Frames

One type of casting which may be of interest is a special blank for locomotive frames. This piece is 10 ft. 5 in. long, 3 ft. wide, and 5 in. thick, with an auxiliary piece to increase the thickness to 6 in. From this blank it is possible to cut frame pieces for seven different types of locomotive. Its use results in a great saving of stock parts and always furnishes the necessary piece for a quick repair. We have poured this piece several ways, on the flat with heads at both ends, poured from the center; on the flat, poured uphill 18 in. from the bottom, with two large heads at the upper end; and on the edge from the center with four heads. The latter gives the best piece of steel.

We have also done quite a large amount of experimentation on the making of cast iron from steel scrap and find it both an easy and economical proposition. This has already been described in Chemical & Metallurgical Engineering for Feb. 2, 1922 (vol. 26, p. 270). Pig iron pays a freight rate of $17 a ton from the East by water and $22.40 a ton by rail. Add this to the cost f.o.b. furnace and then compare the sum to a conversion cost of from $12 to $16 plus scrap iron at $10! Under such conditions, synthetic cast iron is the logical source of metal for the iron foundry or for pouring castings direct.

From the general experience of the Southern Pacific Lines with the electric furnace, both from a standpoint of cost and quality, it is apparent to the writer that the future melter for the coast states, both for iron and steel, will be the electric furnace.

The System Furfural-Water—II

Mathematical Relations Governing the Concentration of Furfural From Its Solutions by Distillation—Practical Application of the Results of These Studies to the Problem of Recovering Furfural From the Dilute Solutions Obtained Commercially*

By GERALD H. MAINS
Color Investigation Laboratory, Bureau of Chemistry

FROM such a liquid-vapor, or solution-distillate, composition diagram,[15] as has been demonstrated by Lord Rayleigh,[16] the amount of distillate that must be collected in order to obtain any given portion of the furfural contained in the original solution can be readily calculated.

Following closely Lord Rayleigh's mathematical treatment of the subject, with only such changes as apply to this special case: Let w be the weight of solution remaining in the flask at any one time, and y the weight of furfural in the solution. The composition of solution, or abscissa, ξ, of the curve is $\frac{y}{w}$. As the distillation proceeds for a short time w becomes $w + dw$ and y becomes $y + dy$ (dy and dw being negative), and the composition of the vapor (or distillate), that is, the ordinate, η, of the diagram, is $\frac{dy}{dw}$. Thus

$$\xi = \frac{y}{w}, \quad \eta = \frac{dy}{dw} \tag{1}$$

The relation between the composition of solution and distillate as given by the curve may be expressed as

$$\eta = f(\xi) \tag{2}$$

$$\text{Now from (1)} \quad y = w\xi \tag{3}$$

$$\text{then } \frac{dy}{dw} = \frac{d(w\xi)}{dw} = \eta = f(\xi) \tag{4}$$

$$\frac{\xi dw + w d\xi}{dw} = f(\xi) \tag{5}$$

$$\frac{dw}{w} = \frac{d\xi}{f(\xi) - \xi} \tag{6}$$

$$\text{Whence } \log \frac{w}{w_0} = \int_{\xi_0}^{\xi} \frac{d\xi}{f(\xi) - \xi} \tag{7}$$

When the composition of solution, ξ, is small, say up to 3 per cent for furfural and water, the curve does not deviate much from a straight line. The relation may then be written

$$f(\xi) = k\xi \tag{8}$$

$$\log \frac{w}{w_0} = \frac{1}{k-1} \log \frac{\xi}{\xi_0} \tag{9}$$

$$\frac{\xi}{\xi_0} = \left(\frac{w}{w_0}\right)^{k-1} \tag{10}$$

That is, when a certain amount of solution is distilled off, the ratio of the final composition, ξ, to the initial composition, ξ_0, of the solution in the flask is proportional to some exponent, $(k - 1)$, of the ratio of the weights of the final and initial solutions, w and w_0, and this exponent is determined by the slope of the curve.

Calculating the value of k from the data for the lower portions of the curve, it will be seen that k is practically constant at 7.5 for solutions of less than 0.5 per cent furfural, and then gradually decreases. The value of k has decreased to 5.7 at 3 per cent furfural, beyond which concentration the curve deviates too far from a straight line to permit the use of equation (10) for any close approximation.

From these data the proportion of a dilute furfural solution of known strength which must be distilled over to secure any required fraction of the furfural can be determined. To illustrate: Given a solution containing 1 per cent furfural by weight, to obtain approximately 99 per cent of the furfural in the distillate. Using equation (10) and substituting values:

$$\frac{\xi}{\xi_0} = \left(\frac{w}{w_0}\right)^{k-1}$$

$$\frac{1}{100} = \left(\frac{w}{1}\right)^{6}$$

$$w = 0.464$$

$$w_0 - w = 0.536$$

Thus, by distilling over approximately 54 per cent of the original 1 per cent solution, the furfural concentration of the residual solution is reduced to 0.01 per cent. Nearly half of the water has been eliminated with a loss of less than 0.5 per cent of the furfural, and the concentration of the distillate has reached 1.84 per cent. By repeating this process with the distillate, it would be possible to obtain finally about 97 per cent of the original furfural and to eliminate practically all of the water simply by successive distillations. As the concentration of the furfural increases, the value of k becomes smaller and a greater proportion of the solution must be distilled over to obtain the same effect. Hence a very large number of distillations would be required and the process would be very tedious.

If it is desired only to reduce the concentration of the residual solution to one-tenth that of the original solution or to obtain about 90 per cent of the original furfural in the distillate,

$$\frac{1}{10} = \left(\frac{w}{1}\right)^{6}$$

$$w = 0.681$$

$$w_0 - w = 0.319$$

so that only 32 per cent of the original 1 per cent solution need be distilled over. Two-thirds of the water is thus eliminated, with a loss of only 6.8 per cent of the furfural, and at the same time the concentration of the distillate is brought to practically 3 per cent. Repetition of the distillations, each time reducing the concentration of the residual solution to one-tenth that of the initial solution, would eliminate practically all

*For Part I see CHEM. & MET. ENG., vol. 26, No. 17, p. 779, April 26, 1922.

[15]See Part I of this article.

[16]Lord Rayleigh, *Phil. Mag.* [6], vol. 4, p. 527 (1902).

of the water in seven or eight distillations, but would entail a loss of approximately 25 per cent of the furfural.

Table VIII gives the values of k for solutions up to 3 per cent, and the percentage of solution that must be distilled over in each case to reduce the concentration of the residual solution one-tenth or one-hundredth of the initial concentration.

Fractional Distillation

By using a somewhat different procedure the major portion of the furfural can be recovered from a dilute solution by comparatively few distillations. Use is made of the data here given to ascertain how much solution may be left in the still without appreciable loss of furfural. The distillate, however, which is constantly weakening during the distillation, is split into fractions.

Furfural solutions weaker than 1.5 per cent are brought up to that concentration by straight distillation, using the data given. When the concentration of furfural solution has reached 1.5 per cent the distillate from it will be approximately a 10 per cent solution, which will deposit a furfural later upon cooling to room temperature. This furfural layer is separated before any additional weaker distillate comes over to dissolve it. In this manner fractions consisting of wet furfural, saturated solution and two or more weaker concentrations are obtained. The weaker fractions are redistilled and their distillates distributed among the more concentrated fractions. Starting with a solution as dilute as 1 per cent and making use of this method, four or five distillations will usually suffice to obtain about 95 per cent of the total furfural in the form of wet furfural and saturated solution. The wet furfural can be practically freed from water in one distillation, and the small volume of saturated solution can be saved for combination with other lots.

The process just described is simply a mechanical approximation to the process carried out automatically by a fractionating column, and the use of a properly designed column will give a direct separation of wet furfural from dilute solutions in one operation.

Practical Applications

The question will arise as to the limitations in the application of the data here presented to the concentration of the dilute furfural solutions obtained in the commercial manufacture of furfural.

The preparation of furfural by the digestion of corncobs with 20 to 30 per cent sulphuric acid has given satisfactory results on a small factory scale in this laboratory. In co-operation with Dr. F. B. La Forge, the use of superheated water alone as a digestive agent is now under investigation. In France hydrochloric acid solutions have been used to digest kapok and other pentosan-containing materials for the manufacture of furfural. The hydrochloric acid process may be disregarded because of its commercial impracticability for producing furfural at a very low price.[17]

With the other two methods the condensed distillate from the digestion is a dilute furfural solution with the following approximate composition: furfural, 1 to 3 per cent; acetic acid, 1 to 2 per cent; acetone, 0.02 to 0.04 per cent; water 95 to 98 per cent, with small amounts of sulphuric and sulphurous acids carried over in the case of the sulphuric acid digestion.

The acetic acid may be separated by neutralization with lime before the distillation of the solution. This treatment, however, gives rise to much foaming during distillation, and it is better to recover the acetic acid from the residue after concentrating the furfural. The presence of the dilute acetic acid does not interfere with the distillation or separation of the furfural from the solution. Whereas acetic acid is carried over in the distillate, its concentration there is somewhat smaller than in the original solution and the greater part of the acetic acid is concentrated in the residual liquid in the still.

On the other hand, the acetone, although present in very small quantities, interferes somewhat with the separation of the furfural. It lowers the boiling point of the furfural-water system, and, being completely miscible with furfural, increases its solubility in the first portions of the distillate. During distillation the acetone portion comes off at slightly below 97 deg. C. and is a clear solution. When the temperature reaches 97 deg. C., the distillate becomes milky, owing to the separation of the furfural layer. When the temperature has reached 97.9 deg. C., the distillate will be practically free from acetone. The acetone portion must be removed as soon as the distillate appears turbid, and then concentrated separately. Although small in volume, it is rich in furfural. The remainder of the original solution behaves during the rest of the distillation simply as a pure furfural-water solution.

TABLE VIII—MATHEMATICAL DATA ON THE CONCENTRATION OF FURFURAL BY DISTILLATION

—Per Cent Furfural by Wt.— Composition of Solution ξ	Composition of Distillate η	Ratio: Comp. of Distillate to Comp. of Solution $\frac{\eta}{\xi} = k$	Per Cent to Be Distilled Off to Reduce Conc. to Given Fraction of Initial Conc. $\frac{\xi}{\xi_0} = \frac{1}{10}$	$\frac{\xi}{\xi_0} = \frac{1}{100}$
0.2	1.5	7.5	30	51
0.4	3.0	7.5	30	51
0.6	4.4	7.3	31	52
0.8	5.8	7.2	31	53
1.0	7.0	7.0	32	54
1.5	10.0	6.7	34	56
2.0	12.7	6.4	35	58
2.5	15.0	6.0	37	61
3.0	17.1	5.7	39	63

Traces of sulphuric or sulphurous acids cause no difficulty. If an appreciable quantity of sulphuric acid has been carried over during the digestion, however, it tends, upon being heated, to react with the furfural to form resinous substances, and should be partly neutralized.

Small quantities of furfural may be concentrated by several distillations as previously described, but in manufacturing furfural in large quantity an efficient fractionating column is essential. On the small-scale work at the Color Laboratory, making as much as 5 lb. of furfural a day, an ordinary copper column filled with porcelain balls has been used with fairly satisfactory results. For larger scale operations a special column is being designed.[18] Such a column will deliver three main fractions: *A*, containing acetone, furfural and water, boiling from 60 to 97.9 deg. C.; *B*, containing furfural and water, boiling from 97.9 to 100 deg. C.; and *C*, the remainder, boiling at 100 deg. C. and above, and consisting of water containing acetic acid and small

[17] Furfural is now being made in this country on a commercial scale by the Miner Laboratories, Chicago, Ill., but the details of the process are not available.

[18] Continuous furfural distillation apparatus, designed by the aid of the data presented, has just been placed in operation at the Color Laboratory. It has a capacity of 50 lb. of furfural per day when handling a 2 per cent solution.

amounts of formic, and perhaps sulphuric and sulphurous acids. The furfural layers are to be separated from fractions *A* and *B*, and the residual portions of these fractions continuously returned to the upper portion of the column. The crude, or wet, furfural obtained from such a column is purified by adding a small amount of sodium carbonate to the liquid, distilling, and, after the water has separated in the first portions, collecting the distillate coming over at a constant boiling point. This final distillation can also be conveniently carried out in a vacuum still.

Summary

The corrected boiling point of pure furfural has been found to be 161.7 deg. C. at 760 mm., and its density $D^{\frac{20}{4,\ Vac.}} = 1.1598$ and $D^{\frac{25}{4,\ Vac}} = 1.1545$. The composition-density tables at 20 and 25 deg. C. have been determined for solutions of furfural in water up to the saturation concentration.

Making use of these tables as a method of analysis, the mutual solubility curves at atmospheric pressure, and the boiling point and condensation point curves, or the liquid-vapor phase boundaries, have been determined for the system furfural-water.

The curve showing the relation between corresponding solution and distillate composition for dilute furfural solutions has been carefully determined with the elimination of errors due to partial condensation in the still head.

The mathematical relations for the distillation of mixtures as developed by Lord Rayleigh are discussed with reference to the case of furfural and water.

The application of these physicochemical data to the commercial concentration of the dilute furfural solutions obtained during the manufacture of furfural is discussed.

Sources of Thorium in Ceylon

Ceylon offers several possible sources of thorium, used in the manufacture of gas mantles, in the deposits of monazite sand, containing thorium, thoria, thorianite and raw thorite ore, or black thorium silicate, according to the report of Consul M. M. Vance from Colombo. Monazite sand was shipped from Ceylon in the amount of 72 long tons, valued at 40,000 rupees, in 1920. A British firm controlled the plant utilizing this particular deposit, and because of financial difficulties no shipments were made subsequently. Deposits of monazite sand are claimed to exist in practically every part of the Ceylon coast, and the Department of Mineralogy there is anxious to increase the market for the product and is willing to erect more machinery for extracting the thorium if successful in extending the market.

Thoria and thorianite have been offered in limited quantities at low pre-war figures, which will be furnished, together with the name of the person offering these minerals, upon application to the Bureau of Foreign and Domestic Commerce. Small samples of these two ores have been referred to the United States Geological Survey. The same merchant was reported as being able to furnish small quantities of what was thought to be thorite, or black thorium silicate, to purchasers in the United States. Thorite was formerly very generally used in obtaining thorium for gas mantles.

Investigation of Georgia Clays by Bureau of Mines

The kaolins and bauxites of Georgia occur principally in the coastal plain, the belt running diagonally across the state from east to west. The railroad lines of the Central of Georgia reach about 80 per cent of the white clays and bauxites of the coastal plain. The white clays are being mined at a few points, principally at Gordon, Claymont, McIntyre and Butler. These clays are sold principally to the filler trade. Bauxite mining has been carried on in the Cuthbert, Toomsboro and Andersonville districts and the bauxite is used principally in the manufacture of alum, abrasive and aluminum. The value of the clays and bauxites for ceramic purposes is little known. The investigation undertaken by the Ceramic Station of the Bureau of Mines, Columbus, Ohio, in co-operation with the Central of Georgia R.R., will consist in experiments to devise better refining methods and to test the physical properties of the different separations obtained. For this purpose a small-size refining plant is being constructed at the Ceramic Station.

Behavior of Clays Under Actual Working Conditions to Be Studied

This equipment is capable of handling from 500 to 1,000 lb. at a time. Evidently some of the clays will show promise of being valuable for pottery making purposes. After the laboratory tests are completed by the Bureau of Mines about 400 lb. of such clays will be taken into a commercial pottery and made up into pottery wares under practical working conditions, and the behavior of such clays as to working properties, color, percentage losses, etc., will be carefully studied. The white clays and bauxites of the coastal plain are closely associated, and this close association indicates that the bauxites were derived from the alteration of kaolins. Deposits are found which vary all the way from kaolin on the one hand to bauxite on the other. Some of these materials, which are higher in alumina than kaolin, show better refractory properties than No. 1 fireclays. Such clays, termed "bauxitic clays," undoubtedly would be most valuable for the manufacture of refractories superior to those now being made from fireclays. The refractory properties of such materials are to be studied, such as fusion temperature, load carrying capacity and resistance to spalling.

English China Clay Compared With Georgia Kaolin

English china clay is preferred to Georgia kaolin by many American potters. In comparing the two it is found that the English clay disintegrates in water more readily, produces a body which casts more satisfactorily, gives lower drying and bisque losses and requires less linseed oil to produce a spreading condition for oilcloth and produces a paper of better finish and more resistant to moisture. In preliminary work by the Bureau of Mines it was found that after calcining Georgia kaolin to low temperatures (500-600 deg. C.) it possesses properties similar to the English china clay—i.e., its adsorptive properties are decreased to that of the English china clay and the rate of capillary flow and the permeability of water is increased. Further tests are to be made to determine its commercial feasibility. The effects of aging the calcined clay in air and water are to be studied to determine how far the calcined clay will revert to its original state and also to study the varieties produced by different calcination tempers.

Reduction of Fuel Wastes in the Steel Industry*

By F. G. Cutler

IN ORDER to show the relative proportion of the energy in the shape of heat or power required for the manufacture of steel that is obtained from the fuel byproducts of the manufacturing process, the following figures have been prepared showing the quantity of heat derived from the byproducts of the manufacture of pig iron.

In the production of pig iron, from under 1,800 to over 3,000 lb. of coke is used. Part of the heat energy of this coke is required to reduce the ore to pig iron. Part is lost in radiation. Approximately one-half is available in the form of blast furnace gas. Most of this gas is used under boilers for the production of steam.

As blast-furnace gas leaves the top of the furnace it usually has a temperature of from under 300 to over 600 deg. F., generally averaging about 400 deg. F. At this latter temperature the sensible heat of the gas is equivalent to about 8 B.t.u. per cubic foot of gas at 62 deg. The B.t.u. per cubic foot of blast-furnace gas according to Brassert is $62.5 + 0.016R$, where R = lb. of dry coke per ton of pig iron; and including sensible heat of the gas at 400 deg. F. would be equal to $70.5 + 0.016R$. The cubic feet of gas per ton of pig iron (as shown by Brassert) is equal to $71.4R$, so that in the top gas from a furnace at 400 deg. F. the B.t.u. per ton of iron is $1.142R^2 + 5033.7R$. Brassert also gives the cubic feet of air per pound of coke equal to $51.4R$, so that both gas production and the blast requirement bear a direct ratio to the coke consumption of the furnace per ton of iron. The figures, so far as the author has been able to discover, are applicable to all blast furnaces using coke as fuel.

Heat Necessary for the Blast

The blast is heated in stoves under pressure, and the heat required per cubic foot of blast is proportional to the rise in blast temperature in the stove and inversely proportional to the efficiency of the stove, which is usually considered to average 60 per cent. After the necessary gas is used to heat the blast, the remainder can be measured in the shape of power.

The blast supplied from the blowing engines is heated by compression to about 150 deg. F., varying somewhat with blast pressure, etc., and is usually heated in the stoves to from 1,150 to 1,350 deg. F. In the following calculations it has been assumed that 0.02 B.t.u. is required per cubic foot of blast per deg. F., that the blast is heated in the stoves to 1,250 deg. F., that the average overall stove efficiency—i.e., ratio of heat given to the blast to the heat in the gas—is 60 per cent and that 55 cu.ft. of blast is heated per pound of coke charged.

The heat required in the gas for heating the blast for 1 ton of pig iron to a temperature of 1,250 deg. F. can therefore be expressed by the following formula where H = B.t.u. per lb. of coke burned in the blast furnace.

$$H = \frac{(1250 - 150) \times 0.02 \times 55R}{0.60} = 2020R$$

The heat in gas per ton product after the blast is heated is, therefore, $1.142R^2 + 3013.7R$. For other top temperatures and blast temperatures the constants will change slightly.

Boiler Horsepower-Hours Available

In 1 boiler horsepower-hour there is 33,305 B.t.u., and assuming that the "standard" efficiency of blast-furnace-gas-fired boilers is 66.6 per cent, in 1 boiler horsepower-hour $33,305 \div 0.666 = 50,000$ B.t.u. would be required in the gas, so that the boiler hp.-hr. per ton would be

$$\frac{\textit{Surplus B.t.u. per ton iron}}{50{,}000\ \textit{B.t.u.}}$$

As the blast-furnace product is usually expressed in tons per day, the average boiler horsepower per hour generated from blast-furnace gas under the above conditions can be expressed by the formula:

Average boiler horsepower per hour per ton of pig iron per day

$$= \frac{1.142R^2 + 3013.7R}{50{,}000 \times 24}$$

The following table shows the boiler horsepower-hours per ton of pig iron for several coke rates as calculated from the above formula:

Pound of Coke Per Ton	Boiler-Horsepower-Hours Per Ton Product	Boiler-Horsepower-Hours Per Ton Per Day
2000	211	8.8
2200	242	10.1
2400	276	11.5
2600	310	12.9
2800	348	14.5
3000	386	16.1

To furnish the blast to the furnace with either high-pressure condensing, turbo-blowers or reciprocating steam engines requires about 70 boiler hp.-hr. per ton of coke burned in the blast furnaces, and to operate the various furnace auxiliaries, such as pumps, air compressors, steam bells, mud guns, hoists, etc., requires from 15 to 25 boiler hp. per ton of product, so that after the furnace requirements have been met, there is available for the generation of power from 100 to 250 boiler hp.-hr. per ton of pig iron, depending on the coke burned in the furnace.

At 2 kw. per boiler hp.-hr., this means that from 200 to 500 kw.-hr. per ton of pig iron is possible with steam equipment from the surplus gas from the blast furnaces.

Heat Required in Steel Manufacture

The manufacture of steel from pig iron in the open hearth requires heat for melting scrap and fluxing the impurities, and power for the various operations incident to this process. The quantities of heat and power required vary materially with different plants on account of difference in equipment, practice, etc., but for the purpose of this paper it will be assumed that a ton of ingots requires 1 ton of pig iron plus enough scrap to offset the losses, and this work requires from 5,000,000 to 9,000,000 B.t.u. and an expenditure of from 20 to 30 kw.-hr. per ton. This ton of ingots will make about 0.85 ton of blooms, and the heating in soaking pits will require from 1,500,000 to 3,500,000 B.t.u. per ton of steel depending upon the temperature of the steel arriving at the pits, rate of operation, etc., and the rolling of the ingots into blooms will require from 40 to 60 kw.-hr. per ton. From the blooming or slabbing mill the material, usually reheated at an expenditure of from 2,500,000 to 6,000,000 B.t.u. per ton, is furnished to finishing mills, the power required, depending on the reduction of section, temperature of rolling, etc., varying from 35 to over 300 kw.-hr. per ton.

*Abstracted from *Mechanical Engineering*, April, 1922. Paper to be read at spring meeting, A.S.M.E.

TABLE I—HEAT BALANCE FOR MANUFACTURE OF 1 TON OF PIG IRON

From the coke plant delivering 1 ton of coke there result the following fuel byproducts for consumption in the steel plant after the heat and power requirements of the byproduct plant have been met:

12 gal. tar at 162,500 B.t.u. per gal., B.t.u.	1,950,000	
30 lb. of coke breeze at 12,000 B.t.u per lb., B.t.u.	360,000	
10,000 cu.ft. gas at 500 B.t.u. per cu.ft. (net value), B.t.u.	5,000,000	
Total per net ton coke		7,310,000
Heat available per ton pig iron	B.t.u.	B.t.u.
In tar from byproduct plant	2,435,000	
In coke breeze from byproduct plant	450,000	
In surplus gas	6,250,000	
Surplus from byproduct plant		9,135,000
In blast-furnace gas		19,635,000
Required for blast heating	5,000,000	
Required for blowing equipment	4,400,000	
Required for blast-furnace operation	1,000,000	
Required for total blast furnaces		10,400,000
Surplus from blast furnace plant		9,235,000
Total heat energy from byproducts		18,370,000
Heat required for steel plant		
Open hearth (pig iron to ingots)		
Melting (approx.)	7,000,000	
Power, 25 kw. at 25,000 B.t.u. per kw.-hr.	625,000	
Total heat consumption		7,625,000
Roughing Mill		
Heating (approx.)	2,000,000	
Power, 50 kw.-hr.	1,250,000	
Total		3,250,000
Finishing Mill		
Heating (approx.)	4,000,000	
Power, 100 kw.-hr.	2,500,000	
Total for finishing		6,500,000
Total heating requirements	13,000,000	
Total power requirements	4,375,000	
Total		17,375,000

Utilization of Industrial Wastes

Waste heat from open-hearth and heating furnaces and kilns is utilized for the production of steam, and otherwise waste steam is utilized in low or mixed pressure turbines for the production of power, but as these subjects have been discussed many times and are not peculiar to the steel industry, they will not be discussed except to say that while these economies are many times worth while in existing plants, very few new installations as designed include waste-heat boilers with furnaces, or low-pressure turbines as integral parts of new power plants.

Surplus byproduct gas, after the ovens are heated, is sold for use as domestic fuel, etc., replacing natural gas, water gas, etc., and is used in the steel plant for melting steel in the open hearth and for various heating operations in the steel industry. In former years this material was considered as having only nominal value and it was but rarely that any attempt was made to utilize it efficiently.

With the advance in fuel prices, shortage of natural gas, etc., and also largely due to special heating requirements connected with the manufacture of artillery and ammunition during the war, a number of combustion systems were developed that by more or less accurately regulating the proportion of air to gas have greatly increased the combustion efficiency of heating furnaces, and the control of combustion has been found of great importance in the maintenance of economy.

Dust coke breeze, from the coke plant—i.e., the material through a $\frac{3}{8}$-in. screen—is used to cover molten pig iron in transit from the furnaces and in making bottoms of soaking pits and heating furnaces. A great deal of this material which was thrown away or more or less inefficiently burned on hand-fired grates, or, by mixing with slack, on mechanical stokers, is now more efficiently burned by itself, on traveling-grate forced-blast stokers.

Tar, either before or after the creosote oils have been removed, has been found to be a very good fuel for open-hearth furnaces, either by itself or in conjunction with byproduct gas, and has been used for steam production either as an auxiliary fuel on blast-furnace boilers or by itself, and its use has been proposed to heat byproduct ovens, thus releasing additional gas otherwise required for heating the ovens.

Heat Balance

Table I gives an example of the approximate heat balance of 1 ton of pig iron as used in the steel plant, using average figures, and based on an average coke consumption in the blast furnace of 2,500 lb. of coke per ton of product.

Necessity of Heat Conservation

From Table I it will be seen that the total heat from the byproducts of a ton of pig iron is more than sufficient to finish the average ton of steel, but upon inspection of the table it will be found that the heating requirements have not been met from tar and byproduct gas, while the average power requirements are more than met from blast-furnace gas and coke breeze.

It therefore becomes very desirable to reduce the heating requirements for production of steel by using more efficient heating furnaces and to conserve all possible heat by charging hot steel into the soaking pit and reheating furnaces, in order to reduce the quantity of fuel required for supplementary heating.

The production of gas at the byproduct plant is practically uniform, while the consumption at the steel plant is variable and as a result the gas pressure at the steel plant (usually some distance away from the byproduct plant) is variable. As gas holders of sufficient capacity to absorb the fluctuations have not been found advisable, it becomes necessary to schedule the use of gas by consuming departments in order partly to equalize the consumption. In many cases it is advisable to use byproduct gas under boilers (although it is more valuable for other purposes) in order to prevent or reduce its waste, as it is easier to change from gas to coal on boilers than to fire up producers.

One of the most important problems of the steel plant manager and engineer is so to regulate the production and consumption of the various fuels occurring as a byproduct of steel-plant manufacture that the consumption of raw coal in producers or under boilers that would otherwise be sent to the byproduct plant is a minimum, for the reason that the byproducts from the coal, coked in the byproduct plant, usually exceed any possible return as fuel.

Japan Building Dye Industry

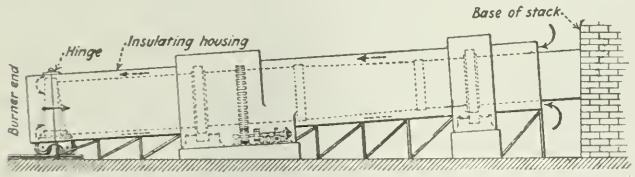
The *Indian Textile Journal*, December, 1921, is authority for the statement that the Japan Dyestuff Co. since its establishment has produced about one hundred different kinds of dyes, of which forty are already on the market. Some additional kinds are also to be put on sale, including scarlet for silk, water blue, pure indigo, acid brilliant red, and direct black 300 per cent. The last mentioned is claimed to be better than the American product. Moreover, the cost of production is said to be much less than in America.

Recovery of Radiated Heat From a Rotary Kiln or Drier

IN THE operation of a rotary cement kiln a quantity of the heat supplied is wasted to the surrounding air by radiation through the kiln shell. This has two undesirable results. First, there is a direct loss of fuel because of the extra amount necessary to make up for this radiation loss. Second, most kilns are located within a building, and the escape of this heat into the building makes working conditions trying and reduces the effectiveness of the workers.

There has been an attempt to eliminate these disadvantages by placing insulation between the brick lining of the kiln and the steel shell. This has not been entirely successful, for where high internal kiln temperatures are encountered the effect of heat on the brick lining must be considered. It is evident that if the heat loss from the brick is reduced, the temperature of the brick is increased. This temperature must not be permitted to reach the point which would reduce its life, yet sufficient insulation should be used to save the maximum heat possible. Kiln linings last only a short time at best, and the decrease of this time by such a misapplication of insulation is sufficient to condemn the method.

In seeking a means of recovering this heat without getting into other difficulties, Johns-Manville, Inc., suggests that the practical method is to surround the kiln with an insulated housing such as is shown in the accompanying sketch. This housing consists of an



HOUSING TO SAVE RADIATED HEAT

angle-iron frame around the kiln, covered with insulating material. The space between the insulation and the kiln shell is sufficiently restricted so that the velocity of the air drawn through this space is high enough to insure the heat being carried away, without increasing the shell temperature. Air is taken into this "live" air space at the open end of the housing, which is at the upper or entrance end of the kiln. It is then drawn through the housing around the shell and into the kiln at the delivery end, where it supplies the necessary air for combustion of the fuel.

Losses by Radiation in Cement Kiln

In developing this housing a study was made of the losses incurred through radiation. It was found that loss through the exposed surfaces of kilns often amounts to more than 1,000 B.t.u. per sq.ft. of surface per hour. Assuming continuous operation for 300 days or 7,200 hours per year, this gives a loss through each square foot of radiating surface equivalent to the consumption of 600 lb. of coal. As the heated air from the housing can be utilized in combustion of the fuel or in other ways so that about 90 per cent of the radiated heat is recovered, the saving in fuel can be made to amount to about 540 lb. yearly per sq.ft. When this heated air is used in place of cold air for combustion purposes in the kiln, conditions are bettered, as the fuel is not brought into contact with cold air which must be heated before combustion can take place.

The insulating housing can be provided with windows at any desired places in its sides, so that conditions within may be observed while the kiln is in operation. The comparative darkness within the housing makes it easier to notice hot spots in the kiln shell than if the kiln were located in the open. This enables repairs to be made to the kiln lining before the heat has damaged the steel shell.

Other Methods of Using the Recovered Heat

If it is not desired to use the heated air from within the housing for purposes of combustion in the kiln, it can be used in a number of other ways. For example, the clay used in the manufacture of some cements is dried before use, and the drier can be heated with this recovered heat. This use is advantageous in a plant where the heated air for kiln combustion is obtained from the clinker cooler. In other cases it can be employed for heating purposes, or such other uses as suggest themselves from plant conditions.

This method of recovery of radiated heat, which up to the present has been developed with rotary cement kilns in view, could well be applied to rotary and stationary driers and various types of industrial furnaces and kilns. In some of these applications the heat recovered would make an appreciable saving in fuel costs. In all cases where the equipment is located within doors general plant conditions could be improved by the reduction of the temperature in which it is necessary for men to work.

Manganese and Manganiferous Ores in 1921

The final statistics of the production of domestic manganese and manganiferous ore in 1921 are summarized by H. A. C. Jenison, of the U. S. Geological Survey, in the following tables:

MANGANESE ORE SHIPPED FROM MINES IN U. S. (EXCLUSIVE OF FLUXING ORES)

Mn Content of Ore, Per Cent	No. of Shippers 1920	No. of Shippers 1921	Gross Tons 1920	Gross Tons 1921	Value 1920	Value 1921
35 or more	56	14	94,420	13,531	$2,396,235	$495,097
10-35	31	6	357,279	8,439	1,450,518	$42,755
5-10	6	3	279,687	62,670	644,572	$147,576

MANGANESE ORE IMPORTED INTO THE UNITED STATES IN 1921*

Country	Quantity (Gross Tons)	Value
Africa	8,453	$27,198
Australia	.....	8
Brazil	262,468	1,952,848
British India	113,730	734,516
Costa Rica	588	17,658
Cuba	34	679
Honduras	14	140
Hongkong	7,319	131,052
	†392,606	†2,864,099

* Taken from records of the Bureau of Foreign and Domestic Commerce.

† About 8,700 tons, valued at $502,000, also reported as imports of manganese ore, but as the average value ranged from $46 to $128 per ton, these figures probably represent either spiegeleisen or ferromanganese.

Dyes From Kaoliang Bran

A method of securing dye from kaoliang bran has been discovered, according to a report to the Department of Commerce from Consul Kirjassof, Dairen. Kaoliang is a kind of sorghum, or giant millet, resembling broom corn. A mixture containing seven parts bran and the remainder consisting of soda, sulphate, etc., will produce the dye which is patented for brown and black, and also patent applied for to cover blue-black. Kaoliang bran may be obtained in practically unlimited quantities in Manchuria, delivered at stations of the South Manchuria Railway at approximately 1.80 yen per 100 kin.

Synopsis of Recent Chemical & Metallurgical Literature

Season Cracking.—In a voluminous paper[1] on "Testing Artillery Cartridge Cases," J. Burns Read and S. Tour state that season cracking, or corrosion cracking, of 70:30 brass cannot be predicted by chemical analysis, tensile or hardness tests or microscopic examination. Immersion in a 1.5 per cent mercurous chloride solution for 4 hours or in a 10 per cent mercurous nitrate solution for 15 minutes will open cracks in some articles. The authors believe that a season crack is the result of slow corrosion weakening the metal until its internal stresses exceed the tensile strength. Corrosion by mercuric salts produces accelerated "season" cracks probably by rapid and preferential amalgamation at the grain boundaries. While the test was vigorously opposed by manufacturers early in the war, the consensus now is that it is the most informative of all tests, both to indicate the quality of the finished piece and also to control the methods of manufacture.

Season cracking occurs in hard or soft pieces which are unequally strained in neighboring portions, and this strain can be removed by reheating to 500 deg. F. (260 deg. C.) for 1 hour, even though it causes no observable change in ordinary physical tests. Slight wear in properly designed tools may cause cracks by putting less work into one portion of the cartridge case than intended. Local strains caused by dirt and chips producing scratches on the metal will also cause season cracking.

Corrective measures vary, but some combination of the following usually suffices:

1. Increase the work during the last redraw, and anneal at the same temperature as formerly, if the increased tensile strength is permissible.
2. Increase the temperature or time of anneal if the lowered tensile strength is permissible.
3. Increase both work and anneal to relieve the strain without change in tensile strength.
4. Redesign the drawing and heading operations.
5. Use a final low-temperature anneal.

The last alternative is particularly effective and should be a matter of routine. The furnace could be heated by waste flue gas from other annealing furnaces, and the conveying done automatically.

Causes of Failure of High-Speed Tools.—A summary of an address by J. F. Kayser before the Birmingham (England) Metallurgical Society was printed in *Iron and Coal Trades Review* for March 31, 1922, p. 458. It is recalled that the method of failure depended in large measure on the shape of the tool; given a correct tool, however, there were two typical causes of failure: (*a*) abrasion of the chip furrowed the tool some distance behind its point, removing the support of the cutting edge which was later pushed away with the chip; and (*b*) up to time of failure there is practically no sign of wear, when suddenly the cutting edge is forced downward and into the lower part of the bar. These two types are found when doing both heavy and light work.

Inquiring into the belief that the "breaking-down temperature" was a measure of tool efficiency, tools of proved analyses were made, bored for thermocouple junctions, and provided with electrical connections whereby both the tool and the work could be heated. It was found directly that the cutting operation raises the temperature of both the work and the tool nose sufficiently to cause a pronounced change in their relative physical properties and the ability of the tool to cut the work was seriously affected. When the tool was first put to work there was a fairly rapid rise in temperature, quickly reaching a point where it remained constant until the moment of failure, when it again sharply increased. An annealed steel bar (Brinell 260) was mounted in a lathe, and a hot tool fed into it. With increasing temperature the cutting efficiency fell off, and at 500 to 550 deg. C. the tool refused to cut at all, even though the cutting edge was doubtless chilled by contact with the cold bar. However, if the work and tool were both at 600 deg. C., the tool readily cut for several minutes at a rate of 20 ft. per minute, $\frac{3}{8}$ in. deep and $\frac{1}{16}$ in. feed.

The Production of Gasoline by Cracking Heavier Oils.—The ordinary processes of refining crude petroleum yield a series of products differing widely in properties and commercial desirability. Cracking is already a factor of importance in the commercial production of gasoline. The experiments described in Technical Paper 258 of the Bureau of Mines, by E. W. Dean and W. A. Jacobs, issued in April, 1922, were not intended to cover the development of any one commercial process, nor do their results answer all the questions that arise concerning cracking. A number of important facts which do not seem to be generally recognized by those developing or operating cracking processes have, however, been demonstrated. The results of the experiments described in this report may be summarized briefly as follows:

1. Evidence obtained tends to support the theory that cracking is a contact-surface reaction, as the controlling temperature is that of the furnace walls rather than of the current of oil vapor.

2. (*a*) The range of temperature favorable for the commercial production of gasoline seems, for any given oil and any given pressure and rate of feed, to be within temperature limits considerably less than 50 deg. C. apart. With oil *A*, a distillate derived from Pennsylvania crude, the yields of gasoline at 550 deg. C. were probably a little lower than would have been acceptable in commercial practice. At 580 deg. the losses in recovery of cracked oil were excessive for commercial operations except possibly when the original fuel oil was exceedingly cheap or the plant was in a locality offering a profitable market for the gas formed.

(*b*) The favorable temperature range is apparently not the same for all oils and seemed to be at least 20 deg. C. higher for a Humble field, Tex., distillate (oil *D*) than for the Pennsylvania gas oil (oil *A*).

(*c*) The present experiments indicate that the degree of cracking possible with contact surfaces at 500 deg. C. or lower is negligible for the rates of feed employed.

3. Pressure is favorable for cracking, at least up to the highest limit (200 lb. gage reading) used in the present experiments. Limitations affecting the use of high pressure are apparently those imposed by the mechanical strength of the equipment rather than by the course of the reactions involved. It appears, however, that the advantage gained by increasing pressure from atmospheric to 100 lb. gage reading is notably greater than the advantage gained by a further increase to 200 lb. One hundred pounds is generally regarded as safe pressure for commercial size units, and fortunately seems high enough to yield a large share of the possible benefit to be derived from high pressure.

4. The quantity of carbon formed for the range of conditions favorable for gasoline production seems to be controlled chiefly by the content of high-boiling fractions, particularly so-called asphaltic material, in the oil cracked. Distillate oils deposit carbon in quantities too small to be measurable under present experimental conditions. It is believed that, in large-scale cracking operations, trouble with carbon can be obviated by using properly prepared oils, by controlling temperatures accurately, and, if necessary, by cleaning tubes occasionally by blowing out all oil vapor with steam and subsequently oxidizing any slight carbon deposit by a brief blowing with air. This latter treatment has been used in commercial sized vapor-phase cracking plants, and the present experience with light deposits of carbon indicates that it is probably efficacious.

5. On the assumption that a gasoline with an end point of approximately 430 deg. F. is to be produced, it appears that the vapor-phase cracking process can in a single treatment produce as much as 28 per cent of gasoline from a naphtha-free original oil. It is not believed, however, that this figure can be attained profitably in commercial practice, as it involves too great a loss in the recovery of

[1] *Transactions*, American Institute of Mining and Metallurgical Engineers, April, 1922.

cracked oil. It is not possible to predict what figure would prove most profitable on a commercial basis, but a yield of 20 to 25 per cent of gasoline seems reasonable and should not involve a loss in recovery of cracked oil exceeding about 15 per cent.

These figures are not impressive compared to those frequently quoted for the commercial possibilities of cracking processes, but it must be remembered that they mean a single treatment in the cracking furnace, that they exclude any naphtha that might be contained in the oil before cracking and that they are calculated on the basis of the oil originally run into the furnace instead of on the basis of the oil recovered. By taking advantage of various omissions in statement, it would have been possible to interpret present results as indicating gasoline yields as favorable as 45 to 50 per cent; but such figures, although imposing on paper, do not represent either an accurate scientific statement of results or the possibility of highly profitable commercial operations.

6. The losses in recovery of cracked oil, accounted for chiefly as gas formation, range from 10 per cent to 30 per cent. It seems possible to obtain commercially satisfactory yields of gasoline with losses not exceeding 15 per cent.

7. (*a*) The gasoline produced by vapor-phase cracking has a relatively high degree of unsaturation, the acid-absorption figures ranging from 25 to 40 per cent. The higher boiling fractions show a smaller acid absorption (lower degree of unsaturation) than the more volatile fractions. It seems, however, that the presence of olefine or unsaturated hydrocarbons is not essentially disadvantageous in the commercial utilization of motor fuel if certain associated products, probably diolefines, are removed. Such removal is undoubtedly possible and has already been accomplished in preparing Burton gasoline for the market, by properly regulated treatment with sulphuric acid. Hot filtration through Florida clay or bauxite is claimed (reference 22, p. 53) to accomplish the same purification.

(*b*) The relatively high specific gravity of some of the cracked products indicates an appreciable content of aromatic hydrocarbons. For gasolines that would be produced commercially, this aromatic content is not likely to exceed a maximum of 10 or 15 per cent and no evidence is at hand that this content is anything but advantageous.

8. The residuum from once-cracked oil does not seem to be quite as good for cracking as the original oil (see references 18 and 29). A higher temperature is probably required to bring about a desired degree of conversion, and unless the residuum is previously distilled to get rid of asphaltic, pitchy or other undesirable material, carbon trouble is likely to result. The Bureau of Mines has been advised that in one commercially operated vapor-phase cracking process no synthetic residuum is put back through the cracking furnace, the accepted practice being first to distill to dryness, then to crack the distillate. Another process of similar type passes the undistilled once-cracked residuum through the furnace, but distills it before attempting a second rerun.

9. Residuum fuel oils appear to be unfavorable material for cracking, the disadvantage, however, being excessive carbon deposition rather than failure to form gasoline. Some types of distillate oils seem to crack better than others, but no distillate oil was tried that did not seem to be satisfactory material for cracking.

10. It was shown that the recovery losses incident to a given percentage of gasoline formation were smaller when the temperature and rate of feed were relatively high than when these were lower. This seems to be a decided commercial advantage and is the reverse of what might have been expected on the basis of previous experience with cracking at very high temperatures.

Black Fractures and Graphitized Cementite.—Prof. W. Heike of Freiberg discusses "Reversed Chill and Similar Phenomena"[1] in *Stahl und Eisen*, March 2, 1922, vol. 42, p. 42. By reversed chill the author means the appearance of a rim richer in free carbon than the center of the casting. The name is derived from the fact that this is the reverse phenomenon to that encountered in chill castings where the surface is richer in combined carbon and poorer in free carbon than the center.

The author then describes specimens of iron in the museum of metallography at Freiberg. The first is a gray iron with a light colored rim and a dark center. The rim is composed of graphite, much ferrite, relatively little pearlite and steadite.[2] The center consists of graphite, pearlite and steadite, ferrite being absent. Apparently the formation of graphite has proceeded further at the surface than at the center. The second specimen, a black fractured steel containing 1.25 carbon and 0.80 silicon, has a dark rim containing temper carbon and a center consisting of pearlite and cementite without temper carbon. The rim is presumably due to a heat-treatment which the specimen has received.

Former investigators have attempted to ascribe reversed chill to a high sulphur or phosphorus content, or to oxides dissolved in the metal. Others have felt that the phenomenon is one of supercooling. None of these explanations seems to the author to be adequate.

Heike prepared two iron-carbon alloys from very pure material by remelting in a carbon resistor furnace. In these melts reversed chill was observed, even though sulphides and phosphides were not present in any significant amount in any of the materials from which the melt was made; nor was the graphite encountered in mottles after the fashion of temper carbon, thus controverting an opinion expressed by Bardenheuer.[3]

In iron-carbon alloys saturated with carbon and raised to high temperatures in graphite crucibles the author makes the unsupported assumption that iron oxide was not present dissolved in the iron. Thus he concludes that the opinion of Osann and others that oxygen is a significant factor is disproved.

Heike draws attention to a consequence of Le Chatelier's principle the application of which has apparently been overlooked—namely, "Every external influence arouses opposing forces in a system at equilibrium which strive to bring it back to its original condition." Pressure is the external influence not ordinarily considered in the equation

$$Fe_3C \rightleftarrows 3Fe + C$$

Since decomposition of cementite is associated with increase in volume, pressure should shift the equilibrium to the left—i.e., cause any free carbon to combine with iron and form cementite, thus decreasing the volume and relieving the added pressure, at least in part.

It follows that graphitization is opposed by any conditions tending to exert pressure upon the graphitizing material, or to exercise any constraint on the accompanying increase of volume. Chemical composition also plays an important part in graphitization, since graphitization accelerated by a high-silicon content—for example, when occurring in the outer layers of a casting—materially increases the pressure of these layers on the liquid or plastic center. Just how an increase in dimensions of the outer layers of a casting should exert pressure on the interior is not made clear.

Heike then refers to certain researches published by Ruer[4] regarding the formation of graphite directly from liquid iron and not from cementite. He dismisses these considerations with the statement that first the separation of such primary graphite occurs chiefly in very high-carbon alloys, and second that even though it occurred in the ordinary alloys, the separation of such graphite in the liquid must involve an increase of volume.

The author then proceeds to elucidate his thesis that the reaction $Fe_3C \rightleftarrows C + 3Fe$ will proceed only under such conditions where a material increase in pressure does not hinder it. He feels that this condition exists so long as a considerable part of the alloy is in a liquid condition. If, however, the metal has become completely solid through the freezing of the last residues of molten material, then the energy of the reaction is no longer sufficient to overcome the constraint exercised upon the equilibrium by the surrounding pressure, the possibility of expansion being there-

[1] Umgekehrter Hartguss und verwandte Erscheinungen.

[2] Iron : phosphorus eutectic.

[3] *Stahl und Eisen*, April 28, 1921, p. 569; May 26, p. 719.

[4] *Z. angew. Chem.*, Dec. 17, 1918, p. 244.

by limited or destroyed. He regards this explanation as also applying to the occurrence of cementite at the junction of several crystals in material otherwise consisting of graphite, ferrite and pearlite. He feels further that this explains why graphite formation is materially retarded in alloys relatively low in carbon, say between 2 and 3 per cent. He writes as follows:

"If we consider further the increase of volume occurring within the space of a single crystal as a consequence of graphitization, the pressure upon the still unfrozen part must increase as the freezing progresses. On the other hand, the casting as a consequence of its cooling shrinks in from the outside so that the last residue of molten material is subjected to a pressure which the graphitizing reaction can no longer overcome. In addition to external conditions the chemical composition of the iron is of consequence, inasmuch as it largely determines the energy with which the transformation of cementite into iron and carbon occurs."

Heike then shows that the location of the graphitic areas in these and commercial specimens corresponds to those areas in which compression stresses may be considered absent. No explanation is offered, however, why this phenomenon should not constitute the rule rather than the exception, nor of the peculiar occurrence sometimes noted in even the most carefully made crucible tool steel—that the axis has graphitized and the surface remains normal.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cooling Coke.—A series of three patents covering the principle and apparatus for cooling coke by steam (or other gases) and utilizing the water gas thus formed.

The first specification, 173,761, covers the arrangement of the cooling chamber, Fig. 1. The incandescent coke is conveyed from the distillation plant to a hoist by buckets *e* and the truck *q*, and is tipped into a fixed chute *i*, which discharges it into the dry cooling chamber *a* provided with an outlet *c*. The chute *i* is provided with a slidably movable lip *k* connected by a rope *l* to a lever *n*, which is connected by a pulley-guided rope *p* to a hood *d* which normally rests in a liquid seal and closes the inlet *b* of the chamber *a*. The lip *k* is thus retracted when the hood is down and projects into the opening *b* when the hood is raised, the lever *n* being operated by the bucket *e* in such a way that the hood is raised when the bucket is tipped. The rails *h* of the hoist are U-shaped in cross-section and bent over at the top, the lower roller *f* engaging the outer flanges of the rails *h* and the upper roller engaging the recess between the flanges.

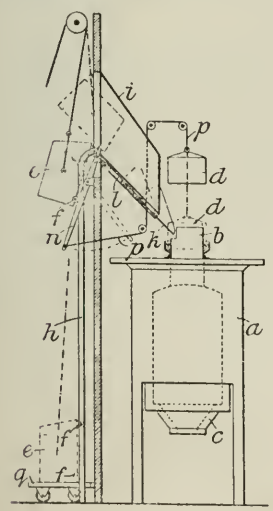


FIG. 1.

The second specification, 173,762, covers the process of cooling by means of a gas in the apparatus shown in Fig. 2. The coke is fed in known manner into a cooling chamber *a* and is cooled by a gas, preferably neutral, which is forced in a cycle through the cooling chamber and heat-exchange device. The gas enters the space *d* between upper and lower hoppers *c*, and ascends through the descending mass of coke. The lower hopper *c* is provided with slides which regulate the outlet and are symmetrically arranged always to form an outlet directly below the baffle plate *f*, which prevents the central core of the mass from descending too rapidly. As shown, forked slides *h* are used which are operated by right and left handed screws *i*. A door *g* is provided mounted on rollers *k* and is movable on rails *l*, which are pivoted at *m*, their free ends being vertically adjusted by toggle sleeves *o*. The cooling of the coke is effected progressively from the bottom, the lower layers being cooled and discharged gradually while the top layers are still incandescent, the fresh coke being added gradually.

The third specification, 173,763, covers the use of steam for cooling the coke in the apparatus shown in Fig. 3. In

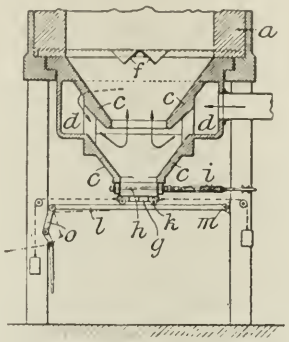


FIG. 2.

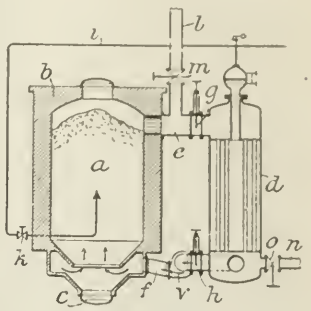


FIG. 3.

this process, the heat contained in the coke when it is below the temperature at which water gas is formed—namely, 600-700 deg. C.—is utilized to produce the necessary steam. The incandescent coke from the retorts passes through the cover *b* into the chamber *a*, which communicates by pipes *e*, *f* at top and bottom with a steam generator *d*, valves *g*, *h* being interposed and a blower *v* being provided to circulate the gases in the chamber *a* through the steam generator *d*. Steam is supplied to the coke mass through a pipe *i* and valve *k*, the water gas being withdrawn through a valve *m* and pipe *l* or, if it is desired that the heat of the water gas should be absorbed in the steam generator, through a valve *o* and pipe *n*. The first charge is cooled entirely by the blower *v*, thus producing steam for subsequent charges. The cooled coke is discharged at *c*.

Tanning.—Instead of using iron formate for tanning hides, as described in the parent specification, a tanning material made by partial double decomposition between an iron salt and a formate is used. Examples are given of associations of ferric chloride and ferric sulphate in excess quantities with calcium and sodium formates. Calcium sulphate when formed is filtered off. Sodium chloride is allowed to remain in the liquor as an aid to tanning. In one example 10 kilos of ferric sulphate dissolved in water is treated with 2.5 kilos of calcined sodium carbonate at 30 deg. C., 4 kilos of solid calcium formate being stirred into the liquor after cooling to 25 deg. C. (Br. Pat. 173,853. Chemische Fabriken Worms Akt. Ges., Frankfort-on-Main, Germany. March 1, 1922.)

Decolorizing Carbon.—Carbon for purifying and decolorizing purposes, and especially adapted for filtering, is made from vegetable material of fibrous structure and not containing much inorganic matter, by carbonization in the closed retort with the injection of gas or steam. The product is ground in a dry state to a degree of fineness short of that at which the fibrous structure is obliterated. In an example, pine wood in a granular state is heated to about 400 deg. C. for 6 hours or less, the gaseous products being evacuated continuously. The temperature is then raised to 1,200 deg. C. for 6 hours or more, and superheated steam is passed in. In the third stage, a temperature of 1,500 deg. C. is maintained for 3 hours without injection of gas, or with injection of nitrogen. The product is ground in a ball mill using steel balls until it almost all passes through a sieve of 20 to 30 mesh, but rests on a 90-mesh sieve. (Br. Pat. 173,624. J. N. A. Sauer, Amsterdam. Feb. 22, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Strong Technical Program Announced for Chemical Engineers' Meeting at Niagara

Important papers on acid manufacture and nitrogen fixation will feature the technical program of the fourteenth semi-annual meeting of the American Institute of Chemical Engineers, which will be held at Niagara Falls, Ont., June 19 to 22, 1922. The general headquarters for the summer meeting will be at the Hotel Clifton, one of the leading hostelries on the Canadian side of the Niagara River. Special automobile and boat trips have been arranged and one entire day will be given over to sightseeing and plant visits in Toronto. A similar trip to Buffalo on the following day will include business and social sessions at the Hotel Lafayette.

An interesting program has also been arranged for the wives and guests of the Institute's members. Sightseeing trips, theater parties and afternoon teas have been substituted for the technical and business meetings of the members. The ladies' program is in charge of Mrs. A. H. Hooker, chairman for Niagara Falls, and Mrs. C. B. Morey, chairman for Buffalo.

G. Prescott Fuller, chief chemist of the National Electrolytic Co., is chairman of the executive committee. The vice-chairman is C. B. Morey, manager of the soap department of Larkin Co., Inc. Finances are under the direction of David H. Howard. The chairman of the Toronto committee is Prof. J. Watson Bain of the University of Toronto.

The members of the principal committees are as follows:

Buffalo Committee—C. B. Morey, *chairman;* C. C. Heriage, J. D. Kerr, W. L. Spalding, H. J. White, E. G. Rippel and D. H. Howard.

Niagara Falls Committee—G. P. Fuller, *chairman;* T. L. B. Lyster, H. W. Kellogg, Max Mauran, F. A. Lindbury, F. J. Tone, R. C. Snowden, and E. M. Sergeant.

Transportation arrangements have not yet been announced, although it is possible that a special trip by boat and train will be arranged for the benefit of members residing in the New York district. A number have expressed their desire to make the trip by automobile and the Institute's secretary, Dr. J. C. Olsen of Brooklyn Polytechnic Institute, is arranging to organize these into special parties to follow a definite route and schedule.

The principal features of the detailed program follow:

MONDAY, JUNE 19

Meeting at Hotel Clifton

Registration.

9:30 a.m. Papers:

"Thermal Considerations in Sulphuric Acid Concentration," F. C. Zeisberg.

"Modern Methods of Concentrating Sulphuric Acid, Including Concentration of Sludge Acid and Acid Proof Masonry Construction," P. S. Gilchrist.

"Increased Capacity of Cascade Systems," Dr. L. A. Thiele.

"The Solubility of Quartz Packing in the Glover Tower," L. J. Michael and J. R. Withrow.

"Sulphur Dioxide and Fume Problems and Their Solutions," Dr. P. J. O'Gara.

2:15 p.m. Automobile trip, Niagara Falls, Ont., including new power canal and inspection of Niagara Falls plant of Hydro-electric Commission.

8 p.m. Public Lectures, Hotel Clifton:

"Geology of the Niagara District," John Jackson.

"Niagara Power Development" (illustrated), John L. Harper, chief engineer Niagara Falls Power Co.

TUESDAY, JUNE 20

Special cars leave for Lewiston at 9:30 a.m. via the Gorge route on the American side. The boat is taken for Toronto at 10:30 and after business session and luncheon aboard, the party disembarks at 1 p.m. and the afternoon is spent in sightseeing and plant visits. The return boat leaves Toronto at 5:25.

WEDNESDAY, JUNE 21

8:30 a.m. Special cars for Buffalo leaving Hotel Clifton.

9:45 a.m. Meeting at Hotel Lafayette: Papers:

"Manufacture of Nitric Acid," Arthur Hough.

"Manufacture of Hydrogen and Nitrogen for Synthetic Ammonia Manufacture," H. S. Taylor.

"Some Economic Aspects of Ammonia Oxidation," Dr. G. B. Taylor.

"Muriatic Acid—Saltcake Industry," P. C. Kingsbury.

"Vapor Tension at Low Temperatures," N. T. Bacon.

2:15 p.m. Automobile trip and visits to Buffalo plants.

8 p.m. Smoker, Hotel Lafayette.

THURSDAY, JUNE 22

9:30 a.m. Meeting at Hotel Clifton. Papers:

"Production of Hydrochloric Acid for Chlorine and Hydrogen," Hugh Kelsea Moore.

"Tank Cars for Transportation of Muriatic Acid," J. M. Rowland.

"Manufacture of Phosphoric Acid," Dr. P. E. Landolt.

"Manufacture of Phosphoric Acid," Theodore Swann.

"Recent Advances in the Production of Phosphoric Acid for Fertilizer and Food Purposes," W. H. Waggaman.

"Value of Water-Soluble Phosphates," Milton Whitney.

Automobile trip at 2:15 p.m. and optional visits to plants at Niagara Falls, N. Y., followed by a complimentary tea at the Niagara Falls Country Club.

Explosibility of Synthetic Ammonium Nitrate Subject of Study by Bureau of Mines

Upon the recommendation of the committee on the investigation of the explosibility of ammonium compounds of the National Research Council, the Bureau of Mines will undertake an investigation of the explosibility of synthetic ammonium nitrate by boosters on small scale. The work of the committee has for its general purpose the investigation of the explosibility of ammonium compounds, but the Bureau of Mines portion of this, as now proposed, is limited to (*a*) small-scale tests with charges not to exceed 10 lb.; (*b*) that particular ammonium compound designated ammonium nitrate; (*c*) that particular ammonium nitrate which is customarily transported and stored as such outside of powder factories—that is to say, imported synthetic ammonium nitrate. This new investigation is to be conducted on samples at normal temperature, at normal density and a definite but as yet unstated confinement, and the criterion of explosibility is to be the compression of small lead blocks.

Butterworth-Judson Receivers Organize

Receivers for the Butterworth-Judson Corporation, manufacturer of chemicals and dyestuffs, with a plant at Newark, met on April 24 at the offices of the company, 30 Church St., New York City. They are Thomas G. Haight and Henry G. Atha, Newark, and James O'Grady, Scarsdale, N. Y. No statement was given out after the meeting, but it is understood that a plan will be worked out later for carrying on the business of the firm.

Tariff Discussion Opens in Senate—Opposition to Dye Embargo

Discussion of the tariff bill has occupied most of the time of the Senate since April 20. The leaders of each party have outlined the general course their arguments will take. With a couple of exceptions specific rates have not yet entered into the debates.

Initial discussion of the tariff bill in the Senate reveals that there is practical unanimity of opinion in that body that the ad valorem rates in the bill should be based on a valuation made in the country of origin. Sentiment in the Senate seems to be as strongly opposed to American valuation as that of the House is in favor of it. Approximately 60 per cent of the commodities covered by the dutiable list take ad valorem rates. The remainder of the articles on the dutiable list are covered by specific rates. Every effort was made by the Finance Committee to apply specific rates wherever possible. The difficulty is that specific rates are impracticable in many cases.

Many Senators are in favor of passing over American valuation without dignifying it by discussing the plan in the Senate. It seems probable, however, that it will be necessary to debate the whole subject, as the bill reported to the Senate provides for the application of American valuation if the President should deem it necessary.

Chairman McCumber, of the Finance Committee of the Senate, agrees that of all times in our history this is the very worst to formulate and put into effect a new tariff measure, but he declares there never has been a time when it is more necessary to protect American industry against abnormal situations abroad which give special advantage to the foreign producer. He points out that wages in Germany declined enormously immediately following the armistice. In the other countries, he said, measured by the only stable currency in the world, the American dollar, the spread between American cost of production and foreign cost of production has been growing greater and greater. On the other hand, costs of production increased in this country until January, 1921.

Comparisons between the present bill and the Underwood act or the Payne-Aldrich law are of little value, in the opinion of Senator McCumber. He declares his committee gave but casual attention to either of these acts. The whole industrial, commercial and economic world has changed since those bills were enacted, he contends.

Sees Tariff Commission More Powerful

Under the bill as amended by the Finance Committee, Senator McCumber expects to see the Tariff Commission become a forum in which any complaints may be lodged as to the unfairness or the injustice of any rate. With the powers given the President, it will be possible to rectify any injustice caused by rapidly changing conditions.

On April 24 Senator Smoot addressed the Senate at length on the bill. He pointed out that tariff making is becoming more and more intricate with the progress of invention and the development of American industry. He referred to the fact that the tariff of 1890, including the free list and omitting all administrative regulations, covered only 47 pages of the size on which the bill is printed. The act of 1909 covered 71 pages, while the present bill covers 85 pages of the same size. He predicted that tariff making will continue to take more and more of the time of the legislative branch if the present method of procedure continues to be followed. If Congress is to have time for other legislative duties, he points out that it will be necessary to delegate a certain portion of the work to executive and administrative agencies. He thinks business interests will welcome any change in the tariff policy which will render less frequent and less violent the upheavals incident to tariff revision.

Believes American Valuation Impractical

The Utah Senator pointed out that under world conditions as they exist today it will be absolutely necessary to make frequent modifications of rates if the tariff is to be equitable to producer and consumer alike and does not burden unnecessarily our foreign trade. He attempted to show that American valuation would be unworkable. He said the research of the Senate committee had demonstrated that relatively few products having the same generic name as domestic articles are sufficiently similar to permit of price comparisons. The trade mark on most goods, he declared, has almost as much to do with their value as have their physical qualities. He cited specific examples to show that 28 per cent ad valorem, the American valuation equivalent of 60 per cent on foreign value, would result in American valuations varying from 164 to 297 per cent. One of the chief objections, in Senator Smoot's opinion, to adopting the American selling price of the imported article as a basis for the assessment of duty lies in the fact that an importer will reduce the selling price of any particular article which he desires to make closely competitive with a comparable domestic article. It is such articles which are used by merchants as leaders, sold at a very small marginal profit and sometimes under cost to attract trade likely to purchase other articles in his stock. American valuation permits the importer to sell his leader below the average level upon which the American valuation equivalent rate of duty necessarily would have to be based.

Senator Smoot said the Reynolds investigation, made for the Committee on Finance by the Treasury Department at a cost of $100,000, revealed conclusively the wide fluctuation in importers' margins and demonstrated that imported articles in the American market fluctuate more widely than does the value of these articles in their home markets. The Senate rates, he contends, offer greater security to the American manufacturer than equivalent rates based on American values. Nothing could be more disturbing to business, in the opinion of Senator Smoot, than a revolutionary change in the basis of valuation.

Will Oppose Dye Embargo

In his initial speech on the tariff, Senator Smoot indicated clearly that he would be active in his opposition to the dye embargo provision added to the bill by the Senate committee. He declared that the embargo may have had its justification in the period immediately following the armistice, but he believes it to be unnecessary to incorporate the plan in a permanent tariff bill. He said it is inevitable that the weaker coal-tar chemical industries will be eliminated anyway in competition with the stronger domestic concerns, and that the embargo will do little to help them and will place an unnecessary burden on the dye-consuming industries.

One of the important aims of the Senate committee's bill, Senator Smoot said, is to apply one tariff to all countries alike, and force all countries to give American products equal treatment with those accorded to other countries.

Basis of Democratic Opposition

Senator Simmons of North Carolina, the ranking Democrat on the Finance Committee, declared that the bill is based on three erroneous assumptions. One is that present importations are excessive and a menace to the business of the country. The second, he says, is the assumption that the home selling price and the export selling price of foreign merchandise are so much lower than the selling price of comparable domestic products that higher rates of duties are needed to bring about fair competitive conditions. He also branded as unsound the deductions from the Reynolds report. The report, he said, was based on selling prices in August, 1921. The committee, he asserts, has assumed that price levels have not changed since that date. He charges that the bill will cause higher prices, will add materially to the cost of living and will permit further monopolization of American industries. The rates in the Senate bill, he declared, are 40 to 50 per cent higher than the average Payne-Aldrich rates when the difference of price levels between that period and the present are taken into consideration. The current volume of imports, he declared, is not excessive and is relatively small when compared with the volume of our exports. Among the other points he made against the bill was the need for expanding foreign markets so as to absorb our surplus production from the field, the factory and the mine. If our surplus capacity is not utilized, he argued, the amount of unemployment will increase.

Crystallizing Sentiment on Muscle Shoals Presages Rejection of All Offers

Disinterested opinion on Capitol Hill is to the effect that no one of the Muscle Shoals offers will be accepted. It is believed the government will reopen work on the dam and will complete it, after which leases will be made for the disposal of the power.

A sub-committee of the Committee on Military Affairs of the House has made a formal report to the effect that no offer will be considered which does not conform to certain fundamentals. The first essential is that the property be subject to requisition at any time by the government for the production of war materials, and that Nitrate Plant No. 2 be kept in such condition as to be capable of producing nitrates at any time. Another condition, held by the sub-committee to be fundamental, is that a definite contract be entered into for the manufacture and sale to the public of a fixed quantity of mixed fertilizer. A third condition is that any deal must be made for the entire property with the exception of the steam plant at Gorgas and the transmission lines connecting it with Plant No. 2.

The Military Affairs Committee is discussing the proposition in executive session. All offers except that of Henry Ford have been tabled. The Ford offer, at this writing, is being read paragraph by paragraph. The committee expects to make its final report during the first week in May.

Senate Considers Engstrum Offer

The Senate Committee on Agriculture heard former Senator Marion Butler at great length on the Engstrum proposal for Muscle Shoals. Among other things, he said:

"Here we have two nitrate plants and two steam power plants, and the greatest hydro-electric dam in the world partly completed, which has cost the government $106,000,000. The act of Congress appropriating this money declares that it should be used to produce nitrates from the air for explosives and also for fertilizers. We produced nitrates there during the war by use of steam power; but we could not produce sufficient nitrates both for explosives and for fertilizers, therefore agriculture starved for want of nitrogen during the war.

"When the war was over, we stopped these nitrate plants, and we stopped work on the hydro-electric dam. We should correct that mistake at the earliest possible moment; with that dam finished, we could now be producing the cheapest nitrates for fertilizers in the world, but we could not even then produce as much nitrogen as is now needed for fertilizers alone until we build more nitrate plants.

"Under these serious conditions, it would be nothing less than a crime to abandon this great nitrogen project at Muscle Shoals. It will be as bad in principle and almost as bad in results to lease or sell this Muscle Shoals project to parties who will use only one-tenth of that great power to produce nitrogen while nine-tenths of it will be used for making automobiles, aluminum, etc., for private profit.

Would Utilize All Water Power for Nitrates

"The duty of Congress is plain; we should go forward and utilize this great investment and great water power to serve the public good. We should, at once, finish dam No. 2 and put both of these nitrate plants to work, day and night; we should then build dam No. 3 and put up another nitrate plant by its side. Indeed, we should go forward and develop the whole one million horsepower on that river, and use it all to make cheap nitrates for fertilizers."

Commenting on the published statement of Secretary Wallace that the War Department surplus ammonium nitrate was not being bought by fertilizer manufacturers and calling attention to the availability of Chilean saltpeter for this use, Mr. Butler said that these statements are absolutely true, but without explanation would cause misapprehension. He said that ammonium nitrate, offered for sale by the government, is not suitable for fertilizer. The imported sodium salt, on the other hand, is so expensive that the farmer is not using half the fertilizer the soil needs.

In conclusion Mr. Butler appealed to Congress either to go ahead with Muscle Shoals as a government enterprise, as provided in the national defense act, or to lease it under a contract which will produce the largest output of cheap nitrates for fertilizers as proposed by the Engstrum company.

R. R. Grant, president of the American Non-Ferrous Corporation and the Aluminum Wheel Co. of America, is conferring with War Department officials on a plan whereby the companies would take over on a 25-year contract the Muscle Shoals nitrate plant, for production of aluminum and fertilizer.

Ford Wants Gorgas Plant

Henry Ford insists that the government's equity in the steam plant at Gorgas on the Warrior River and the transmission line to Plant No. 2 be included in the property which he proposes to lease. W. B. Mayo, chief engineer for Mr. Ford, gave this message to the members of the Military Affairs Committee on April 27, when he appeared before the committee in executive session.

The committee has made up its mind quite definitely that the government should not lease the Gorgas plant and transmission line at this time. The action of Mr. Ford in demanding that these items be included in the list of property which he wishes to lease came as a surprise to the committee, a majority of which appears willing to recommend the acceptance of Mr. Ford's offer, provided it is amended in certain important particulars.

Chicago Section, A.C.S., Elects Officers—Papers on Yeast and Temperature Control

Synthetic nutrient mediums for yeast culture were discussed before the Chicago Section, American Chemical Society, on Friday evening, April 21, by Prof. Ellis I. Fulmer of the department of agricultural chemistry, Iowa State University. The effect of varying the amount of each of the following components was carefully studied: NH_4Cl, K_2HPO_4, $MgSO_4$, $CaCO_3$ and cane sugar. Points of optimum concentration were found in some cases, notably ammonium chloride and calcium carbonate, which explain conflicting results reported previously. As a result of this work, yeast has been grown continuously for 2 years by subculturing in a medium containing only K_2HPO_4, NH_4Cl and sugar.

At the group meeting on synthesis, R. C. Shuey of the Redmanol Chemical Products Co. described the methods used for controlling the temperature during the various steps in the manufacture of synthetic resins. The reactions are exothermic and very careful regulation is essential in order to keep a batch from getting beyond control. A system comprising a thermocouple element operating a small compressed air valve which in turn controls the movement of the main valve was found very satisfactory in regulating steam-heated stills where the pressure in the steam line was kept practically constant.

Officers were elected as follows: Chairman, C. S. Miner; first vice-chairman, P. N. Leech; second vice-chairman, E. S. Weirick; secretary, S. L. Redman; treasurer, O. N. Berndt; editor of the *Chemical Bulletin*, E. H. Volwiler; trustee, W. Lee Lewis; councilors, D. K. French, H. N. McCoy, L. V. Redman, W. R. Smith, Ethel M. Terry, L. M. Tolman, Paul Van Cleef, G. L. Wendt, F. C. Whitmore; Willard Gibbs jurors, Lauder W. Jones, W. Lee Lewis, H. N. McCoy, J. H. Mathews.

Immigration Bars Hinder Erection of German Briquetting Machinery

Half a million dollars worth of German briquet-making machinery, contracted for to be used in connection with the lignite deposits in Victoria, Australia, may have to be refused, since under the Australian immigration act of 1920, Germans are prohibited for a time from entering the country and the two experts who were to have put up the machinery are being kept out. The question is being actively discussed, and references have been made as to the possibility of obtaining similar machinery in the United States to take the place of the German machinery, or else to employ Americans to erect the German machinery.

Information Desired on Standard Analytical Methods

American Engineering Standards Committee, 29 West 39th St., New York City, would be glad to hear from chemists who are using the A.S.T.M. Standard Methods for Chemical Analysis of Tin, Antimony and Copper, and their methods for laboratory sampling and analysis of coke, as to the extent the specifications are used, and any comment on their usefulness. These are proposed as "Tentative American Standards."

Dye Hearings About to Close—Developments of Past Week

Hearings before the sub-committee conducting the dye investigation were virtually brought to a close last week. This was the outstanding development of the week, although a touch of light drama was injected by the National Association of Hosiery and Underwear Manufacturers when their counsel was interrupted in the midst of his testimony and told that his clients had suddenly decided not to play any more. As far as Senator King's monopoly charges are concerned, it seems pretty generally accepted that the industry has shown a clean bill of health and the only mention made of monopoly during the testimony were the occasional references which seemed necessary to entitle the speakers to the floor before such a committee.

The sub-committee plans to hear Paul Pickhardt of Kuttroff, Pickhardt & Co. and representatives of the Chemical Warfare Service this week. Senator Shortridge announced that every opportunity would be given to anyone believing he has additional evidence of importance to present it. He also announced that the sub-committee will discuss the reparation dyes situation with Secretary Hughes some time this week.

Socks and Shirts—A Comedy in Three Acts

The first appearance of representatives of the National Association of Hosiery and Underwear Manufacturers was on March 11, when George Demming, a lawyer, of Philadelphia, handed Senator Shortridge a letter violently attacking the conduct of the dye investigation, after which he promptly disappeared. The letter purported to express the sentiment of the association, and was quite caustic in its criticism of the sub-committee's methods. Shortly afterward John N. McCullaugh, consulting industrial manager for the association, denied authorship of the letter and asked that it be stricken from the record.

The second act opened on April 20, with Mr. McCullaugh testifying as to Mr. Demming's unquestioned right to speak for the association in testimony before the sub-committee. He stated that Mr. Demming was appointed special counsel for the association and was authorized to appear for it by authority of the board of directors.

The third act is laid at the next meeting of the sub-committee 5 days later. Mr. Demming's testimony was suddenly and dramatically interrupted by Mr. McCullaugh, accompanied by Joseph Rambo of Philadelphia, one of the board of governors of the association, who declared that by authority of a majority of the board of directors of the association he wished to withdraw Mr. Demming as its representative and to withdraw his evidence as far as the association was concerned.

Both Mr. Demming and Senator Shortridge expressed surprise at this action. Mr. McCullaugh explained the changed attitude by saying that a majority of the board of directors had decided that "we have our own hands full with our own business" and did not wish to interfere in the hearing.

Hosiery Company Supports Embargo

Senator Shortridge read a telegram from John Fitzgibbon, manager of the Phoenix Knitting Works, Milwaukee, Wis. The text of the telegram follows:

> We have noticed George Demming's opposition before your committee to selective embargo protection for American dye manufacturers. As one of the largest hosiery manufacturers of the country and also a member of the National Association of Hosiery and Underwear Manufacturers, we entirely indorse a selective embargo as applied to dyestuffs. We strongly urge you and your associates to give adequate protection to American dyestuffs manufacturers to enable this industry to continue successfully. We buy substantial quantities of American dyestuffs for our plants and find American manufacturers are manufacturing dyes of equal quality with the German products at reasonable and continually decreasing prices and that cost of American dyes is no hardship to us.

Isermann Testifies Again

Representing the small dye manufacturer, Samuel Isermann, with statistics at his fingertips and keenly aware of the facts, added to his previous testimony as to the value of the embargo and the competition among domestic producers. The selective embargo has smashed the German grip on dyes and other coal-tar products, he said. The results have been of incalculable value to American consumers, for when it swept away the monopolistic control here of German manufacturers the exorbitant prices charged for many products were likewise broken. Dr. Isermann cited examples in perfumes and drugs, showing how American manufacturers had brought down exorbitant German prices.

The witness then attacked the testimony of H. A. Metz, in which the latter stated that his manufacturing interests are greater than his importing interests. Dr. Isermann also made a detailed attack on the testimony of E. R. Pickrell, of Mr. Metz's staff, and criticized the testimony of Ward Thoron, of the Merrimack Manufacturing Co., who based much of his testimony on the term "drugs," which, as Dr. Isermann pointed out, included many things in addition to dyestuffs.

The Small Producer and American Monopoly

Dr. Isermann emphasized the great strides made by American dye manufacturers since the war and pointed out the importance of the small manufacturer in developing the processes. He recounted briefly the reasons set forth by previous witnesses showing why more than a tariff is needed to protect the American industry, and then took up in more detail the problem of substitution.

Less than a thousand different dyes were imported into the United States prior to the war, he said. But for each one of these dyes imported there were satisfactory substitutes which would produce substantially the same results when used in substantially the same manner, and the German chemical industry knew how to make them. If a tariff was written for the protection of one American dye the German producers could simply turn to a substitute product not specified in the tariff law, he said.

There is quite a danger that large concerns by cutting prices will force the smaller companies out of business, and it has been suggested that in course of time there might be a tendency to form a monopoly. There is a possibility that this could take place, but competition today is keen.

Metal Failures Discussed by Steel Men

"The Influence of Quality From the Standpoint of Workmanship and Material" was the title of the address by Frank P. Gilligan, president of the American Society for Steel Treating, before the Washington chapter of that organization on Friday, April 21. Mr. Gilligan, who is the vice-president of the Henry Souther Engineering Co., of Hartford, Conn., discussed his general subject broadly, but gave particular attention to the question of metal failures, which he and his engineering organization have investigated thoroughly. The importance of quality in relationship to metal performance was emphasized.

King Would Investigate Alien Property Activities

Senator King of Utah has introduced a resolution for an investigation by a committee of five Senators of various activities of the Alien Property Custodian, including the sale of patents, trade marks and trade names to the Chemical Foundation, or others.

American Institute of Chemical Engineers to Hold Conference on Chemical Engineering Education

The American Institute of Chemical Engineers is arranging for a conference on the report of its committee on chemical engineering education presented at the Baltimore meeting. Invitations have been sent to the presidents of eighty-three universities and technical schools which offer courses in chemical engineering to attend or send representatives to the conference for discussion of the report. A printed copy of the report was sent with the invitations. The conference will be held on May 16 at the Brooklyn Polytechnic Institute, sessions being held at 10 a.m. and 2:30 p.m. and also at 8 p.m. if necessary.

A preliminary report of the findings of this committee was presented at the Detroit meeting of the Institute and was published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, No. 24, pp. 1047-53, June 15, 1921.

Power Test Codes Committee Completes Three Codes to Be Discussed at A.S.M.E. Meeting

On Tuesday morning, May 9, of the spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga., a public hearing is set for the discussion of the three additional power test codes which have reached this stage in their development during the past year. Last May at Chicago this committee, of which Fred R. Low, editor of *Power*, is chairman, presented codes on general instructions, steam engines and evaporation apparatus. It now presents codes on definitions and values, displacement compressors and blowers, and hydraulic power plants, all three of which have appeared in *Mechanical Engineering*.

Though these codes have passed through six successive revisions in reaching their present form, the committee will welcome a full and frank discussion by the members of the society and others interested. Members not planning to attend the spring meeting and others are invited to prepare written discussions.

Reprints of all three codes revised to date have been prepared by the committee and may be obtained by addressing C. B. LePage, secretary to the committee, at the society's headquarters.

In 1918 the power test codes committee of the A.S.M.E. was reorganized to revise and enlarge the power test codes of the society, published in 1915. The committee is a large one, consisting of a main committee of twenty-five under the chairmanship of Fred R. Low, and nineteen individual committees of specialists who are drafting codes for the different classes of apparatus comprised in power-plant equipment.

Symposium on Glycerine and the Fatty Acids

An extremely practical treatment from the industrial standpoint featured the symposium on glycerine and the fatty acids held at a joint meeting of the Society of Chemical Industry, American Chemical Society, American Electrochemical Society and the Société de Chemie Industrielle at the Chemists' Club, New York, April 21.

J. W. Bodman, of William Garrigue & Co., gave a very interesting talk on the distillation of glycerine from the standpoint of a chemical engineer. The talk was profusely illustrated with slides showing details of the apparatus and process. The distillation of glycerine is essentially an application of the principle of a double effect vacuum evaporator. In the manufacture of dynamite glycerine, the apparatus used consists essentially of an evaporator, two condensers known as the superheater and cooler, and a concentrator. The steam used in the concentrator is obtained from the evaporator, and the sensible heat in the vapors as well as the latent heat of evaporation of the glycerine is used in the heat interchangers.

It would be possible to condense all the glycerine in the first condenser, but in practice a certain amount is permitted to go through to the second condenser, as otherwise some of the lower fatty acids would condense out with the glycerine. The construction details of the tubular copper condensers and of the ingenious catch-all, which throws out some of the salt between the still and superheater, were shown.

In the manufacture of pure glycerine, the first distillate is diluted, treated with lime, filtered and redistilled. The yield of the operation depends upon the disposal of the "foots." In good operation about 94 per cent of dynamite glycerine is obtained, with 4 per cent in the "foots" and 1.9 per cent in the "sweet water." Mr. Bodman pointed out the saving accomplished by the utilization of the latent heat of vaporization of glycerine.

Passing to the subject of the distillation of fatty acids, Mr. Bodman described the commercial process and gave some interesting figures on the fatty acid and glycerine yields from stocks from different sources.

R. C. Farra, of the Standard Textile Products Co., Passaic, N. J., described the modern method of manufacture of oilcloth, describing the qualities desired in the fabric, the calendering process which precedes coating and the preparation and coating of the "daub." The oil is boiled for 2 hours at about 600 deg. F., some oxide of lead, iron or manganese having been added to aid the oxidation. These so-called driers also prevent the "separation" of the oil. The oil is cooked to a standard viscosity and mixed with china clay. Alkali, usually ammonia, is added, giving a water in oil emulsion. A solution of casein or other sizing is added, giving an oil in water emulsion, which can be thinned to proper consistency with water. The fabric is coated and surface dried for 5 minutes, when the second coat may be applied. Final drying is carried out in a festoon drier for about 8 hours at 130 deg. F. The pigment used for white oilcloth is zinc oxide and for black oilcloth is carbon black. The glazing operation was described and several promising lines of research were suggested.

A. C. Langmuir discussed the need for a standard method of evaluating glycerine.

American Ceramic Society Plans Summer Trip to England and Europe

In response to an invitation extended last year by the British Society of Glass Technology, the American Ceramic Society is making arrangements for a party to sail from New York on the Cunard liner Aquitania, Aug. 22.

With regard to the reception of members interested in things other than glass, Dr. Turner writes that the refractories group surely will be welcome. While negotiations are still pending for the other groups, there have been no definitely unfavorable reports.

Dr. Turner has in charge the arranging of the tour of England, which will require about 3 weeks after arrival in England. Special trips will be arranged for the several groups representing the divisions of the society. Those wishing to visit the Continent will be expected to make their own arrangements, since no organized visit will be made.

All members interested are urged to communicate at once with Dr. E. Ward Tillotson, Mellon Institute, Pittsburgh, Pa.

American Leather Chemists Association to Hold Summer Meeting in Canada

Bigwin Inn, delightfully situated in the Lake of Bays district, Ontario, Canada, has been chosen for the nineteenth annual meeting of the American Leather Chemists Association, June 21 to 23. In addition to the usual committee reports, special addresses of interest to the tanner as well as the chemist are being arranged. Prof. F. E. Lloyd of the department of botany, McGill University, will speak on "The Mode of Occurrence of Tannin in the Living Cell." Several papers will be contributed from the Leather Research Laboratory of the Tanners' Council in the University of Cincinnati. Titles of two of the papers have been announced by Prof. McLaughlin—"Bacteriology of the Fresh Hide" and "The Science of Curing." Further details will be given as they assume definite form.

The association is particularly desirous of having the practical men of the industry well represented at the meeting, it being felt that there will be much of interest to them on the program.

Domestic Potash Producers Encouraged by Tariff Prospects—Operations Resumed

Domestic producers of potash are much pleased with the action of the Finance Committee of the Senate in approving the potash paragraph put into the tariff bill by the House. Commenting on this action, Frederick W. Brown, the executive secretary of the United States Potash Producers' Association, says:

"No industry ever presented a fairer proposal in seeking protection. A study of the potash situation is all that is necessary to reveal the justice of the American producers' request for a diminishing scale of duties. The industry should be protected, not only that we may be insured an increasing production of domestic potash but in the interest of the farmer himself.

"With the indorsement of the committee, only one step remains to be taken—the passage of the item by the Senate —to free America from the foreign potash monopoly."

Operations Resumed at Searles Lake

The American Trona Corporation resumed operations at Searles Lake April 10, with expectations of reaching a record production of potash and borax in the near future. With the exception of an installation of new condensers, no change has been made in the operations or equipment since the shut-down. The company plans to apply the results of recent research to the production of several new byproducts as soon as practicable.

"Informashow" Planned in Connection With Rochester Meeting of Purchasing Agents

An "Informashow," an industrial exhibition with a new idea behind it, is scheduled in Rochester, May 15 to 20, in connection with the convention of the National Purchasing Agents' Association which is to be held there at that time.

The consideration which chiefly influences the purchasing agent is value, which comprises service, quality and favorable price. These considerations sum up the benefits that the corporation will derive as a result of the purchase. Consequently, any exposition that shows the value of equipment should be of value to purchasing agents. The "Informashow" is designed as a medium for demonstrating the value of various industrial equipment, and to furnish an opportunity for the seller to inform others of the value of his product and for the purchaser to learn. With this principle in mind, every effort has been made to include exhibits which demonstrate the value and uses rather than the products themselves. About 100 exhibitors have reserved space. It is expected that about 1,200 purchasing agents will be present.

Minerals Separation Suits Closed by Settlement

On April 28 the negotiations which have been in progress during the last 4 or 5 weeks between the Minerals Separation and the Jackling interests and also the Miami Copper Co. terminated in a settlement satisfactory to all parties. This settlement will, therefore, terminate the hearings before the masters in the Butte & Superior case and the Miami Copper Co. case, as well as the cases pending in courts against all the mines of the Jackling interests.

Personal

W. H. Alger of Orange, Va., has been elected president of the Amelia Mica Mining & Developing Co., Chula (Amelia County), Va. W. W. Alger has been elected vice-president and R. B. Roberts secretary and treasurer.

Dr. Hugh P. Baker, executive secretary of the American Paper and Pulp Association, will spend 8 weeks in Europe this summer studying conditions in the paper industry in Norway, Sweden, Finland, Germany, Austria, Poland and Czechoslovakia. The Department of Commerce is particularly interested in the effect on the paper industry here and abroad of the establishment of the new European republics and the revision of boundaries. Dr. Baker will bear a special commission to study this phase for the department.

J. W. Bostwick has been appointed general manager of the Kansas & Gulf Oil Corporation, with headquarters at Tulsa, Okla.

H. C. George, of the petroleum division of the Bureau of Mines, is en route to Alaska.

Prof. W. D. Harkins of the University of Chicago addressed the Franklin Institute in Philadelphia on April 19, taking for his subject "The Structure and Building of Atomic Nuclei."

F. M. Harrison, president of the U. S. Industrial Alcohol Co., New York, has resigned. He will be succeeded by H. S. Rubens, chairman of the board of directors, who will continue also in the latter capacity.

The partnership of Huntoon & VanArsdale has been discontinued. L. D. Huntoon will continue practice as consulting mining engineer at 115 Broadway, New York City, and G. D. VanArsdale will continue practice as consulting chemist and metallurgist at 1011 South Figueroa St., Los Angeles, Cal.

Dr. Irving Langmuir of the General Electric Co. spoke before the Delaware Section of the American Chemical Society in Wilmington on April 19 on "Molecular Structure and Its Relation to Chemical Valence."

Charles A. May, president of the Maddock Pottery Co., Trenton, N. J., was the guest of honor at the tenth anniversary banquet celebration of the local Federal Club, April 18.

Prof. Alan C. W. Menzies of Princeton University addressed the Philadelphia Section of the American Chemical Society on April 20, on "Modern Study of the Atom."

C. Wilbur Miller, president of the Davison Chemical Corporation, Baltimore, Md., plans to sail for Europe May 16, for business and pleasure, and will be absent for a number of weeks.

H. O'Connell of Plattsburg, N. Y., has been engaged by the Dexter Sulphite Pulp & Paper Co. of Dexter, N. Y., as chemist in charge of the chemical laboratory and experimental station.

Edgar S. Ross, formerly chief chemist for the Charlotte Chemical Laboratories and Columbite Reduction Co. of Charlotte, N. C., and for the past several years engaged in private research concerning the metals tantalum and columbium, is now chemist and assistant manager for McKechnie Bros., Inc., metal smelter and refiner of Philadelphia, Pa.

Kenneth D. Tucker, connected with Magnus, Mabee & Reynard, New York, manufacturers of essential oils, and previously associated with the essential oil department of the National Aniline & Chemical Co., resigned May 1, to engage in business with his father.

Obituary

Sir John Benn, known in England as the "father" of the London County Council, and chairman of the board of Benn Bros., Ltd., the largest publisher of technical and trade papers in Great Britian, died in London, April 10. He entered the field of business journalism in 1880, when he established the *Cabinet Maker*, devoted to the furniture trade. The venture succeeded and in time the business expanded until at his death the firm was publishing thirteen business journals, including the *Chemical Age*, the *Electrician* and the *Gas World*.

George C. Ripley, superintendent of the Electrolytic Zinc Refinery of the Anaconda Copper Mining Co. at Great Falls, Mont., died on April 17, 1922, of pneumonia. He graduated from the Colorado School of Mines in 1906, then spent about 10 years in China and the Philippines. Returning to the United States, he joined the operating staff at Great Falls shortly after the electrolytic zinc department started operations.

Market Conditions

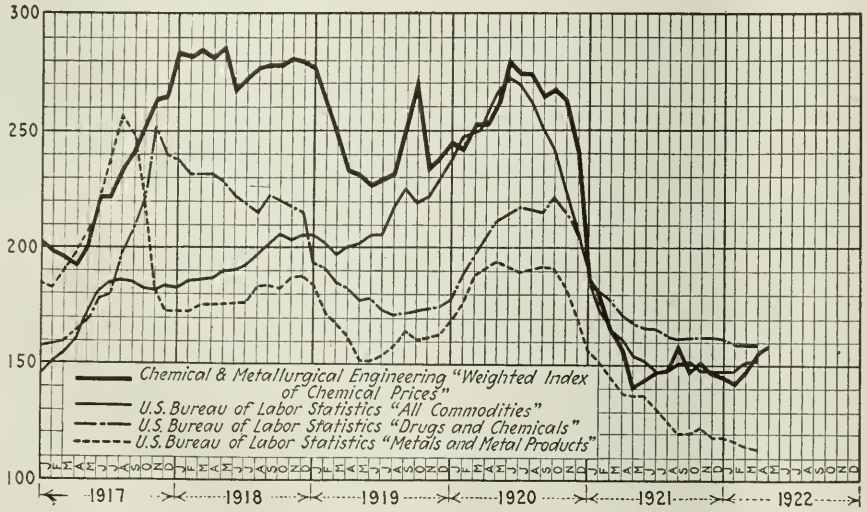
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

April's Progress Toward Better Business

Continued progress was made during April in the return to that mythical state of business which we sometimes call "normalcy." That term, to be sure, is capable of many interpretations and to the individual manufacturer it is likely to mean the particular time at which his own plant was running at its maximum capacity. Normalcy so defined may never be reached again, but certainly there is much in the fundamental economic situation to indicate that better business is definitely ahead.

Many powerful factors are making for an industrial betterment that cannot be accounted for strictly by seasonal influences. Of these factors, four are outstanding at the present time: (1) A larger volume of manufacture is evident in many of the basic industries. (2) Increases in wholesale prices are gradually predominating over the decreases. (3) There has been a noticeable easing up of money rates which has directly or indirectly resulted in (4) sustained strength and unusual activity in the stock and security markets. The most prominent gains in production are probably in the iron and steel industries. In the face of firm and even advancing prices, steel production has increased until present operations are in the neighborhood of 75 per cent of capacity as compared with 40 per cent at the beginning of the year. This rate approximates that for the year 1913. The monthly output of steel ingots in March (2,370,751 tons) was better than at any time since November, 1920. Pig-iron production during April was said to be larger than for any month since January, 1921.



THE UPWARD TREND IN CHEMICAL PRICES SINCE JANUARY, 1922

In other basic industries, especially paper, petroleum products and certain of the heavy chemicals, there has been a moderate increase in manufacturing output. Probably some little gain in freight movement of general commodities has occurred, although car loadings, the usual index of this movement, have fallen off somewhat during April. This has been due largely to the coal strike and the feverish activity which preceded it. For example, car loadings during the week ended April 8 were 714,268 cars, as compared with 827,011 during the previous week, a reduction of 112,743 cars. Coal loadings for the same week in April totaled 69,456, a decrease as compared with the week before of 115,496 cars.

The activity in the stock market which has been noted in our earlier reports continued without interruption during April. Toward the end of the month there were occasional tendencies toward reaction and a rather general feeling that the peak has been reached in the present upward movement. The *Annalist's* average of twenty-five industrials, which stood at 73.0 on Aug. 1, 1921, had mounted to 92.9 by April 1 and ended the month at 96.6. A similar gain had been shown in CHEM. & MET.'S average of the stocks of twenty representative companies in the chemical and allied industries, which rose from 46.1 on Aug. 1, 1921 to 63.8 on May 1, 1922. A comparison between the low figures of 1921 and the recent high for certain chemical, metallurgical and related industrials gives a definite idea of the extent of this appreciation. The approximate gains in actual dollars based on the outstanding stock issues have been calculated by W. J. Wollman & Co. and are shown in Table I.

One of the factors of potential importance is the coal strike, although its effect has not, and perhaps may not, be felt by industry in general. The recent rise in iron and steel prices has been attributed in part to the trouble in the coal fields, but certainly there were other factors of more serious import. About the only element of surprise in the situation has been the larger number of non-union

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	158.41
Last week	158.27
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

TABLE I—RECENT APPRECIATION IN THE STOCKS OF CERTAIN CHEMICAL, METALLURGICAL AND ALLIED COMPANIES

Stock	Low of 1921	Recent High	Approximate Gain in Dollars
Allied Chemical & Dye Corp	34	68	$73,763,578
Anaconda Copper Mining Co	31¾	54½	68,250,000
American Smelting & Refining Co	29⅝	59½	18,223,152
American Sugar Refinery Co	47⅛	74½	12,037,500
Corn Products Refining Co	59	108	24,394,160
Davison Chemical Co	23	63	8,000,000
General Asphalt Co	39½	65½	5,118,958
Mexican Petroleum Co	84½	135½	21,903,649
U. S. Steel Corp	70¼	99¼	147,407,725

miners who have joined the movement. As yet there is no indication of the settlement of the strike, and even when it does come it can scarcely be regarded as a permanent answer to the problem of the bituminous coal industry. The only satisfactory solution will depend upon the elimination of the intermittent operation caused by overcapacity and overproduction.

The foreign exchange market has remained comparatively stable throughout the month, presumably pending the results of the Genoa conference. All of the exchanges have, however, shown slight recoveries from the low levels reached toward the end of March. Sterling rose from $4.37 on April 1 to $4.41⅜ on April 15, and has since maintained this level. German marks, which on March 27 had fallen to $0.0028⅝, the lowest on record, recovered to $0.0035 toward the end of April. French francs rose from 9.09c. on April 1 to 9.26½c. on April 20.

The continued rise in general wholesale prices during March as indicated by the index numbers of the Bureau of Labor Statistics, were reviewed in last week's issue. These slight gains were probably maintained for most commodities during April, although comparatively few striking advances were recorded. Chemical prices, however, may be regarded as an exception in that higher prices were maintained throughout practically the entire list. CHEM. & MET.'s weighted index of chemical prices averaged 158.04 for the month of April, as compared with 156.19 for March. These are the highest quotations since August, 1921, and show a gain during the last 3 months of approximately 16 points.

Not all the factors in the business situation may be regarded as favorable, and some setbacks are bound to occur, but it may be said with no undue optimism that the industries served by CHEM. & MET. are gradually emerging from the period of depression.

Margarine Production in 1921

The annual report of the Commissioner of Internal Revenue for the fiscal year ended June 30, 1921, gives the following figures for the production of oleomargarine as well as the materials entering into its manufacture. The difference of about 60,000,000 between the total weight of vegetable oils and other materials consumed and the output of finished margarine is due almost entirely to the water content of the milk.

	Lb.
Oleomargarine, produced	281,081,514
Materials consumed:	
Cocoanut oil	103,111,916
Milk	79,715,584
Oleo oil	49,675,749
Neutral oil	29,267,960
Salt	25,365,499
Cottonseed oil	18,532,860
Peanut oil	16,332,498
Vegetable oil	6,559,034
Oleo stearine	4,857,972
Oleo stock	2,065,231
Butter	1,498,625
Corn oil	925,999
Soy bean oil	461,129
Edible tallow	233,227
Mustard seed oil	109,748
Coloring	25,915
Miscellaneous	3,216,742
Total materials	341,955,688

International Paper Shows Loss

Another company to make an unfavorable report for operations in 1921 is the International Paper Co. The net loss for the year before payment of preferred dividends was $7,442,890. Of this amount $6,276,607 was for depreciation of inventory, although at the ordinary rate of depreciation this would amount to only about $2,379,967. The operating profit for the year was $1,542,642 notwithstanding the fact that during May and June the company's mills were shut down on account of a strike.

President Dodge in the report significantly stated that inventory might have to be adjusted either way at the end of 1922. General opinion is that prices of pulpwood have reached bottom and can be expected to move upward later this year when the large buying interests come into the market.

Government Nitrate Sales

Prices obtained for the nitrate of soda recently sold by the government are as follows:

At the Old Hickory Ordnance Reserve Depot, $42.50 per ton; at Middletown Ordnance Reserve Depot, $47; at Nitro, W. Va., $41 and at Morgan General Ordnance Depot, $50 per ton.

The successful bidders were Baugh Chemical Co., Baltimore; Baugh & Sons Co., Baltimore; M. D. Biddeson, National Aniline & Chemical Co., New York; Butterworth-Judson Co., New York; Caraleigh Bros. & Fertilizer Co., Raleigh, N. C.; Egyptian Powder Co., East Alton, Ill.; Equitable Powder Co., East Alton, Ill.; Farmers Fertilizer Works, Elizabethtown, Pa.; Farmers Guano Co., Norfolk, Va.; J. R. Gay, Gay, Ga.; W. R. Grace & Co., New York; General Chemical Co., New York; Granton Chemical Co., New York; Graselli Chemical Co., Cleveland, Ohio; King Powder Co., Cincinnati, Ohio; Lancaster Chemical Co., Lancaster, Pa.; Mahoney & Hoban Chemical Co., New York; John K. McIver, Savannah, Ga.; Read Phosphate Co., Savannah, Ga.; A. F. Pringle, Charleston, S. C.; Senior Powder Co., Cincinnati, Ohio; Southern Agricultural Chemical Corporation, 61 Broadway, New York; Stauffer Chemical Co., Chauncey, N. Y.; Tennessee Copper Co., 61 Broadway, New York; Trojan Powder Co., Allentown, Pa.; Wessel Duval Co., New York; York Chemical Co., York, Pa.

The New York Market

NEW YORK, May 1, 1922.

In general the chemical market during April was not up to expectations of many observers. Although the early advances were practically all maintained throughout the month, activity was confined to comparatively few commodities, and the remainder of the list was almost entirely neglected. However, leading producers now report a very favorable outlook and in many cases production has been increased considerably in order to take care of recent new business.

DEVELOPMENTS OF THE WEEK

The market during the past week has remained quite steady throughout the entire list. Although buying cannot be called brisk, the general feeling in the trade is very optimistic. The basic reason for this condition lies in the present strong position of caustic soda, which is the recognized barometer of trading in the chemical market. The export demand for this commodity has been very active during the past month and with domestic producers quoting lower prices than foreign competitors the outlook is promising for a continuance of active trading. May shipments are practically sold up among the more important factors and in some instances the output is booked as far ahead as the latter part of June.

One of the leading features in the week's trading was the notable rise in the prices of prussiates. Consumers resumed their former buying operations and a marked difference was noted in the final quotations. Still another feature was the continued activity in the market for barium products. During the week barium chloride touched a new high level. Glaubers salt and chlorate of soda have also attracted increased attention from the consuming industries. Bleaching powder developed a steadier tone. Copper sulphate merited added interest and producers reported a sold-up condition.

GENERAL CHEMICALS

Barium Chloride—Spot material is very scarce and it is doubtful if better than $105 per ton could be done on available round lots. Some dealers quoted up to $110 per ton. The acute shortage is the principal reason for the present strength.

Carbonate of Potash — Spot quotations have shown a firmer tendency and the demand was rather active. Calcined 80-85 per cent was quoted at 5c. per lb. Some odd lots were still available at 4¾c. per lb.

Copper Sulphate—The market for this product is much firmer and the demand seems to be exceeding the supply.

Producers quote prime large crystals 99 per cent at 5½c. per lb. and small crystals at $5.40 per 100 lb. The general tone is good and the consensus is for higher prices in the very near future.

Glaubers Salt — The demand has shown a considerable increase during the past week and large tonnages were moved at higher prices. Several carlots in barrels were sold at $1.05 per 100 lb., with lesser quantities quoted up to $1.25. Bag material did not find a ready market, and quotations continued to sag at 85c. per 100 lb. Domestic prices for bags were held at $1.25 per 100 lb. and $1.40 for barrels.

Prussiate of Soda—The market for this material recorded a sharp advance owing to the renewed interest shown by large consumers. Several odd lots were available at the close of trading at 17½c. per lb., with the majority of holders not inclined to offer at any figure. Shipments were quoted at 17c. per lb.

Soda Ash—The market continued steady throughout the entire week with spot goods quoted firm at $1.80 per 100 lb. for carloads in single bags and up to 2c. per lb. for smaller lots. Barrels were quoted at 2@2¼c. per lb. Leading factors offered contracts at $1.20 per 100 lb. in single bags and $1.40 in barrels, basis 48 per cent, f.o.b. works.

Vegetable Oils

Linseed Oil — The market for this material was very steady early last week, but eased up considerably at the close. Crushers were offering shipment oil at 86c. per gal. Consuming interest has fallen off considerably during the last few days, owing to the present high price. English material ex-dock sold as low as 81c. per gal., duty paid. Shipment oil was somewhat higher at 82c. Dutch oil on spot sold at 81½c.

Chinawood Oil — The market on spot was rather steady under an improved inquiry. Spot oil sold in small lots at 13½c. per lb. May arrival at New York was offered at 12½c., with June-July at 12½c. per lb.

Coconut Oil — This material showed a tendency to ease off and some dealers were inclined to shade prices. Prompt shipment from the coast in tanks sold at 7¼c. per lb. Ceylon type oil in New York was quoted at 7⅞c. per lb., sellers' tanks.

Corn Oil — Offerings of crude corn oil were somewhat scarce and prices ranged from 9¾@10c. per lb. Spot crude in less than carloads sold at 11½c. per lb.

The St. Louis Market

St. Louis, April 25, 1922.

The movement of heavy industrial chemicals since our last report could not be termed vigorous in every respect, but the demand has increased and is showing up very favorably in the larger volume of sales. The lack of confidence prevailing several weeks ago has been entirely subdued by a feeling of optimism which is a positive indication that the improvement will be a permanent one. The demand for chemicals emanating from industrial sources has added greatly to the present condition of the market. Furthermore, with the approach of the spring and summer seasons there are many commodities that will move in a larger way and will add substantially to the volume of business transacted. This should be an opportune time to cover for several months' requirements, as prices in general have begun to advance and probably will continue in this direction with the increased activities.

Alkalis

The singular innovation of a chemical dealer advertising his wares in the daily paper was introduced to the St. Louis market last week, and through it we have the following prices on alkalis: *Caustic soda*, 76 per cent, solid, in 5-drum lots, $3.93 per 100 lb.; flake, 76 per cent, $4.41½ per 100 lb.; *soda ash*, 58 per cent, light, in bags, $2.21½ per 100 lb., in barrels, $2.45 per 100 lb. So far as we are able to determine this price is being met by all dealers. *Bicarbonate* can be obtained at $2.25 per 100 lb. in 5-bbl. lots, with the demand light. *Sal soda* has declined 10c. per 100 lb. during the interval since our last report.

General and Special Chemicals

Reports coming from the heavy *mineral acid* manufacturers are very favorable and the tone of the market has greatly improved during the current month. Manufacturers have today advanced their price on *acid carbolic crystals*, also the liquid medicinal grade, 1c. per lb., with the demand very favorable. *Citric acid* is in good demand, with a scarcity of stock, and an advance in price would not prove at all surprising. *Ammonia water*, 26 deg., has been in better demand for the past several weeks with a firm market. *Carbon bisulphide* is firm and the demand very encouraging. Last week factors in *chloroform* reduced their prices 5c. per lb. on both the U.S.P. and anesthesia grades. Stocks of *copperas* continue to move into consumptive channels as fast as accumulated and the demand is still far in excess of the production. A reduction of 1c. per lb. in the price of c.p. *glycerine* did not stimulate the market extensively, and it is still a slowly moving item; a further decline would not come as a surprise. *Sulphur* is still holding with no change in price and apparently a good demand.

Vegetable Oils and Naval Stores

Castor oil is holding firm, with an increasing demand for spot goods. *Turpentine* can be bought today at 85c. in drums, which happens to be the same as in our last report; the prices have been up and down during the interval.

Paint Materials

Ochers have advanced slightly, while *oxides* suffered a decline. *Zinc oxide*, lead free, is offered at 7⅞c. in barrels, 7½c. in bags in carloads; warehouse price at 8c. and 8½c. *Zinc oxide* containing 5 per cent lead at ¼c. less, and 8 to 10 per cent lead at ½c. less on above lists. *Barytes* is quoted at $23 in carloads and $24.50 in less than carlots in barrels. Prices per ton for *whiting* follow:

	Barrels	Paper Bags	Cotton Bags
Whiting—Commercial	$15.50	$13.50	$15.00
Extra gilders	16.50	14.50	16.00
Putty whiting	10.50	10.00	11.00
Vera blanc	17.00	15.00	16.50

The Iron and Steel Market

Pittsburgh, April 28, 1922.

The volume of business in finished steel products, as a whole, has been decreasing somewhat and is now at a materially lower level than the average of March. The decrease in general buying is still greater, for there has been some activity in railroad material, particularly in connection with freight cars.

Buyers and sellers alike contribute to the decreased market activity. There is less inquiry on the part of many buyers, including both jobbers and manufacturing consumers, obviously because they anticipated present requirements by buying in February and March, having in mind the coal strike of April 1. Among steel producers there is decidedly less disposition to sell. In most quarters this disinclination is attributed entirely to the coal strike, with its tendency to prevent increases in steel production, but as a matter of fact part of the disinclination is only indirectly connected with the coal strike, the point being that in some cases the steel mill believes that the inquiry is due to the coal strike and thus has a little speculative flavor. There are cases in which a consumer refused to buy recently but now urges a mill to accept his order, when there is no evidence that his actual requirements have changed, the change being in his mental attitude, and the sales manager reflects that such a buyer may change his mind once more.

Strike Situation Largely Met

The steel producers affected by the Connellsville region strikes have largely met the situation. Except in the case of a few merchant furnaces, production is being maintained at nearly if not quite the rate obtaining at the end of March, and in all cases at much above the rates of earlier in the year. Since April 1, when it developed that non-

union strikes in the Connellsville and Lower Connellsville region would be much more extensive than had been expected, there has been aggressive buying of coal by several large interests and in various districts. There is some Connellsville coal available for purchase, production being perhaps maintained by paying "bonuses" to the miners, while there is much coal to be obtained in West Virginia and Kentucky. The Elkhorn, Ky., coal runs under 4 per cent ash and under 0.60 per cent sulphur, lower limits than the Connellsville region ever showed, and there is to be quite a movement of it to the Clairton byproduct plant of the Carnegie Steel Co., which normally has used only Connellsville coal and was moderately well stocked with it on April 1. The Carnegie company is blowing thirty-one or thirty-two blast furnaces, against thirty-four on April 1, but might be operating forty by this time had no strikes occurred. The Steel Corporation has increased its steel production in the Chicago district, which would scarcely be affected by the coal strike before July.

Steel ingot production cannot be estimated closely, but is probably running at between 36,000 000 and 38,000,000 tons a year. The rate was about 35,000,000 tons April 1, 30,000,000 tons March 1 and 20,000,000 tons in December. Thus if a material decrease in steel production should be forced, the rate would not be set far back in point of time.

As a matter of fact, the coal strike is probably doing the steel-producing industry more good than harm. Buyers are very anxious to receive deliveries of all material already bought and there is more anxiety to buy on the part of some consumers hitherto doubtful. Prices asked are being paid without demur, and concessions from regular market prices have practically disappeared.

There are rumors, as would naturally be expected, of premiums being paid for prompt deliveries, but there is no reason to suppose that premium prices are being paid on any tonnage worth considering. Rolling schedules are now so well filled that consumers and distributors need more stock than formerly, but this does not mean that their deliveries will not be heavy, in general, or equal to actual requirements.

Prices

Market prices are quotable as follows: Bars, shapes and plates, 1.50c.; hoops, bands and hot rolled strips, 2c.; blue annealed sheets, 2.40c.; black sheets, 3.15c.; galvanized sheets, 4.15c.; automobile sheets, 4.50c.; standard steel pipe, 71 per cent basing discount. Independent wire mills are rigidly adhering to $2.50 on nails, while the American Steel & Wire Co. continues its old price of $2.40.

It has become very difficult to buy any semi-finished steel, as the mills prefer to reserve their capacity for their own regular finished steel products. There is no demand for billets, but there is quite a demand for sheet bars, partly because some sheet mills neglected to cover fully on sheet bars when they were selling sheets so freely prior to their recent advance of $3 a ton. Sheet bars were then $29. Now it is certain they cannot be bought at less than $33, and there is a question what price really would bring out tonnage.

Pig Iron and Coke

The pig-iron market in this general territory has almost disappeared. Few merchant furnaces were running when the coal strike started and some of these have had to bank, the result being that there are no regular sellers in the market. Basic pig iron has sold at $24 furnace, against $18 at the beginning of the month. Bessemer and foundry may be quoted nominally at the same figure. There is little inquiry, in point of volume, but there may be two or three insistent buyers of basic iron.

The Connellsville coke market is very narrow in point of tonnage. The merchant furnaces, in view of their low-priced sales of iron, would not buy at over $3.50. Offerings are very limited, and in one or two cases steel interests have been buying, making a market at the moment of $6, against not over $3.50 at the end of March and $2.75@$3 in January. Foundry coke is $6.50, with offerings and inquiry light.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		$0 38 – $0 40
Acetone	lb.	$0 08 – $0 09	09¼ – 10
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	11 – 11½	11½ – 12
Boric, powder	lb.	11 – 11½	11½ – 12½
Citric	lb.		45½ – 46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	11 – 11½	11½ – 12
Lactic, 44 per cent tech	lb.	09½ – 10	10½ – 12
Lactic, 22 per cent tech	lb	04 – 04½	04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg.	lb.	06 – 06¼	06½ – 07
Nitric, 42 deg.	lb.	06½ – 06¾	07 – 07½
Oxalic, crystals	lb.	11½ – 12	12½ – 13
Phosphoric, 50 per cent solution	lb.	08 – 08	08½ – 09½
Picric	lb.	22 – 24	24½ – 30
Pyrogallic, resublimed	lb.		1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	11 00 – 12 00	
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20 00	
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.		60 – 75
Tannic (tech.)	lb.	40 – 45	46 – 50
Tartaric, imported crystals	lb.		26 – 28
Tartaric acid, imported, powdered	lb.		27½ – 30
Tartaric acid, domestic	lb.		– 30
Tungstic, per lb. of WO	lb.		1 00 – 1 10
Alcohol, ethyl	gal.		4 75 – 4 95
Alcohol, methyl (see methanol)			
Alcohol, denatured, 188 proof No. 1	gal.		32 – 34
Alcohol, denatured, 188 proof No. 5	gal.		32 – 34
Alum, ammonia, lump	lb.	03½ – 03¾	04 – 04¼
Alum, potash, lump	lb.	03¾ – 04	04¼ – 05
Alum, chrome lump	lb.	07½ – 08	08½ – 08¾
Aluminum sulphate, commercial	100 lb.	1 50 – 1 65	1 70 – 2 25
Aluminum sulphate, iron free	lb.	02½ – 02¾	03 – 03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ – 07¾	08 – 08¾
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30 – 30½	31 – 33
Ammonium carbonate, powder	lb.	07 – 07½	08 – 09
Ammonium nitrate	lb.	06 – 06½	06¾ – 07½
Amylacetate tech.	gal.		2 00 – 2 25
Arsenic, white, powdered	lb.	06½ – 07	07¼ – 07½
Arsenic, red, powdered	lb.	12 – 12½	12½ – 13
Barium chloride	ton	108 00 – 110 00	111 00 – 115 00
Barium dioxide (peroxide)	lb.	20 – 21	21½ – 22
Barium nitrate	lb.	06½ – 07	07½ – 08½
Barium sulphate (precip.) (blanc fixe)	lb.	03¾ – 04	04¼ – 04½
Blanc fixe, dry	lb.	04 – 04½	
Blanc fixe, pulp	ton	45 00 – 55 00	
Bleaching powder	100 lb.	1 60 – 1 75	1 80 – 2 75
Blue vitriol (see copper sulphate)			
Borax	lb.	05½ – 05¾	06 – 06¾
Brimstone (see sulphur, roll)			
Bromine	lb.	27 – 28	28½ – 35
Calcium acetate	100 lbs.	1 75 – 2 00	
Calcium carbide	lb.	04½ – 04¾	05 – 05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	01½ – 01¾	02 – 02¼
Calcium peroxide	lb.		1 40 – 1 50
Calcium phosphate, tribasic	lb.		15 – 16
Camphor	lb.		80 – 82
Carbon bisulphide	lb.	06 – 06½	06¾ – 07½
Carbon tetrachloride, drums	lb.	09½ – 10	10½ – 12
Carbonyl chloride, (phosgene)	lb.		60 – 75
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chalk, precip.—domestic, light	lb.	04¼ – 04½	
Chalk, precip.—domestic, heavy	lb.	03½ – 03¾	
Chalk, precip.—imported, light	lb.	04½ – 05	
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	05 – 05½	05¾ – 06
Chloroform	lb.		37 – 40
Cobalt oxide	lb.		2 00 – 2 10
Copperas	ton	15 00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	19 – 20	20½ – 21
Copper cyanide	lb.		58 – 60
Copper sulphate, crystals	100 lb.	5 50 – 5 60	5 65 – 6 15
Cream of tartar	lb.		24 – 26
Epsom salt (see magnesium sulphate)			
Ethyl acetate com. 85%	gal.		60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.		90 – 95
Formaldehyde, 40 per cent	lb.	08½ – 09	09½ – 10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	
Fullers earth—imported powdered—net	ton	30 00 – 32 00	
Fusel oil, ref.	gal.		2 15 – 2 50
Fusel oil, crude	gal.		1 30 – 1 50
Glauber's salt (see sodium sulphate)			
Glycerine, c. p. drums extra	lb.		15 – 15½
Iodine, resublimed	lb.		4 05 – 4 15
Iron oxide, red	lb.		12 – 18
Lead acetate	lb.		09½ – 12
Lead arsenate, powd	lb.	14 – 14½	14½ – 15½
Lead nitrate	lb.		15 – 20
Litharge	lb.	07½ – 07¾	08 – 08½
Magnesium carbonate, technical	lb.	06 – 06½	06½ – 08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.		1 60 – 1 80
Methanol, 95%	gal.		57 – 58
Methanol, 97%	gal.		59 – 60
Nickel salt, double	lb.		11 – 11½
Nickel salt, single	lb.		11 – 11½
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	45 – 46	47 – 50
Phosphorus, yellow	lb.		30 – 35

		Carlots	Less Carlots
Potassium bichromate	lb.	.10⅛ – .10¼	10½ – 13
Potassium bromide, granular	lb.	..... –	.17 – 20
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – 16
P tassium carbonate, 80–85%	lb.	.05 – .05¼	.05½ – .06
P tassiu n chlorate, crystals	lb.	.06¼ – .06½	.06 – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic p tash)	100 lb.	6.00 – 6.10	6.25 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07⅜ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
P tassium prussiate, yellow	lb.	28½ – .29	.29¼ – .29½
Rochelle salts (see sodium potas tartrate)	....	..... –	..... – ....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .07⅝	.08 – .08¼
Salsoda	100 lb.	1.40 – 1.45	1.50 – 1.80
Salt cake (bulk)	ton	18.00 – 20.00	..... – ....
Soda ash, light	100 lb.	1.80 – 2.00	2.05 – 2.60
Soda ash, dense	100 lb.	1.85 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.04¼ – .04½	.04¾ – .05
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07⅝	.08 – .08¼
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04⅝ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12.00 – 13.00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda)	100 lb.	3.70 – 3.75	3.80 – 4.25
Sodium hyposulphite	lb.	.03 – .03¼	.03½ – .03⅝
Sodium nitrite	lb.	.08¾ – .09	.09¼ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¼ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.17½ – .17¾	.18 – .18½
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.15	1.20 – 1.50
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate,crystals(glaubers salt)	100 lbs.	1.00 – 1.15	1.20 – 1.50
Sodium sulphide,fused,60-62 per cent(conc.)	lb.	.04⅜ – .04½	.04 – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10½ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 – 20.00	..... – ....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 – 40.00	..... – .....
Ta'c—domestic powdered	ton	18.00 – 25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06¼ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00½
Beta-naphthol, sublimed	lb.	.55 — .60
Beta-naphthol, tech	lb.	.26 — .28
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.70 — .75
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.14 — .15
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.50 — 2.60
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75
Ortho-nitro-toluene	lb.	.12 — .15
Ortho-toluidine	lb.	.16 — .20
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.14 — .16
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.60 — .70
Para-phenylenediamine	lb.	1.50 — 1.55
Para-toluidine	lb.	1.05 — 1.15
Phthalic anhydride	lb.	.36 — .38
Phenol, U. S. P., drums	lb.	.13 — .15
Pyridine	gal.	1.75 — 2.75
Resorcinol, technical	lb.	1.30 — 1.35
Resorcinol, pure	lb.	1.75 — 1.80
Salicylic acid, tech., in bbls.	lb.	.24 — .24½
Salicylic acid, U. S. P.	lb.	.25 — .26
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 — .12
Sulphanilic acid, crude	lb.	.24 — .26
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.30 — .35
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.26 —	.28
Beeswax, refined,light	lb.	.30 —	.32
Beeswax, white pure	lb.	.35 —	.40
Candellila, wax	lb.	.25 —	.26
Carnauba, No. 1	lb.	.45 —	.46
Carnauba No. 2, North Country	lb.	.25 —	.25½
Carnauba, No. 3, North Country	lb.	.16 —	.16½
Japan	lb.	.17 —	.18
Montan, crude	lb.	.04 —	.04¼
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ —	.04½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02⅜ —	.....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 —	.03⅛
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04¼ —	.04½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05¼
Stearic acid, single pressed	lb.	.09 —	.09¼
Stearic acid, double pressed	lb.	.09¼ —	.09¾
Stearic acid, triple pressed	lb.	.10¼ —	.11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.25 —	5.30
Rosin E-I	280 lb.	5.35 —	5.40
Rosin K-N	280 lb.	5.45 —	6.55
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	.92 —	93½
Wood turpentine, steam dist.	gal.	.85 —	.....
Wood turpentine, dest. dist.	gal.	.70 —	.70
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.37 —	.....
Rosin oil, second run	gal.	.39 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr.1.025-1.035 tank cars f.o b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.75 —	.....
Blood, dried, f.o.b., N. Y.	unit	3.65 —	.....
Bone, 3 and 50, ground, raw	ton	27.00 —	28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.90 —	3.00
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	5.50 —	7.00
Tennessee, 78-80%	ton	8.50 —	9.00
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	.....

Crude Rubber

Para—Upriver fine	lb.	$0.18¾ —	.19
Upriver coarse	lb.	.13¼ —	.13½
Upriver caucho ball	lb.	.14 —	.14¼
Plantation—First latex crepe	lb.	.16¼ —	.16½
Ribbed smoked sheets	lb.	.16¼ —	....
Brown crepe, thin, clean	lb.	.14 —	....
Amber crepe No. 1	lb.	.16 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10 —	$0.10½
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.13¼ —	.13½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09¼ —	.09½
Corn oil, crude, in bbls.	lb.	.11⅛ —	.11¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.09¾ —	.10
Cottonseed oil, summer yellow	lb.	.12 —	.12¼
Cottonseed oil, winter yellow	lb.	.13¼ —	.13
Linseed oil, raw, car lots (domestic)	gal.	.86 —	.87
Linseed oil, raw, tank cars (domestic)	gal.	.82 —	.83
Linseed oil, in 5-bbl lots (domestic)	gal.	.89 —	.90

Olive oil, denatured	gal.	1.12 —	1.15½
Palm, Lagos	lb.	.07½ —	.07¾
Palm, Niger	lb.	.05¾ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09½ —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.86 —	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11¼ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09⅛ —	....
FISH			
Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$900 00	$1,100.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	70.00	—110 00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	15.00	— 17.50
Barytes, ground, white, f.o.b. mills	net ton	17.00	— 23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00	— 21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	— 24 00
Barytes, crude f.o.b. mines	net ton	8.00	— 8.00
Casein	lb.	.10½	— .12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	— 8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	— 9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	— 20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00	— 20.00
China clay (kaolin), imported, lump	net ton	14.00	— 20.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, No. 1 pottery grade	long ton	6.50	— 6.75
Feldspar, No. 2 pottery grade	long ton	5.75	— 5.90
Feldspar, No. 1 soap grade	long ton	7.00	— 7.50
Feldspar, No. 1 Canadian, for mill	long ton	22.00	— 22.50
Graphite, Ceylon lump, first quality	lb.	.05	— .07
Graphite, Ceylon chip	lb.	.04	— .05½
Graphite, high grade amorphous crude	ton	18.00	— 45.00
Kieselguhr, f.o.b. mines, Cal	per ton	40.00	— ....
Kieselguhr, f.o.b. N. Y	per ton	55.00	— 60.00
Magnesite, calcined (crude)	per ton	12.00	— 15.00
Pumice stone, imported	lb.	.03	— .05
Pumice stone, domestic, lump	lb.	.05	— .05½
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	.86	— .87
Shellac, orange superfine	lb.	.88	— .89
Shellac, A. C. garnet	lb.	.68	— .69
Shellac, T. N.	lb.	.83	— .84
Silica, glass sand, f.o.b. Indiana	per ton	1.25	— 1.50
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	— 4 50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16 00	— 16 00
Silica, building sand, f.o b. Pa	per ton	2.00	— 2.75
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	— 12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	— 20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	41–44
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–37
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o b. works)	net ton	55
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	35–37
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	37–39
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	27–30

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225 00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	11½ —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	67.00 —	69.00
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2 25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	56 00 —	58.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	3.00 —	3.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19 00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	4 25 —	4.75
Coke, furnace, f.o.b. ovens	net ton	3.50 —	3 75
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12 00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20 00 —	22 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.26½ —	27
Manganese ore, chemical (MnO_2)	net ton	60.00 —	65 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	40 —	.42
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27 00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.25 —	2.50
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2 50 —	2 75
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1 25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2 25 —	2 50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	12.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	5 00
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.125
Lead, New York, spot	5.25–5.00
Lead, E. St. Louis, spot	5.25
Zinc, spot, New York	5.55
Zinc, spot, E. St. Louis	5.05

OTHER METALS

Silver (commercial)	oz.	$0.67½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1 15
Platinum	oz.	85.00@ 90 00
Iridium	oz.	160.00@170 00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	56 57

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	18.75
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23.00
Brazed bronze tubing	28.00
Seamless copper tubing	20 75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current
Copper, heavy and crucible	10.25@10 50
Copper, heavy and wire	10.00@10.25
Copper, light and bottoms	7.75@ 8.25
Lead, heavy	3.90@ 4 15
Lead, tea	2½–2
Brass, heavy	4.50@ 4 75
Brass, light	4.00@ 4 25
No. 1 yellow brass turnings	4.00@ 4.25
Zinc	2.00@ 2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2 48	$2.38
Soft steel bars	2 38	2 28
Soft steel bar shapes	2 38	2 28
Soft steel bands	2 98	2.88
Plates, ¼ to 1 in. thick	2.48	2.38

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GEIGER—The Sumter Farm & Stock Co. has preliminary plans under way for the establishment of a new mill for the manufacture of cottonseed oil specialties.

ANNISTON—The Farmers' Union Warehouse Co. is considering the erection of a new mill for cottonseed oil manufacture. Work will be commenced in the near future. G. W. Eichelberger is president.

California

OAKLAND—E. H. Hart, secretary of the Oakland Merchants' Exchange, is in negotiation with the La Blume Soap Co., Paris, France, for the erection of a local plant for the manufacture of high-grade soap products. A site is being selected. The project is estimated to cost about $1,000,000, including plant buildings and machinery.

PITTSBURGH—The King Mfg. Co. has completed the erection of a new local mill for the manufacture of plaster board specialties, and will commence production under an initial output of about 5,000 sq.ft. a day. This will be increased at a later date. R. W. King is president and general manager.

SAN FRANCISCO—The Magnolia Metal Co., Pacific Bldg., has awarded a contract to Frederick Moller, 180 Jessie St., for the erection of a new 1-story plant at Bryant and Sterling Sts., to cost about $15,000. Dodge A. Reidy, Pacific Bldg., is architect. Work will be commenced at once.

SAN FRANCISCO—The National Magnesite Products Corp., represented by Sterling Carr, 201 Sansome St., has acquired the property and equipment of the Sonoma Magnesite Co., in the Guerneville Section, Sonoma County, Cal., at public sale, for a consideration of about $175,000. The new owner plans for early operations at the plant and will make a number of improvements.

Florida

BAGDAD—The Bagdad Land & Lumber Co. has arranged for a bond issue of $1,200,000, a portion of the proceeds to be used in connection with the construction of its proposed new turpentine mill on a site recently acquired in Escambia County, Ala. W. B. Harbeson is president.

Illinois

HIGHLAND PARK—The North Shore Sanitary District, Lake Forest, Ill., has preliminary plans under way for the construction of a new purification plant on Gillette Ave., Highland Park, to cost about $125,000, including equipment. Alvord, Burdick & Howson, 8 Dearborn St., Chicago, are engineers.

Indiana

SEYMOUR—The Buhner Fertilizer Co. is considering tentative plans for the rebuilding of the portion of its plant, destroyed by fire, April 12, with loss estimated at about $50,000. Ferdinand Buhner heads the company.

Kentucky

ASHLAND—In addition to a number of improvements in its present plant, the Ashland Firebrick Co., Winchester Ave., will build a 1-story addition, 135 x 190 ft., to be equipped for general manufacture, to total about 50,000 firebrick and other refractory shapes per day. The building contract has been let. E. H. Gartrell is general manager.

LOUISVILLE—The Producers' Wood Preserving Co., an interest of the Ayer & Lord Tie Co., 80 East Jackson Blvd., Chicago, Ill., is completing plans and will soon commence the erection of its proposed new local creosoting plant, to cost about $200,000, including equipment. Oscar E. Bond, Marion E. Taylor Bldg., Louisville, is in charge.

Louisiana

MONROE—The Southwest Pulp & Paper Co. has acquired a tract of property in the vicinity of the Monroe-Columbia Highway, a few miles from the city, totaling about 18 acres of land, as a site for the erection of a new pulp and paper mill. Plans will be placed under way at an early date, and it is expected to begin construction later in the year. The plant is estimated to cost about $250,000, including equipment.

SHREWSBURY—Fire April 21 destroyed the local plant of the Armour Fertilizer Works, 209 West Jackson Blvd., Chicago, Ill., with loss estimated at about $250,000, including buildings, equipment and stock. It is said that the plant will be rebuilt.

CEDAR GROVE—The Louisiana Oil Refining Corp. has leased for an indefinite period the local refinery of the International Oil & Gas Corp., and will place the plant in operation at an early date for the refining of crude oil from the Bellevue field. A number of improvements will be made. The plant was shut down about a year ago, and has a rated capacity of 1,000 bbl. a day.

Maryland

EVERGREEN — The Loyola College Trustees, James A. S. McEneany, 700 North Calvert St., Baltimore, president, will soon take bids for the erection of a 2-story chemistry-biology building at the institution, estimated to cost about $200,000. Otto G. Simonson, Maryland Casualty Bldg., Baltimore, is architect.

SNOWHILL—The plant of the Snowhill Brick Co. has been leased by A. J. Laurenson and William F. Johnson, both of Norfolk, Va., who plan to place the works in operation at an early date. A number of improvements will be made.

BALTIMORE — The Oil Products Co. has leased the 3-story building at 302 North Holliday St. for a new local plant.

Massachusetts

EVERETT—A portion of the plant of the Beacon Oil Works, South Everett, including compressor building, was destroyed by fire April 14, with loss reported at $12,000.

Michigan

DETROIT—The Detroit Soda Products Co., 9077 West Jefferson St., is completing plans and will soon take bids for the erection of a 2-story addition to its plant, 60 x 80 ft. L. B. Alger is president.

Mississippi

JACKSON—The Hi-Power Mfg. Syndicate has leased a local building for the establishment of a plant for the manufacture of battery fluids and other chemical products. Operations will be commenced at an early date.

Missouri

KANSAS CITY—The American Foundry & Mfg. Co., Kansas City Life Bldg., will defer temporarily the erection of its proposed new 1-story foundry, 90 x 140 ft., at 18th and Manchester Aves., estimated to cost about $30,000. Plans have been drawn. H. H. Akers is general manager.

Montana

GREAT FALLS — The American Refining Co. is planning for the erection of an addition to its oil refinery, for general service operations and production.

New Jersey

WOODSTOWN—The South Jersey Farmers' Exchange is selecting a site for the erection of a new fertilizer-manufacturing plant, to replace its works destroyed several months ago with loss estimated at about $150,000. The new plant with equipment will cost close to a like amount.

HOBOKEN—The White Metal Mfg. Co., 1006 Clinton St., has commenced excavations for the erection of a 2-story addition to its plant on the Paterson Plank Road, North Bergen, to cost about $50,000. Leo Feinen, 3697 Boulevard, Jersey City, N. J., is architect.

WAYNE — Fire April 19 destroyed the Corning Mill at the local powder plant of E. I. du Pont de Nemours & Co., Wilmington, Del. It was caused by an explosion. The estimated loss has not been announced.

New York

LOCKPORT—The A. W. Jack Corp., North Transit Road, manufacturer of asbestos mill board and other asbestos specialties, is completing plans for the erection of the first unit of its proposed new plant, to be 1-story, 125 x 500 ft., and estimated to cost in excess of $300,000. George F. Hardy, 309 Broadway, New York, N. Y., engineer, will call for bids at an early date.

BUFFALO—The Webb Clean Sweep Co., manufacturer of floor-sweeping compounds and other chemical products, is planning for the erection of a new 1-story plant on Troupe St., near Westcott St. I. H. Webb heads the company.

ONEIDA—The Maxwell Steel Vault Co., 4 Warner St., has awarded a contract to Frazio & Millard, Oneida, for the erection of the first unit of its new plant, to be 1-story, 60 x 90 ft., and estimated to cost about $30,000, including equipment. Work will be commenced at once.

RENSSELAER—The Grasselli Chemical Co., 347 Madison Ave., New York, has plans under way for the erection of a 1-story building on local site.

Oklahoma

BARTLESVILLE—The Bartlesville Zinc Co. will make a number of improvements in its plant, including repairs to equipment. The works have been closed for the betterment program.

Pennsylvania

LOCK HAVEN—The Queens Run Refractories Co., is considering the erection of a new 1-story addition. Improvements will be made in the present plant. William Sleicher is president.

PHILADELPHIA—The United Gas Improvement Co., Broad and Arch Sts., has tentative plans under way for the construction of a new artificial gas plant, to cost in excess of $1,500,000. The exact location has not been announced.

PHILADELPHIA—The Shingle Leather Co., 315 Vine St., has completed plans for the erection of a new plant at Grays Ave. and 54th St. Work will be commenced at an early date.

ALLENTOWN — The plant of Robert A. Reichard, devoted to the manufacture of fertilizers, has been acquired at a public sale by Harry H. Shisler and associates for a consideration of $30,500. The plant represents an investment of $150,000. The new owners will organize a company and operate the works for the same line of manufacture as heretofore, including phosphates, etc. A number of improvements will be made.

Texas

ROBSTOWN—The Nueces County Water Improvement Commissioners, District No. 3, are planning for the installation of a new purification plant in connection with extensions and improvements in the local waterworks.

WEATHERFORD—The Weatherford Refining Co., operating a local oil refinery, has been reorganized. Plans are under way for the erection of an addition to the plant, with extensive improvements in the present refinery. New equipment will be installed. The company has increased its capitalization to $200,000.

MOUNT PLEASANT—The City Council will install a new filtration plant in connection with extensions in the local waterworks. H. S. Wilder is engineer.

BRECKENRIDGE—The Ebony Carbon Co. has made application to the State Railroad Commission for permission to build a local plant for the manufacture of hydro-gas carbon. The initial works will have a capacity of about 3,000 lb. of carbon black every 24 hours, consuming approximately 2,000,000 ft. of gas in this period.

Washington

CENTRALIA—The Vader Tile Co., organized to take over and operate the plant of the Standard Clay Co., has plans under way for the reconstruction of a large portion of the works, with enlargements in a number of departments. Additional equipment will be installed.

SEATTLE—The Pacific Oil Mills will soon commence the construction of an addition to the tankage department at its vegetable oil mills on East Marginal Way.

Canada

MONTREAL, QUE.—The Hochelaga Cement Co., Ltd., recently organized with a capital of $3,000,000, will operate a large local cement mill. The initial plant will have a capacity of about 2,000 bbl. a day, and this will be increased to 5,000 bbl. output at a later date.

New Companies

THE EASTERN CHEMICAL CO., Trenton, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry and M. H. Bernstein, and Solomon R. Block, 137 East State St., Trenton.

THE MCMULLEN PETROLEUM & REFINING Co., 220 South State St., Chicago, Ill., has been incorporated with a capital of $75,000, to manufacture refined oil products. The incorporators are Frank R. Cain, Charles A. Snapp and Stillman T. Meservey.

THE PUGET SOUND REDUCTION CO., Buffalo, N. Y., has been incorporated with a capital of $150,000, to manufacture fertilizer products. The incorporators are E. Stengel, P. J. Ferkel and J. Gehm. The company is represented by Sullivan, Bagley & Wechter, Chamber of Commerce Bldg., Buffalo.

THE BARRON-NORCROSS SOAP CORP., Hamilton, Mass., has been incorporated with a capital of $10,000, to manufacture soaps and affiliated products. Harry Barron is president, and Austin L. Norcross, South Hamilton, Mass., treasurer.

THE WHEELING OXYGEN CO., Wheeling, W. Va., has been incorporated with a capital of $200,000, to manufacture commercial oxygen and kindred products. The incorporators are W. H. Frank, P. J. McGinley and James W. Ewing, all of Wheeling.

THE UNIFORM OIL CO., 1231 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of $25,000 and 2,500 shares of stock, no par value, to manufacture oil products. The incorporators are W. Howard Hamilton, W. Woodward Cook and William S. Hammond.

THE SHEA CHEMICAL CO., 1107 White Bldg., Seattle, Wash., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are George A. Shea and F. W. Strang.

THE BERKSHIRE OIL CO., Pittsfield, Mass., has been incorporated with a capital of $25,000, to manufacture oil products. The incorporators are William S. and Irwin H. Farrar, and Adam D. Hall, all of Pittsfield.

THE COZZINS CHEMICAL CO., Madison, N. J., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Fred A. Brown, William Scott and William J. Nicholson, all of Madison.

THE PITTSBURGH SLAG BRICK & TILE CO., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture brick, tile and kindred products. The incorporators are Robert L. Taylor, William C. Taylor and C. Q. Markhart, all of Pittsburgh. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE COLUMBIA ENAMEL CO., Albany, N. Y., has been incorporated with a capital of $50,000, to manufacture enamels and kindred products. The incorporators are J. J. Schulda, R. Phillips and A. P. Sponable. The company is represented by C. R. Watson, Albany.

THE FLO-TEX OIL CO., Tampa, Fla., has been incorporated with a capital of $150,000, to manufacture petroleum products. George M. Thompson is president; R. E. Moore, vice-president; and V. B. Thompson, secretary.

THE CASALE AMMONIA CO. OF AMERICA, INC., Jersey City, N. J., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture ammonia and kindred products. The incorporators are George H. Russell, George J. Nutting and Samuel Drayton. The company is represented by the New Jersey Coroporation Agency, 243 Washington St., Jersey City.

THE ALCO CHEMICAL CORP., Brooklyn, N. Y., has been incorporated with a capital of $12,000, to manufacture chemicals and chemical byproducts. The incorporators are A. H. Green, H. M. Gordon and I. A. A. Blish. The company is represented by Samson Selig, 233 Broadway, New York.

THE DENMAN CORD TIRE CO., Edgemere, N. Y., has been incorporated with a capital of $100,000 under Delaware laws, to manufacture automobile tires and other rubber products. The incorporators are R. H. Johnson, Edgemere; A. H. Shapiro, New York; John A. Morris, Westchester, N. Y.; and Frank Fritts, South Beach, Conn. The company is represented by the Registrar & Transfer Co., 900 Market St., Wilmington, Del.

THE WOLVERINE OIL CORP., 711 West University Ave., Champaign, Ill., has been incorporated with a capital of $250,000, to manufacture oil products. The incorporators are Fred W. Green, Howard C. Lawrence and John W. Stipes.

THE WINEGAR PRODUCTS CO., Syracuse, N. Y., has been incorporated with a capital of $10,000, to manufacture boiler compounds and kindred specialties. The incorporators are C. E. Brown, J. S. Armstrong and R. S. Davis. The company is represented by R. T. Murray, attorney, Syracuse.

THE DIAMOND TWIN CORP., Hoboken, N. J., has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are Ralph M. Ketcham, William A. Sands, Jr., and Edwin S. White, Clinton St., Hoboken.

THE VELVO-LITE PRODUCTS CO., 3826-28 Indiana Ave., Chicago, Ill., has been incorporated with a capital of $50,000, to manufacture paste specialties, etc. The incorporators are Harrington A. Talbot, J. W. Montgomery and T. L. Douglas.

THE JEWELL OIL CO. OF KENTUCKY, Lexington, Ky., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are John B. and M. H. W. Jewell, and Harry M. Rowe, all of Lexington.

THE WINCHESTER BRICK CO., Winchester, Mass., has been incorporated with a capital of $50,000, to manufacture brick, tile and other burned clay products. John K. Whiting, Longwood Ave., Brookline, Mass., is president and treasurer; Isaac S. Whiting, is vice-president.

THE INTERNATIONAL PRODUCING & REFINING CO., Wilmington, Del., has been incorporated with a capital of $500,000 under state laws, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE CONSTANT HEAT CORP., Albany, N. Y., has been incorporated with a capital of $200,000, to manufacture chemical heat packing, and other chemical products. The incorporators are O. L. and L. L. Perrault, and C. Z. Smith. The company is represented by E. A. Gifford, Albany.

TH ST. CLAIR SILICA CO., 744 North Third St., East St. Louis, Ill., has been incorporated with a capital of $30,000, to manufacture refined silica and silica products. The incorporators are W. D. Abraham, A. J. Kahle and William A. Luft.

THE SCUORZO CHEMICAL LABORATORIES CO., Newark, N. J., has filed notice of organization to manufacture chemicals and chemical byproducts. Ernest and Alfred A. Scuorzo, 235 Oliver St., Newark, head the company.

THE ES-TE OIL CO., Chicago, Ill., has been incorporated under Delaware laws with a capital of $2,000,000, to manufacture refined oil products. The incorporators are H. L. Casey, C. W. Smith and T. Goodrich, all of Chicago. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE WELLSBURG PAPER CO., Wellsburg, W. Va., has been incorporated with a capital of $500,000, to manufacture pulp and paper products. The incorporators are George T. H. Hammond, Thomas George and Allen Burt, all of Wellsburg.

THE SOAP SALT CO., Tarentum, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture washing compounds and kindred products. The incorporators are J. F. Henry, Tarentum; J. B. and L. H. Cowan, both of Brackenridge, Pa. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE HAT CITY FOUNDRY CO., Danbury, Conn., has been incorporated with a capital of $15,000, to manufacture iron, steel and other metal castings. The incorporators are F. A. Shepard, E. S. Roos and J. P. Fahy, all of Danbury.

POUCHER, TRABOLD & SIDNEY, INC., New York, N. Y., has been incorporated with a capital of $225,000, to manufacture leather products. The incorporators are R. I. Poucher, P. Sidney and F. W. Trabold. The company is represented by Churchill, Marlow & Hines, 63 Wall St., New York.

THE LEONARD CHEMICAL CO., 10 South La Salle St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture chemicals and chemical byproducts. The incorporators are John A. Kelly, T. J. and A. M. Leonard.

THE CALVERT OIL CO., Fort Smith, Ark., has been incorporated with a capital of $25,000, to manufacture petroleum products. C. C. Calvert is president; C. A. Lick, vice-president; and W. E. Decker, secretary, all of Fort Smith.

THE BURTON HEIGHTS CO-OPERATIVE OIL CO., Wilmington, Del., has been incorporated under state laws with capital of $165,000, to manufacture oil products for motor and other service. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE MAWSON INK CO., Boston, Mass., has filed notice of organization to manufacture ink and kindred products. William F. Simpson, 334 Cambridge St., Allston, Mass., heads the company.

THE HART-PEDERSON GLASS CO., 3242 Carroll Ave., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture glass products. The incorporators are Walter V. Hart and Paul N. Pederson.

THE LIQUID SOAP CO., 128 North Wells St., Chicago, Ill., has been organized to manufacture soaps and other products. The company is headed by I. C. Brennan and T. Deutsch.

Capital Increases, Etc.

THE RUDOLPH PAPER CO., INC., 2740 Park Ave., New York, N. Y., has filed notice of increase in capital from $100,000 to $500,000.

THE Z. & M. INDEPENDENT OIL CO., Norwich, N. Y., has filed notice of increase in capital from $50,000 to $100,000.

THE SERVICE RUBBER CO., Chicago, Ill., manufacturer of rubber products, has filed notice of increase in capital from $500,000 to $1,000,000.

THE HOLSTON TILE CO., Rogersville, Tenn., has filed notice of increase in capital from $35,000 to $100,000.

THE CHEROKEE CHEMICAL CO., Gaffney, S. C., has filed notice of increase in capital from $50,000 to $200,000. George Riehl is secretary.

THE HERCULES WATERPROOF CEMENT CO., Mutual Life Bldg., Buffalo, N. Y., has arranged for reduction in capital from $150,000 to $50,000.

THE AMERICAN VULCANIZED FIBRE CO., Wilmington, Del., has filed notice of change of name to the Fibre Securities Co.

THE BRIDGEPORT BRASS FOUNDRY, INC., Bridgeport, Conn., has filed notice of dissolution under state laws.

THE MANATI SUGAR CO., 112 Wall St., New York, N. Y., has disposed of a bond issue of $8,000,000, the proceeds to be used for general operations, financing, etc.

THE NEW ENGLAND OIL REFINING CO., 19 Milk St., Boston, Mass., has arranged for the sale of bonds for $1,000,000, to be used for general operations.

Industrial Notes

KURT MUNZINGER of Buffalo, N. Y., sailed recently from New York for Havre, France. From Havre Mr. Munzinger will go to Barcelona, Spain, to open a foreign office for Pratt & Lambert, Inc., Buffalo, manufacturer of varnish. He will also care for the company's interests in Spain, Holland, Denmark, Sweden, Norway and Finland.

THE PFAUDLER CO. has moved its New York office from 110 West 40th St. to 8 West 40th St.

THE COMBUSTION ENGINEERING CORP., New York, announces that it has recently completed arrangements with the Power Plant Equipment Co. of Kansas City, Mo., to represent it in that territory.

THE SOUTHWESTERN ENGINEERING CO., Los Angeles, Cal., has recently appointed D. W. Salsbury Eastern manager, with offices at 200 Broadway, New York City. Mr. Salsbury will act as Eastern manager for the Southwestern Condenser Co. and will have charge of all Eastern sales for the MacCamy condenser and intercooler.

THE DRIVER-HARRIS CO., Harrison, N. J., announces that on May 1 its Chicago branch moved to larger quarters at 562-574 West Randolph St.

THE IRON PRODUCTS CORP., the Central Foundry Co., the Central Iron and Coal Co., the Chattanooga Iron and Coal Corp., the Molby Boiler Co. and the Central Radiator Co., have moved their New York offices to 41 East 42nd St.

W. H. CAMPBELL, for the past 2 years general sales manager of the Charleston Industrial Corp. at Nitro, W. Va., announces the opening of offices as W. H. Campbell, Inc., at 30 Church St., New York City. This business has been incorporated for the sale of new and carefully inspected used chemical, refrigeration and power apparatus. While with the Charleston Industrial Corp. Mr. Campbell devoted his time to the sale of equipment for the former government munitions plant at Nitro, purchased by the company.

New Publications

INDUSTRIAL STABILITY is the title of a book, Vol. V, No. 1, dated January, 1922, published by the Society of Industrial Engineers, which is a complete report of the proceedings of the seventh national convention held under the auspices of the Society of Industrial Engineers at Springfield, Mass., Oct. 5, 6 and 7, 1921.

THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH (London) has published Special Report No. 1, by the Fuel Research Board, on "Pulverized Coal Systems in America," by Leonard C. Harvey.

THE IMPERIAL INSTITUTE (London) has published a new edition, revised and enlarged, on "Potash," by Sydney J. Johnstone, which has been prepared under the direction of the Mineral Resources Committee of the Imperial Institute with the assistance of the scientific and technical staff. Copies can be obtained from John Murray, Albemarle Street, W., London, at 6s. net.

THE IMPERIAL MINERAL RESOURCES BUREAU has published "Laws and Regulations Relating to Lead Poisoning," being an analysis with texts of the laws and regulations made in the chief industrial countries to prevent Plumbism, by Gilbert Stone. Copies can be obtained from H. M. Stationery Office, London, England, at 5s. net.

Manufacturers' Catalogs

WILSON-MAEULEN CO., New York, has issued its fourteenth Pyrometer Catalog. It illustrates and describes the Tapalog, both single- and multi-record pyrometer recorders, high-resistance Monopivot indicator, Monopivot pyrometers, pyods and accessories.

THE SOUTHWESTERN CONDENSER CO., 1223 Hollinsworth Bldg., Los Angeles, Cal., has issued Bull. A-5, on "Intercoolers and Aftercoolers for Compressors."

THE ELECTRO METALLURGICAL SALES CORP., New York, has just received from the press its new catalog entitled "Electromet Brand Ferro-Alloys and Metals." This attractive 26-page booklet gives a brief description of the most important Electromet brand products and their uses in the fields of ferrous and non-ferrous metallurgy, together with some historical statements.

W. S. ROCKWELL CO., New York, in Bull. 241, on "Forging and Heating Furnaces," has prepared a booklet on the need for better heating in forging and forming practice. It indicates some fundamental principles affecting the quality and cost of forgings and other formed parts that are generally overlooked in practice. It is claimed that proper application of the ideas outlined should lead to better and cheaper products, irrespective of the form of furnace or fuel employed. Illustrations of typical equipment are shown, with descriptions of the heating and handling methods employed to meet a wide variety of plant and manufacturing conditions, form and cost of available fuels.

STRUTHERS-WELLS CO., Warren, Pa., manufacturer of steel plate equipment for the chemical, petroleum refining, iron and steel, creosoting, paper, soap, alcohol and related industries, has published a new and well-illustrated catalog. Descriptions of plate shop, engineering department, welding shop, foundry, machine shop are complete and well illustrated. Among the products are tanks, kettles, coolers, agitators, stills, flues, boilers, etc.

Industrial Developments

CERAMIC—The Blackwell Brick Mfg. Co., Blackwell, Okla., has resumed operations on a capacity basis, following a shut-down for some time past. More than 60 men will be employed, with output totaling 40,000 bricks a day.

All brick-manufacturing plants in the Birmingham, Ala., district are operating on a full-time, full-capacity basis.

Potteries at East Liverpool, O., and vicinity have increased capacities to 90 and 95 per cent of normal. A number of chinaware plants are operating under full production. During March a total of 13,000 packages of chinaware was shipped from the Sebring, O., territory, establishing a new high record.

RUBBER—The Vulcanized Rubber Co., Morrisville, Pa., manufacturer of hard rubber products, has increased operations to a capacity basis. Orders on hand insure this basis of output for more than 12 months to come in a number of departments. Employment is being given to 400 persons.

The Lehigh Tire & Rubber Co., New Castle, Pa., is increasing production and adding to its working force. Close to normal operations are being maintained.

The Firestone Tire & Rubber Co., Akron, O., has advanced production to a basis of 22,000 tires a day, as against 20,000 tires during the early weeks of April.

The Goodyear Tire & Rubber Co., Akron, O., has increased manufacture from 22,000 to 24,000 tires a day. About 1,000 additional employees have been added to the working force during April.

GLASS—The Sneath Glass Co., Hartford City, Ind., has resumed operations in its blowing department, following a curtailment for a number of weeks. Improvements have been made for increased production.

The majority of the large glass bottle-manufacturing plants at Millville, N. J., have adopted a full time operating schedule. Tube workers in this section have accepted a wage reduction of 15 per cent.

LEATHER—The B. D. Eisendrath Tanning Co., Racine, Wis., is increasing production in its calf leather department, and is arranging for further enlargement at an early date.

The American Hide & Leather Co. is increasing production at its tanneries in the Chicago, Ill., district for calf and grain material. The upper leather plants of the company in different parts of the country are running at 50 to 100 per cent capacity, with present average in excess of 75 per cent.

The Continental Leather Co., Philadelphia, Pa., is advancing the production schedule in the hide departments at its two tanneries in Virginia. Plans are under way for the establishment of a new leather plant in the vicinity of Elkton, Va.

IRON AND STEEL—The Republic Iron & Steel Co., Youngstown, O., has resumed operations at its bessemer plant, idle for more than a year past. The company now has thirteen sheet mills in service in this district, and has also resumed at its plate mill.

The Crucible Steel Co., Pittsburgh, Pa., has blown in another blast furnace at its mills.

The McKinney Steel Co., Cleveland, O., is arranging for the immediate resumption of operations at its open-hearth plant. Four furnaces will be lighted.

The Bethlehem Steel Co. is increasing production at its Steelton, Pa., works. Blast furnace "B" at this plant, which has been out of commission for about a year past, will be blown in within the next fortnight, for pig-iron production. Operations are being advanced in the coke-oven department, and men added to the working force.

The Woodward Iron Co., Birmingham, Ala., has made its No. 2 Vanderbilt furnace ready for operation, and the unit will be blown in at once.

The Tennessee Coal, Iron & Railroad Co. is making ready to place another bessemer furnace in operation at its Ensley, Ala., works.

The LeMoyne Steel Co. has resumed operations at its plant at New Eagle, near Washington, Pa., following a shut-down for several months.

The Eastern Rolling Mill Co., Baltimore, Md., manufacturer of steel sheets, is arranging for an immediate advance in production from 90 to 100 per cent capacity, the first that the mill has been on this basis for some time past. Additions are being made to the working force.

The Newport Rolling Mill Co., Newport, Ky., will place additional sheet and tin mills in service during the next fortnight. A total of eleven mills are now in operation at the works. The working force is being increased.

MISCELLANEOUS—The Atlas Powder Co. has resumed production on a full-time basis at its plant at Tamaqua, Pa.

The Vulcanite Cement Co., Vulcanite, N. J., is maintaining full operations at its local plant, and has advanced the wages of employees 6 cents an hour. The Edison Portland Cement Co., New Village, N. J., in this same district, is running full, and has announced a wage increase for operatives of 5 cents an hour.

The American Trona Corp. has reopened its potash plant at Searles Lake, Cal., following a shut-down for nearly a year past.

The Atlas Mineral Products Co., Mertztown, Pa., has resumed operations at its plant, following a suspension of operations for some time past.

Coming Meetings and Events

ASSOCIATION OF CHEMICAL PLANT EQUIPMENT MANUFACTURERS will meet at the Chemists' Club, 52 East 41st St., New York, on May 10, to complete organization, elect officers and oppoint committees.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the association, on the occasion of the annual meeting of the latter, in Salt Lake City June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., May 8 and 9.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at Atlanta, Ga., May 8-11.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS of the NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

IRON AND STEEL INSTITUTE (British) will hold its annual meeting on May 4 and 5 at the House of the Institution of Civil Engineers, Great George St., S. W., 1, London.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15-22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TANNERS' COUNCIL will meet at the Copley-Plaza Hotel, Boston, May 4 and 5.

The following meetings are scheduled to be held in Rumford Hall, the Chemists Club, New York: May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting: June 9—American Chemical Society, regular meeting.

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Chemists' Club Employment Bureau

FOR many years the Chemists' Club of New York has maintained an employment bureau for the benefit of chemists. The small service fee charged has made it possible for the bureau to show a profit in good times, but in bad times, when it really can be of the greatest benefit, it becomes a liability. At the last meeting of the American Chemical Society it was proposed to turn the bureau over to it, but the Council rejected the proposal. In our judgment this was a mistake, because the large membership of the Society would give greater scope to the work of the bureau. Further, this business of fitting men to the places where they belong is a function that the Society might well assume in the interest of stabilizing chemical employment. Its fears that the Society might become involved in responsibility for recommendations are quite groundless, and other objections were without much force. Nevertheless the Society rejected the offer, and the bureau is to remain with the Chemists' Club. It will continue under the direction of Dr. MOODY, who has succeeded the late Prof. BASKERVILLE as director of the department of chemistry of the College of the City of New York. Under his past direction the bureau has rendered splendid service for a number of years, and we commend it to our readers.

The Beginnings Of Science

UNFORTUNATELY to many students who are at once intelligent and diligent the beginnings of both chemistry and physics are difficult and dull. Many who have "had" or "done" these studies remember them as so many hours of misery which are recalled with no enlightenment whatever. They studied to pass examinations and then the subjects were dismissed.

How then are we to get the scientific vision spread abroad among the intelligent part of the community? What seems needed rather than so many hours of chemistry or physics or biology as "a science" which leads to the passing requirement at school or college is a more general and correlated course in science as a whole. Dr. OTIS W. CALDWELL, director of the Lincoln School of Teachers College, Columbia University, with Prof. W. L. EIKENBERRY of the University of Kansas, wrote a textbook several years ago on the subject that points out the road. The sciences are called on for explanation indiscriminately as needed under the project method of teaching. Various efforts by other authors along similar lines have appeared since then. There is now in process of publication by Putnam's a beautiful exposition in four volumes called "The Outline of Science" by Prof. J. ARTHUR THOMSON of Aberdeen. Later and cheaper editions may bring it also into schools. It begins with the most engaging introduction to astronomy we have ever read and then proceeds along lines of biology, geology and physical chemistry in the first and only volume so far published.

Of course, in secondary schools we have the difficulty of preparing for college entrance examinations, but these difficulties are bound to be solved some day. Our contention is that the better way to begin science is as one great co-ordinated empire of knowledge. We have specialized too much at the beginning, and this does not lead to wisdom or even to scholarship. Everyone needs this larger vision to illuminate life. We men of science need it so that we may sense co-ordination and perceive the truth. Let's teach the high lights of nature to all, and then those who specialize in their work will be more enlightened than we of this generation.

Chemistry as the Foundation for Medicine

IT WAS along in about 1896, in conversation with the late Dean HENRY BOWDITCH of the Harvard Medical School, that we inquired where his best students came from. "Harvard College, perhaps?" we asked, as though, in such a Brahmin atmosphere as Bowditch Hill in Jamaica Plain, no other thought was possible. "Not at all," replied the old master of physiology. "Harvard is like any other college; some students are well prepared, and some are not. There is one place and one only in the United States from which they come inspired by a great teacher, and that is the Sheffield Scientific School of Yale. Their contact with Professor CHITTENDEN there is wholly unique. He gives them a remarkable course in physiological chemistry and he makes them understand. It is a great pity that there are not more like him. His students get the scientific attitude of mind. They come here with the chemical curiosity; with the will to search where the treasure is hid. Indeed, I may say we have as students graduates from the Sheffield Scientific School who have studied with CHITTENDEN, and then we have others. It is hard to make a comparison between them." That was about 1896. By 1898 the Corporation of Yale, having had difficulty in finding a good director for Sheff, took Dr. CHITTENDEN from his illuminating work as professor, promoted him out of the sphere of it and into the adjudication of such serious problems as what to do with a student who is laggard in his attendance at chapel, or the settling of quarrels between two boys, or determining whether X, who is deficient in English, may or may not play on the football team.

To be dean of a college is an honorable calling. So it is to be president of a bank or agent for HENRY FORD'S automobiles. But these things do not compare with teaching, real teaching, which is the greatest of all

the arts. Here was the one place in America where students of medicine were getting the start they needed, and it was put out of commission, so far as they were concerned, by the "promotion" of a professor.

Dr. BAILLY of Texas says we have far too many students of chemistry at this time. Not too many for the general good, but too many to find good places. So he suggests that they be inducted into organic research, and that with this and with biological chemistry as working capital to help them to establish themselves in the study of medicine we may look for a new generation of physicians. We all know the difference between the few physicians who have chemical understanding as diagnosticians and as physicians who know what to do, and the many who have only that smattering of chemistry which is the usual equipment of the practitioner.

Had it not been for the unfortunate, short-sighted—indeed almost blind—decision of the authorities of the Yale Corporation back in 1898 when they took Dr. CHITTENDEN from his chair of physiological chemistry and put him at the desk of the dean, we should have had more of those superpractitioners of medicine today who have "the will to search where the treasure is hid."

At the regular meeting of the Corporation on March 11, very complimentary resolutions were adopted over Dr. CHITTENDEN'S successful leadership of the Sheffield Scientific School for nearly a quarter of a century. And well they might resolve to this effect, for Dr. CHITTENDEN is a man of rare ability, and whatever he does he does well. But we think the Corporation should also have passed a vote of censure upon itself for its act in 1898 when, for its own convenience, it robbed the profession of medicine of so important a source of inspiration. It was an act that without doubt condemned a large number of persons to untimely death.

Nickel in Steel vs. Brains in Heat-Treatment

SOME incredulous questioning was leveled at Dr. RICHARD MOLDENKE at the recent meeting of the American Electrochemical Society when he stated that a leading German steel foundry was now able to produce plain carbon steel castings the equivalent of 4 per cent nickel steel castings made before the war. The details were not forthcoming. Apparently they were in line with the steps which German metallurgical industry had been forced to take by reason of war shortages of alloys, deoxidizers and high-quality ores. Captured ordnance was often full of metal of most suspicious chemical analysis, yet apparently good enough for the stresses it had to bear. The speaker inferred that such things were possible only by minute attention to correct metallurgical practice at every stage; ordinarily correct chemical composition is an indication that such painstaking care had been taken. Yet it is the care which is essential; given that, the composition may be what it may.

To a certain degree that is true, but if the practice is right the chemical analysis will usually come out right at the same time. For instance, a steel or iron which has been desulphurized must first have been deoxidized, and the quality in the product may actually be caused by freedom from gas rather than freedom from sulphur. But nickel is supposed to give certain peculiar and unique qualities to metal which ought therefore to be lacking when nickel is absent. One might cite the toughness and resistance to cracking which a nickel-steel armor plate exhibits when hit by a high-velocity shell if he were sure that this toughness were not due to a laminated structure caused in turn by non-metallic inclusions (dirt) rather than nickel!

Is not the wonderful German metallurgy which produced carbon steels the equivalent of nickel steel only an indication of what is going on elsewhere among up-to-date metallurgists? Perhaps they have known for some time that good nickel steel is not the easiest thing in the world to make, and have also discovered that sound, clean, simple steels can be wonderfully improved by correct heat-treatment. In other words, were they not making a mediocre nickel steel 10 years ago, while today they are making an excellent heat-treated carbon steel?

That this is at least a reasonable assumption may be inferred from the following: Hütte (1915), the reliable German engineering handbook, quotes the following physical properties for annealed 4 per cent nickel steel castings for machine parts: ultimate strength, 78,000 lb. per sq.in.; elastic limit, 50,000 lb. per sq.in.; elongation, 25 per cent; reduction in area, 55 per cent. This would probably be acceptable to them, but is far from being as good as can be obtained. Quoting from tests taken from mill production, HALL, NISSEN and TAYLOR (1919) quote many double-treated 0.26 carbon steel castings made in America which average ultimate strength 83,000 lb. per sq.in., elastic limit 51,000 lb. per sq.in., elongation 30 per cent, reduction in area 58 per cent, Fremont impact number 28, cold bend about 1 in., 180 deg.

Would you insist on nickel in the steel or brains in the heat-treatment?

Learning How to Think

IN THEORY we are always ready to admit that as a race we are going to make progress along new lines in future, but in practice we rather stick to the line of developing and expanding old ideas. We are disposed to extrapolate rather than seek to strike off at a tangent.

Just lately there is rather a new idea going the rounds, that while in the last hundred years development has been along the line of subjugating material forces, the next hundred years is going to see great development in subjugating the human brain—in other words, in learning how to think.

There are those to whom this prediction will not appeal. They are jealous of our ability, or supposed ability, to think, and at once suspect that the proponents of this new notion are actuated by a belief that most of the subjugation of materials and physical forces has been accomplished. Perish the thought, they are likely to explain, that we are any more than on the threshold, that we have done more than gather up a few grains of sand on the ocean's shore!

We may perhaps get some distance toward a fair viewpoint by comparison and analogy. We can observe in some cases what men's aspirations and expectations used to be, and note whether they have been fulfilled. A convenient case is found in railroading. The history of steam railroading in the United States covers less than a century. Go back half way, and we find certain train speeds achieved, with expectation that speeds would increase almost indefinitely, but the in-

crease has not occurred. Twenty years ago an 18-hour train between New York and Chicago was established, but this was achieved by the train keeping at it rather than by its going faster than trains had gone many years earlier. The speed of the fastest trains has increased but little in the second half of railroad history to date.

It is no dreadful thing to admit that along certain lines we have succeeded, have got along far enough, and can afford to go in for wholly new things. It is only about 20 years since we began developing physical efficiency in performing manual operations, and there are not a few now who believe we have gone too far, that we have been trying to produce what really involves a greater drudgery in work. The ergograph helps to tell us when and how long the rest periods for the muscles should be, but it is certain we are not living our lives rightly if we mold them from cradle to grave with ergograph records as the sole rule of faith and practice.

Now, as a matter of plain fact, probably everyone who really thinks knows that he does not know how to think. He has very likely had moments of inspiration that have been depressing rather than elevating, through showing what a waste of time the rest of life has been without similar quick and successful thinking. Here again there will be those who will object, holding that this is merely some fresh press-agent stuff for that fool psychology. Even though most people will admit that "psychology" as it has been taught has been rather dry, here is another point at which we can use analogy and comparison. There was "political economy," invented a long while ago and justifiably dubbed "the dismal science." Lately it has developed into something interesting and very useful, sometimes called "quantitative economics," not because it has made basic discoveries or formulated new theories, but because facts have accumulated, statistical and otherwise. Psychology is in line for a similar development. It is getting away from the question of whether or how an amœba thinks, and in the next few decades it may tell us, not how we think when we think the wrong way, but how we ought to think so that instead of there being an occasional flash of genius in a brain here and there we shall all be geniuses all the time. Then we can take things easy.

Lowering Costs Through Material Handling

IT HAS long been a recognized fact and accepted as common practice that bulky raw materials could be handled by mechanical equipment in a more economical and expeditious manner than by manual labor. We are so used to seeing coal, stone, sand, gravel, ore, sugar cane, pulpwood and similar material handled in this way that the fact has ceased to arouse much interest. We see the raw materials unloaded and stored, and pass on without thought as to how these are handled beyond the first storage point.

But what happens to them is really of great importance. Suppose we ask how many times each pound of raw material must be moved before the finished product is obtained and how much this movement costs. An illuminating example comes to mind. A plant manufacturing refractory brick had the raw materials delivered by rail from a trestle directly into bins. From that point—through every process, grinding, mixing, molding, drying, burning, storing and shipping—the material was entirely transported by hand in wheelbarrows. One movement consisted in transporting the brick from the drying shed to the kilns. It required eight barrowmen two days to wheel sufficient brick for one charge. At a rate of $4.50 each per ten-hour day this brought the cost of transporting the brick for a single kiln charge up to $72, or about $3.50 per ton.

The cost of discharging the kiln to storage was almost as great. There were five other wheelbarrow handlings for each brick besides the two mentioned above. In addition there were numerous intradepartment handlings, some of which possibly could not be eliminated; and which brought the total handling up to 28 pounds of material for each pound of product. As a result, handling operations occupied almost two-thirds of the labor of the plant and accounted for approximately one-half of the cost of the finished brick.

This, perhaps, is a particularly bad case; but many others exist which are almost as startling. Anywhere from one-third to nine-tenths of the cost of manual handling can be saved by the application of machine equipment in a plant where it is at all possible to install it; and this means with the interest charges on the investment and the depreciation charges directly charged to the handling costs. It is of course necessary to make an analysis of a plant before any handling equipment is installed, as it is a matter for careful study and skilled judgment as to just what equipment will best serve any special case. Most of the failures of material-handling installations have been due to the fact that the equipment used has not been proper for the plant where installed. The number of industries, however, in which some improvement cannot be made through the use of the proper equipment is few indeed.

There are additional benefits derived from the correct application of handling equipment, all of which have either a direct or an indirect effect in lowering costs. In many plants where the actual manual handling is less than in the example cited above, or where the process of manufacture is more complicated and more difficult to control, the enhanced efficiency following the installation of handling equipment eases the task of management and greatly lowers the incidental costs. This may be due to less space requirement for the same production, more rapid movement of goods in process, less quantity of goods in process inventory, a more easily determined and steadier output contributing to more efficient work in sales and purchasing, and the speeding up of labor in an unconscious effort to keep the pace of the machines.

The objection is often raised that handling equipment adds complication to the plant, requires an increased force of mechanics to care for it, and tends to hold up production through breakdowns. The first and second of these objections have proved in practice to be negligible, while the third, at one time true, no longer is important, as the handling equipment available is at least as reliable as the other equipment in use in most plants.

It seems that only ignorance of the actual accomplishments of handling equipment and inertia toward the acceptance of new methods have prevented a much greater application of mechanical handling. We believe that the increased production efficiency and lowered cost of production to be obtained through this equipment make it vitally important for all who manage or operate industries to study their plants with a view to obtaining to the full the advantages which may follow their use of such equipment.

Readers' Views and Comments

Ghosts and Undeveloped Senses

To the Editor of Chemical & Metallurgical Engineering

SIR:—Here's Sir Arthur Conan Doyle on a lecture tour talking about ghosts, and whenever they talk about ghosts we poor chemists are bombarded with questions. But as soon as we undertake to present the requirements for sensory phenomena, we are likely to be informed that we don't know anything about the whole subject (which is correct, so far as most of us can understand), on the ground that these spirits and the stuff they are made of are immaterial—and that worries us again, because we want to know how they can be seen and felt and heard, if they are immaterial.

Sir Oliver Lodge and Sir Arthur Conan Doyle insist on the postulate of ether for their familiar manifestations; but to most of us ether is needed only for the wave theory of light, and in current thought this postulate is less firmly insisted upon than it was 10 years ago. If we postulate ether at all, we must postulate it as so dense that matter is, in effect, holes in the ether rather than particles of any sort.

In the Orient, spirits are not such ghosts as we discuss and fear if we think we see them. In Japan, for instance, in Buddhist temples after the proper offerings have been made and the requisite prayers said, it is held that the spirit of one departed comes sailing through the air like an infinitely minute spark which penetrates any wall, and is too small to be seen or felt. We, on the other hand, want them life-size, but shadowy enough to convince us that they are really ghosts, and not solid persons.

A big, fifteen-dollar book by Baron Albert von Schrenck-Notzing, M.D., of Munich, was published in Germany in 1913, and the English translation appeared in 1920 under the title "Phenomena of Materialism" (Duttons). This brought out a tissue-like manifestation emanating from a medium known as Eva C., a French girl, which Dr. Schrenck called "teleplasm." It was a moist, film-like substance that usually, but not always, came from her mouth, and occasionally took rather vague shapes—and then seemed to go back again. It was cool and moist to the touch. Sir Arthur refers to some such ghost-stuff which he calls "ectoplasm," which is probably the same sort of emanation. It seems more like some kind of a ruminant emanation than an honest-to-goodness ghost to one who is not gifted with the faculty of ready belief.

What the spiritualists seem to have missed by clinging fast to the ether theory is what may happen without it. We cultivate but two of our four major senses: sight and hearing. Smell we neglect utterly, and touch we know nothing about. Our eyes perceive light waves from $\frac{1}{60{,}000}$ to $\frac{1}{37{,}000}$ of an inch in length. Longer or shorter we do not see. Our ears hear atmospheric waves from one inch to a hundred feet in length, and we have no organs of apprehension beyond these limits. Therefore the most amazing and exciting phenomena may take place within a room, may frighten insects, but leave no impression on us the while we think everything is at once quiet and dark. Now since we know nothing of touch and pay scarcely any attention to it so long as we can see, we have in this sense a vast field of the unknown, which is exactly the place for ghosts. For the very reason that we know so little, nobody can deny that a person who is supersensitive to touch may become cognizant of all sorts of shapes and sounds and goings on to which the rest of us are blind and deaf and numb. Why insist that we can see that which is not matter when all these goings on are possible? It is a splendid chance, and we are amazed that the mediums have not adopted it. MARTIN SEYT.

Hardness of Solid Solutions

To the Editor of Chemical & Metallurgical Engineering

SIR:—It occurred to me, after hearing Dr. Jeffries' able presentation of "The Slip Interference Theory of the Hardening of Metals" before the February meeting of the Mining Engineers, following his very important paper published in your journal for June 15, 1921, that there is one point which needs to be emphasized in connection with the hardness of solid solution alloys. Suppose we take pure nickel and mix a little iron with it. Nickel happens to crystallize in the face-centered cubic structure. In going into solution, an atom of iron replaces an atom of nickel, but it does so at the expense of a certain amount of distortion in the position of the surrounding nickel atoms, and the extent to which that distortion of position may penetrate into the surrounding nickel is something concerning which we know nothing at present. Ordinarily, the same conditions of force exist throughout the entire crystal of pure nickel. If an iron atom be introduced at any one point, either that iron atom attracts the nickel atoms with a little bit more force than nickel atoms attract each other, or it attracts them with a little bit less force; or, in the extremely rare case (I scarcely can conceive of it as actually occurring), it exerts identically the same force. That last alternative may be put out of mind. In the other cases, the field of influence, the knot, the key, or whatever it may be called, that corresponds to the iron atom is a good deal larger in extent than the diameter of the atom itself. It conceivably might extend for four, five, six, ten or more atom diameters before displacement of the nickel atoms from their normal position would be so slight as to be entirely negligible. ANCEL ST. JOHN.

Union Carbide & Carbon Research Laboratories,
Long Island City, N. Y.

Non-Flammable Mixtures of Solvents

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your March 29 issue there appeared an article by Sievers and McIntyre entitled "Non-Flammable Mixtures of Organic Solvents for Vegetable Oil Extraction," which seems to me to call for some comment. The authors first proceed to discuss the determination of the limiting amount of the vapors of flammable solvents such as benzene, gasoline, etc., which can be mixed with vapors of a non-flammable solvent

such as carbon tetrachloride before a flammable mixture results. Now it is obvious that none of the so-called flammable vapors are really flammable by themselves, but only when mixed with oxygen. Furthermore, it is a theoretical as well as an experimental fact that all such vapors when mixed with air are flammable only within quite narrow limits of concentration. For instance, at ordinary temperatures and pressures, the limits for benzene vapor are about 1.5 per cent and 6 per cent by volume.

The method of testing for flammability outlined in the article referred to was very indefinite, no mention being made of the amount of air admixed with the vapors. In fact, one is led to infer that the mixture through which a spark was sent consisted purely of the vapors in question. If this is so, the fact that ignition was obtained in some cases would certainly contradict all the previous theoretical and experimental evidence. If, on the other hand, the vapors were mixed with air during the test, it is apparent, from the nature of the test as outlined, that the concentration of the solvent vapors must have been indefinite and consequently the possibility of an ignition is determined not only by the relative amounts of, say, benzene and carbon tetrachloride, but also by the concentration of oxygen. In view of these facts, it does not seem that one is justified in drawing any conclusions from the tests as to the effect of non-flammable liquids on the flammability of benzene and gasoline.

Newtonville, Mass. BARNETT F. DODGE.

Notes on the Manufacture of High-Speed and Tungsten Steels

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest J. W. Weitzenkorn's notes in your issue of March 15, 1922, which are a remarkable confirmation of the theory that carbides in high-speed steels are not made soluble by any heat-treatment. As a matter of fact, they form a eutectic which melts at relatively low temperatures. In a research published in the *Zeitschrift für anorganische und allgemeine Chemie*, vol. 118, p. 55, I stated that the melting point of this eutectic in chromium steels lies at about 2,100 deg. F. (1,150 deg. C.) and in tungsten steels as low as about 1,940 deg. F. (1,060 deg. C.). A ternary eutectic exists in high-speed steels containing chromium and tungsten, and it is evident that the eutectic is melted after a careless high heat and squeezed out by subsequent forging. In Figs. 10, 11, 13 and 14 of Mr. Weitzenkorn's notes such a fusion

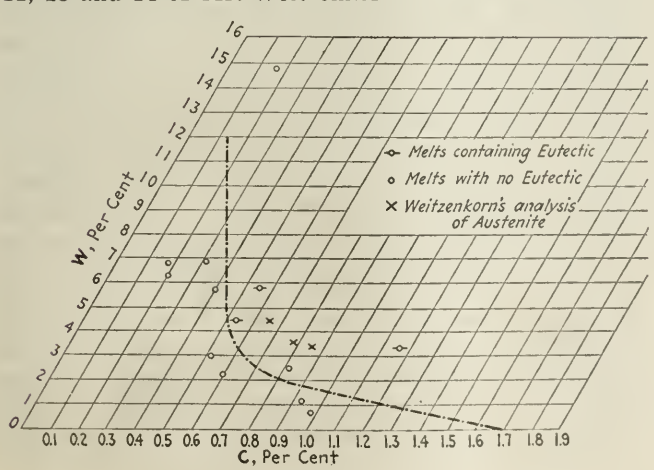


FIG. 1. SOLUBILITY LINE FOR Fe: W: C ALLOYS

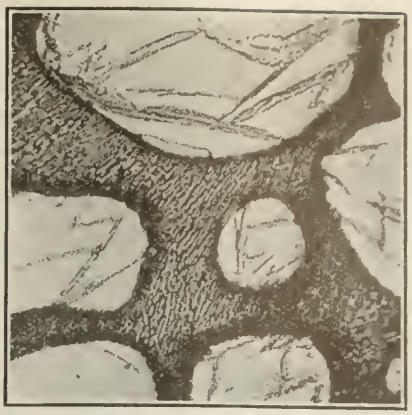


FIG. 2. CARBIDE MASS IN STEEL CONTAINING 1.90 PER CENT C AND 10 PER CENT W. ETCHED WITH HOT SODIUM PICRATE. × 555

is evident: the great freedom of the "eutectiform" carbides may be explained in this way.

Another result of my research was the approximate determination of the solubility line of carbon in chromium and tungsten steels—i.e., the line in the ternary diagram where the eutectic appears first. Fig. 1 shows that this line agrees fairly well with the results in Table II of Mr. Weitzenkorn's article. Crosses represent the chemical analysis of solutions he obtained after removing carbides from the austenite.

The structure to which the carbides revert on being heated to the melting point may be explained in another way, if we assume that the eutectic forms a series of "wires." On the left end of Weitzenkorn's Fig. 13 the "wires" are cut longitudinally and appear as narrow bands, but in the middle they are cut across; therefore the wires appear like spheroidal carbides. Massive carbides shown on the right end of Fig. 13 likewise would show this network if the sample were etched with hot sodium picrate. Fig. 2 shows such a carbide mass etched with sodium picrate in a tungsten steel containing 10 per cent W and 1.90 per cent C.

Düsseldorf, Germany. DR. K. DAEVES.

Electric Furnace Melting

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the letter of Henry Traphagen in the issue of March 22, I was glad to note that the editor added a note to correct the erroneous impression conveyed as to limitations of the process.

We have all been too prone to leave uncriticized the impressions which seem to exist regarding the phenomena attributed to electric heat, when it should be considered simply as a means to an end. As you have so well stated in your editorial, the electric furnace permits the metallurgist to make use of slags for refining purposes which would be impossible to maintain by any other method of heating.

It is unfortunate that on account of the possibility of producing steel in the electric furnace equal in every way to the quality of crucible steel, we have not only compared the two grades of steel, but also the two methods of production and have tried to show points of similarity. To my mind the electric furnace process could better be compared with open-hearth practice, which it closely resembles in many important details, but which it excels on account of its greater flexibility and more accurate control of reactions.

Like the open-hearth, we have to deal with a large

mass of metal and we are constantly observing slag conditions. The entire success of the process, in fact, with exception of temperature, is due to maintaining a proper slag. The chief difference from the open-hearth bath is the advantage attained by the possibility of working with a reducing slag.

Probably one reason for many failures of electric melting has been the generally accepted idea that a crucible melter should be selected to do the melting. Far better success would have been had with an open-hearth man, if one took pains to show him the function of a reducing slag and instructed him how to maintain it. The study of slags is an old problem to him, while with the crucible melter it is a mystery from the start. On the other hand, there is little doubt as to the advantage of having a man familiar with crucible practice to take charge of the pouring, which in itself is an exceedingly important operation.

As to the points made in the letter in regard to impossibility of making good steel from poor grades of scrap, the writer again has been influenced by crucible practice. It is possible to make an excellent grade of steel from low-grade scrap in the electric furnace, just as much so as in the open-hearth in fact; but it is usually not advisable to do so, as the additional cost of current due to the extra time required more than offsets any saving there would be in the price of the scrap.

As to the reference to porous castings made by the electric process, an examination of the melting logs will probably reveal as the outstanding feature a very rapid production of heats. It is of course very desirable to use current for as short a time as possible and to get a high rate of production, but it is considerably more important that the heat should be properly killed before tapping, and this usually requires quite a little time to get correct conditions.

This is perhaps the reason why aluminum is used so freely. But it should not be overlooked that a small amount of aluminum is a good thing to make absolutely sure that the deoxidation has been complete. It has been common practice for many years not only in open-hearth steels but in many plants producing crucible steel to introduce a few ounces for each ingot.

The steel-casting organization has many conditions to meet in order to produce sound castings. It is necessary to have not only a quiet steel, but, what is just as important, properly vented molds. The production of steel castings by an organization not thoroughly familiar with all the details of production is a most hazardous undertaking and accounts for a very fair percentage of failures in this industry.

The electric furnace is a wonderful addition to the working tools of the metallurgist and already has made possible the solution of several important problems. The future will no doubt witness a very great development directly attributable to its use.

New York City. W. H. KEEN.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Mr. Traphagen, in his letter in your issue of March 22, 1922, infers that certain faults exist in electric furnaces. He should, to the extent of his ability and belief, explain the redeeming features, provided there are any. We know the electric furnace possesses many of the latter.

Unquestionably, a "cycle of ups and downs" must be traversed by any scientific innovation before it arrives at its real field of application (and the latter is generally found to be limited). The electric melting furnace has not yet been stabilized in its operation or uses. "Wild advertising" of impossibly broad fields of application has doubtless contributed to the damage, but experience has led to the belief that this has been of small significance as compared with another underlying cause hitherto rarely mentioned.

Since the first commercial application of electric furnaces, competition among so-called furnace manufacturers, instead of leading to ultimate stability in methods, recommended applications, etc., really brought into existence "furnaces" not worthy of the name. The performances of these, most naturally, detracted from the exceptionally few that were deserving of serious consideration. Furthermore, the comparative ease with which successful operation can be obtained from a "crippled" furnace installation bears out the contention that the element most damaging to the industry is the fact that the expense for engineering on the job is usually incurred at the wrong time—namely, after the furnace was installed and operated.

Where Mr. Traphagen states that the electric furnace is a "good nurse for healthy material" only, the term "healthy" should be explained. If "healthy" is intended to exclude cheap scrap, the statement is entirely misleading. To prove this, we would call attention to the following typical costs of foundry steel in the ladle:

I—CONVERTER

1,000 lb. low-phosphorus pig	$21.50
1,000 lb. low-phosphorus and sulphur heavy scrap	7.25
333 lb. coke	1.17
20 per cent melting and converter loss	5.74
Ferro-alloys	1.60
Cupola refractories	.80
Cupola power and labor	1.25
Converter refractories	1.00
Converter power and labor	1.00
Cost per ton	$41.31

II—OPEN HEARTH

1,000 lb. bessemer pig	$13.50
1,000 lb. low-phosphorus and sulphur heavy scrap	7.25
6 per cent melting loss	1.25
60 gal. oil	6.00
Labor (furnace only)	1.00
Ferro-alloys	1.40
Refractory repairs	.60
Cost per ton	$31.00

III—ELECTRIC FURNACE

1,500 lb. steel turnings	$4.88
500 lb. foundry returns	3.62
3 per cent melting loss	.27
14 lb. electrodes	1.12
Refractory repairs	.40
Labor (furnace only)	1.00
Ferro-alloys	.50
Electric power	8.25
Cost per ton	$20.04

Costs are of course based on continuous operation.

Certainly there is no wonderful cleansing power in electric heat. But with a quarantine effectively established against outside "poisons," why cannot those inside the furnace be easily removed, if the furnace is treated as a "mere crucible"? Any temperature-time cycle is possible, permitting the use of as few or as many cleansing fluxes as may be required, and in any sequence. Appreciation of this comes from a detailed analysis of typical, successful practice. The value of being able to hold a neutral atmosphere may appear to be a good point about the electric furnace, but is its importance realized until investigation discloses just what can be done in a neutral atmosphere? One thing alone which is required for successful results and which is particularly a feature of electric furnaces is the ability to supply all of the oxygen used in the removal of deleterious elements and impurities in the solid form.

A discussion of this one item would require far more

space than the present article can be allotted. Could I suggest that better progress might result if we, rather than harshly condemn the electric furnace,

(1) "Jog up" the refractory manufacturers, to keep less than 10 years behind furnace advances.

(2) Eliminate inherently bad furnace designs from the field—regardless of patents or "right to exist."

(3) Utilize sufficient engineering on all installation.

(4) Cut out "wild advertising" to the effect that the electric furnace can do everything.

(5) Endeavor to supply the electric furnace, which is a valuable asset to industry, only to those capable of properly applying it, and see that they can get competent operators. C. A. BIRD.

Sessions Engineering Co.,
Chicago, Ill.

To the Editor of Chemical & Metallurgical Engineering

SIR:—We have noted in your issue dated March 22 a letter from Mr. Traphagen on the electric furnace. It occurs to us that there are certain statements made in this letter which are of a very sweeping nature and appear to require correction.

Mr. Traphagen proceeds to disregard the question of phases, single and multiple arcs, arrangement of electrodes, and electrical systems. We would point out that the selection of the correct electrical system is the secret of the commercial success of an electric furnace installed for any particular process.

Mr. Traphagen inquires what wonderful cleansing power there can be in electric heating, which seems to us to indicate that he has entirely overlooked the fact that the basic lined electric furnace has no equal for the purification of common raw materials, or that the metallurgist may use slags of varying composition so as to make use of varying reactions at will, and that he has not to cope with contamination of the steel from impurities brought in by furnace gases. It may, therefore, be said that the great advantage of electric heat is really the entire absence of contaminating impurities.

In modern designs of furnaces an almost perfect air seal may be obtained by the use of specially designed furnace doors which automatically seal themselves on being lowered into position. Modern electric furnaces are fitted with extremely efficient electrode economizers which surround the electrodes at the point where they pass through the roof. Flame-muffling devices are also fitted to these economizers which also prevent considerable losses of heat.

We would like to point out that the electric furnace can deal with a far greater proportion of rusty or oxidized material than other processes, the only objection to a great proportion of rusty material being the consequent wear and tear upon the dolomite hearth, which of course would apply to any other basic process. Also it is a well-known fact that electric steel is surprisingly free from occluded gases.

We would like to dispute the statement as far as electric furnace practice in Europe is concerned that foundries melting with electricity are particularly liberal with aluminum when casting the metal. This is purely a question of skilled metallurgy.

We are quite in agreement with your note at the bottom of Mr. Traphagen's letter, but we are certainly of the opinion that electric furnace makers in America will be in a position to disprove some of Mr. Traphagen's statements. ELECTRIC-METALS LIMITED,

London, England. By H. NEEDHAM.

Purple of Cassius Found in Bomb Washings

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the paper by H. L. Olin and R. E. Wilkin, of the Department of Chemistry, State University of Iowa, Iowa City, Iowa, on "The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations," published in CHEMICAL & METALLURICAL ENGINEERING of April 12, 1922, the authors reached the conclusion that nickel was not a suitable metal with which to line the bombs. They demonstrated by experiment that nickel linings gave an error of 1.96 per cent up to 2.35 per cent, and recommend the use of some other metal better able to resist corrosion.

The writer has been using a calorimeter in which the linings were copper shells, heavily gold plated. It would appear that with this lining no corrosion could occur, since gold is resistant to the dilute acids formed by combustion—viz., sulphuric and nitric. But it is surprising to note that about half of the samples submitted for examination by this laboratory show that "purple of Cassius" is formed in the residues from the bomb washings, which are collected in water, preparatory to determining their sulphur content. The samples are of bituminous coal, mined principally in Pennsylvania and West Virginia. The purple pigment is rather deep in color in some coal samples, and in others it is not found. Its presence apparently indicates that the gold lining is slowly attacked during combustion of bituminous coal, although it is difficult exactly to account for its formation. The subject is open to some speculation and it may be possible that the small amount of potassium and sodium contained in the mineral matter of the coal, in the presence of the iron from the ignition wire and the nitrogen of the coal, forms alkali cyanides, which attack the lining.

It is interesting to observe that this purple of Cassius usually passes the first filtration and is precipitated with the barium sulphate in the determination of sulphur, giving a gold lake which is of a light violet color. Only a very small amount of gold is lost, however, since this lining, after about 1,500 determinations, is still in good shape and is not worn through to the copper. It is evident from this experience that the selection of an insoluble lining for bomb calorimeters is a difficult matter. Gold-plated linings are certainly a great improvement over nickel, but apparently even gold linings are subject to some corrosion, though very slight.

RANDOLPH BOLLING.

Naval Supply Station,
U. S. Naval Operating Base,
Hampton Roads, Va.

Electrolytic Iron a Commercial Product

On page 639 of our issue for April 5, 1922, a footnote to Mr. McMahon's article on "The Manufacture of Electrolytic Iron" makes reference to a previously published article by Bradley Stoughton on "Electrolytic Iron a Commercial Product." The latter article appeared originally in *Iron Age*, Jan. 5, 1922, and credit should have been given that publication, since CHEMICAL & METALLURGICAL ENGINEERING merely reprinted it by permission.

Concentrating Dilute Nitric Acid Solutions

In the article on "Concentrating Dilute Nitric Acid Solutions," by Clifford D. Carpenter and Joseph Babor, in our March 8, 1922, issue, the heading over the third column in Tables I, II and III should have been "Grams" instead of "Per Cent," as printed.

British Chemical Industries

From Our London Correspondent

London, April 16, 1922.

BUSINESS in chemicals and fertilizers is better than for some time past and prices are well maintained except as regards soda ash and chloride of lime, for which substantial reductions have been made by manufacturers. The most significant feature is the apparent absence of complaints or grumbling as to the state of trade—a sure sign that good business is being unobtrusively transacted and that the forward position is considered favorable. Even the recent depreciation in the mark and the revisions made in the safeguarding of industries act have not affected prices. The demand for fertilizers is still quite phenomenal and is partly due to the fact that buyers held off until the last moment in the hope of obtaining more favorable prices. Superphosphate is in strong request, while sulphate of ammonia is almost unobtainable. The market in coal-tar products is at last improving and cresylic acid is particularly firm.

Official Report Expected on Low-Temperature Carbonization

It is understood that the Fuel Research Board of the Department of Scientific and Industrial Research is about to publish a voluminous report on the experimental and technical development of low-temperature carbonization, and that the full results obtained at H. M. Fuel Research Station will be discussed at length. A preliminary report was issued by the board over 3 years ago and it is felt that some of the information which had accumulated was held back too long and to the detriment of those concerned with the commercial development of the industry. Low-temperature carbonization propositions have always been regarded with scepticism in this country and now that several systems are within measurable distance of success, a stimulus has been given to high-temperature carbonization by the researches of Messrs. Sutcliffe and Evans, who showed that a free-burning smokeless fuel can be obtained if the coal is briquetted under special conditions before carbonizing. It is stated that only 12 cwt. of the new fuel is required to produce 1 ton of pig iron.

Rival Low-Temperature Systems Discussed at Cardiff

The South Wales Institute of Engineers held a symposium at which almost every system except the "coalite" retort was discussed. The Nielsen system of carbonization in a rotary retort using the sensible heat in producer gas generated by part of the resulting semi-coke is of particular interest[1] and a large plant is under construction for India. The Fusion Corporation's report is also noteworthy for its simplicity, low cost and prevention of scale and "balling." One consequence of progress in this type of plant is renewed interest in oil shale retorting proposition, it being now realized here as in America that shale oil will play its part in supplying the ever-increasing demand for oil fuel and motor spirit. The Scottish shale industry was mainly dependent upon its revenue from sulphate of ammonia and paraffine wax, but the commercial future of shales and torbanites found in Great Britain, Australia, Esthonia and elsewhere will depend not only on successful methods and research but upon educational work and propaganda in regard to the marketing of the products. Reference has been made in these notes to English Oilfields, Ltd., a company which has so far been unsuccessful on account of the high sulphur content of the oils obtained and on account of retorting difficulties. There are indications that both obstacles will shortly be overcome.

[1] See *Engineering*, March 25, 1922.

A New Buyer's Guide for the Chemical Trade

S. Davis & Co. are preparing for issue in July a chemical trade directory on somewhat original lines, which may be more truly representative and reliable than those previously obtainable. The normal practice has been to obtain payment not only for the insertion of names of firms but also to make a fairly substantial charge for supplying the directory itself to users, and the result has been that chemical directories have circulated mainly among the advertisers themselves. It was also found that under some classifications either some of the largest suppliers had not thought it worth while to advertise or else the list was chiefly composed of unimportant manufacturers or agents and traders. The present buyers' guide is to have a guaranteed circulation of 10,000 copies among actual buyers, will be issued free of charge and a certain number of entries will be given free to each manufacturer whether he advertises or not.

Automatic Electric Welding

The Cyc-Arc process, which is being developed by Handstock, Ltd., is attracting considerable attention not only in the shipbuilding industry but also for chemical and metallurgical equipment and for other special applications. By this process metal studs, rods and tubes can be automatically and directly welded on to sheets, tubes, forgings, etc., by electrical means and without the use of fluxes. The process is applicable not only to brass and other alloys welded on to iron and steel, but recently it has also been possible to weld high-speed tool steel tips on mild steel shanks, thus effecting a considerable saving in the cost of lathe tools. The strength of the weld is equal to or greater than the original strength of the material and large studs can be welded at the rate of about forty per hour. A process of this kind should prove useful in cases where the maintenance of gas and water tightness is essential and it therefore has possibilities in connection with the design and rapid construction of chemical plant.

General Notes

Among recent decisions in the safeguarding of industries act may be mentioned that of liquid sulphur dioxide, which was held to be free of duty because no greater degree of purification was necessary than if the gas had been used in the manufacture of sulphuric acid by a catalytic process. An unsuccessful attempt was also made to remove the duty on mucic acid on account of its impending manufacture on a large scale by the Acree process of the International Products Co., at Eureka, Mont. The proposal to remove the duty from synthetic camphor, chiefly used by the British Xylonite Co., is still under consideration. Rumors persist regarding the financial reconstruction of the British Cellulose & Chemical Manufacturing Co., and although these have been officially denied, it is fully expected that an arrangement with a Continental firm will shortly be made. Sir Ernest Rutherford is to be the new president of the British Association.

Photo by J. F. Hughes Co., Baltimore

A PORTION OF BALTIMORE'S SKYLINE

Baltimore Meeting of American Electrochemical Society

Report of Technical Sessions Comprising a Symposium on Electric Cast Iron and One on Electrodeposition—Honorary Membership Conferred on Dr. Carl Hering—Dr. C. G. Schluederberg Elected President—Fall Meeting at Montreal Sept. 21-23

THE American Electrochemical Society held its forty-first general meeting at Baltimore, April 27 to 29 inclusive. It was one of the very best meetings the Society has ever held. The attendance was exceptionally good, the technical sessions were very well conducted, there being an unusual amount of animated discussion. The social features were most attractive and enjoyable due to the untiring efforts of the local committee under the chairmanship of William H. Boynton.

Thursday morning and afternoon were given over to the symposium on Electric Cast Iron, one of the best symposiums ever held by the Society, being attended by many engineers of international repute who took very active part in the discussion. This symposium was reported at length in our last issue.

Friday Sessions

A Plea for Rational Interpretation of Hydrogen-Ion Measurements

Dr. William C. Moore of the Research Laboratory of the U. S. Industrial Alcohol Co., Baltimore, reported that he had found that in many biological systems hydrogen-ion regions are of more importance than actual hydrogen-ion concentrations. Thus, invertase has a flat maximum of activity in the range for $[H_+]$ 1×10^{-4} to 1×10^{-5}, and, concurrently, fermenting molasses mashes show within this range no relation between hydrogen-ion concentration and yield of ethanol. He made a plea to express hydrogen-ion concentrations in any one set of measurements in terms of a common denominator instead of as pH values, which for chemical work sometimes seem inconvenient.

Discussing Dr. Moore's paper, Clarke E. Davis of the Research Laboratory of the National Biscuit Co. showed curves based on actual titration of phosphoric acid. The second end point, contrary to Clark,[1] was found to be more than twice the first by an appreciable amount. This result is not accidental, but has shown itself in repeated titrations and by different investigators. Mr. Davis very much favored the Sorensen method of expressing results. Dr. Blum of the Bureau of Standards emphasized that usually the intensity factor was much more important than the quantity factor. C. P. Madsen said that in the case of nickel-plating solutions it was difficult to obtain concordant pH values.

Electrolytic Copper and Zinc

"The Conductivity of Copper Refining Electrolytes" was the subpect of a highly interesting paper by Prof. E. F. Kern and M. Y. Chang of Columbia University. The specific conductivities of solutions of sulphuric acid, copper sulphate, and of mixtures of sulphuric acid and copper sulphate were determined at 25 deg. C., 40 deg. C. and 55 deg. C. The concentrations of the solutions were 5, 10, 15 and 20 grams per 100 c.c. The effects of the presence of arsenic, nickel sulphate and ferrous sulphate upon the conductivity of a copper-refining electrolyte were determined, showing that the presence of arsenic does not appreciably depress the conductivity, whereas the presence of nickel sulphate and of ferrous sulphate depresses the conductivity very much.

The conclusions drawn from the results of these determinations are:

(a) The copper content of refining electrolytes should be kept between 30 and 35 grams per liter (approximately 120 to 140 grams $CuSO_4.5H_2O$) and the free sulphuric acid as high as economy permits up to 175 grams per liter. With higher free sulphuric acid content the solubility of copper sulphate decreases

[1] "The Determination of Hydrogen Ions," p. 32.

rapidly, and also the added increase in conductivity with more concentrated sulphuric acid is relatively not so rapid.

(b) Maintain the temperature of the electrolyte as high as economy permits. The economical temperature limit seems to be 55 deg. C.

(c) Keep nickel and iron content of the electrolyte as low as possible, as the presence of sulphates of these metals greatly depresses the conductivity of the electrolyte.

Lawrence Addicks of New York, in commenting upon the paper, felt that it was important to take into account the adsorption factor, which may change the results found by the authors. Further investigations along the lines pursued by Dr. Kern and his co-workers seemed desirable.

"Electrolytic Zinc and Hydrogen Overvoltage" was investigated by U. C. Tainton of the Bunker Hill & Sullivan Mining Co. of San Francisco.

If there be one factor in the production of electrolytic zinc which would seem to be firmly established, it is that relating to the necessity of a pure electrolyte. From Mylius and Fromm onward, the most gratifying unanimity prevails in the literature in this regard. Laist says, "Pure solution is the greatest single factor in the production of electrolytic zinc." Hansen, "Impure solutions invariably yield imperfect cathodes." Hall states, "The requirement, and I use it in the singular, for zinc electrolysis, is zinc sulphate, and zinc sulphate only." Siemens and Halske, "Every other metal and even carbon must be completely excluded."

These are high ideals. The production of pure zinc sulphate solution is no easy matter.

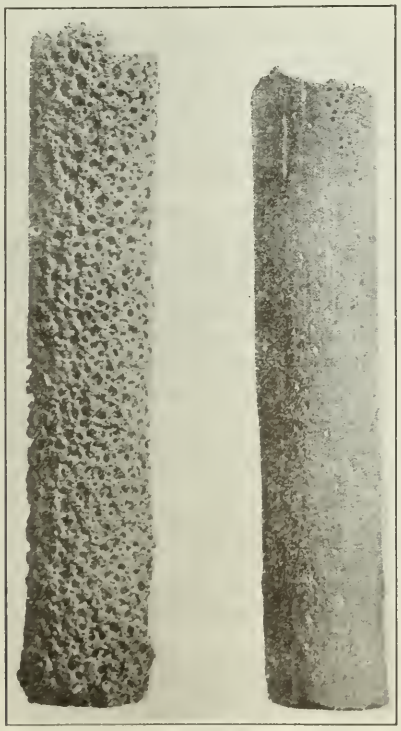


FIG. 1. × 1.5

Left—Zinc deposit from well purified solution, almost free from colloid, showing effect of adhering hydrogen bubbles.
Right—Zinc deposit from same solution but with trace of gelatin added.

Mr. Tainton found the following conditions indicated as favorable to the production of good zinc deposits from impure acid solutions: 1. Highe urrent density. This gives high overvoltage of hydrogen. 2. High electrolyte conductivity. This permits a low potential gradient and restrains "trees" which lower current density. 3. Diminished interfacial tension at contact surface of cathode and electrolyte. This gives a small contact angle, preventing the hydrogen bubbles from adhering to cathode. 4. Rapid upward movement of electrolyte past cathode surface. This usually arises automatically if sufficiently high current densities be employed. 5. Presence of some addition agent which will restrain crystalline growth of cathode deposit and raise overvoltage of impurities.

Commercial electrolytic zinc is deposited from solutions which, from an electrochemical viewpoint, are to be regarded as necessarily impure and containing free acid. The continued deposition of metallic zinc from such solutions depends on the maintenance of a high hydrogen overvoltage at all points of the cathode surface. This is attained by the maintenance at all points of a substantial current density, which, in turn, depends largely on the smoothness of the deposit. By sufficiently increasing the current density the hydrogen overvoltage for all metals examined (lead, cadmium, copper, iron, nickel, cobalt, antimony) may be made to exceed the potential of zinc on the hydrogen scale. This does not accord with figures obtained by the commutator method of measuring the variation of hydrogen overvoltage with current density, and it is believed that this method is unreliable. The overvoltage of the alloys examined lies between the overvoltages of their constituents. In the case of zinc deposits containing impurities, the overvoltage is very high as long as the zinc surface is clean and growing. However, the overvoltage of an impure, corroded zinc surface is found to be very low, and so once corrosion begins (at a point of low current density), it tends continually to spread. The function of colloidal matter such as gelatin in the electrolyte is to raise the overvoltage of hydrogen. It also lowers the contact angle of the hydrogen bubble, thus preventing adhesion of bubbles to the cathode surface. It tends to restrain crystalline structure of the deposit. All these factors tend to maintain smoothness of deposits. Practical work indicates optimum conditions to be a free acid concentration of about 250 to 300 grams per liter with a current density of about 100 amp. per sq.ft., and the presence of a minute quantity of gelatin or similar colloidal matter in the solutions.

Experiments With a.c. in d.c. Electrolysis

W. B. Jones of Buffalo submitted a detailed account of an investigation extending over several years. Potentiometer measurements of the potential difference of a lead cathode and a hydrogen electrode were made over a cycle of 0.04 second, during which combined alternating and direct currents flow through the electrode. This potential was plotted against the current flowing, and a graphic correction made for the true overvoltage. When plotted against coulombs, interesting results were found. These indicate the formation of stable and unstable compounds, as films on the electrode, as the cause of overvoltage. Measurements with intermittent direct current give the approximate stability of the lead hydride when the current is cut off. The potential of the hydride drops in this case about 0.6 volt in 0.08 second. Indications are that there is a lower hydride that is quite stable. An approxi-

mate calculation of the higher hydride formula gives about PbH_3.

The maximum overvoltage attained during cathodic action is only slightly lowered by superimposing increasing amounts of alternating current upon the direct current.

Electrolytic Corrosion

Dr. Robert J. McKay of the Mellon Institute studied "The Corrosion by Electrolytic Concentration Cells." He found that the corrosion could be very much accelerated in the case of a homogeneous metal in acid solutions, due to differences in concentration of dissolved materials in the solution. Copper is dissolved from Monel metal tie rods of pickling tanks due to leaks between the timbers.

A cell was set up with Monel metal electrodes in sulphuric acid (60 grams per liter), the solutions around the two electrodes being separated by a porous cup. The electrodes were connected in external circuit through a galvanometer. When the solution around one electrode was stirred and the other permitted to remain quiet, a deflection of the galvanometer was obtained showing a flow of current through the cell, the agitated electrode being the anode. The current continued as long as the stirring was kept up. If the solution at the other electrode was now stirred and that first stirred permitted to come to rest, the current was reversed. It was also found possible to produce a current with both solutions agitated, by making the agitation at one electrode more violent than at the other. The direction of the current was always such that the more violently agitated electrode was the anode.

Dr. W. C. Moore pointed out that in the past too little attention has been paid to the dissolved air in the acid electrolytes. Very likely this dissolved air played a very prominent rôle in effecting the speed of corrosion. Referring to Dr. McKay's observation on the effect of stirring, Dr. Fink cited the problem of finding a suitable metal or alloy for acid pumps. An alloy may be very resistant to corrosion when quietly suspended in an acid solution and yet this same alloy is a complete failure when used in a pump for this same acid solution. Unfortunately, many of our investigators draw conclusions as to the merits of an alloy without submitting it to actual practical tests. Dr. C. J. Thatcher of New York described tests made on platinized electrodes. The potential readings were very largely dependent upon the rate at which the gas, O or N, was supplied to the electrode. Burnham E. Field suggested that some of Dr. McKay's results might be interpreted by taking into account the difference in oxygen concentration of the solution directly in touch with the tie rod and that some distance away. George B. Hogaboom said that in investigating the speed in pickling solutions he had obtained concordant results by resorting to the "alternate in and out" method of testing samples—that is to say, exposing the samples alternately to the solution and then to the air.

The Effect of Impurities on Storage Batteries

Mrs. Helen Gillette Weir of the Prest-O-Lite Co. gave a highly interesting account of the results of her investigations on the effect of impurities in the sulphuric acid of batteries. The presence of certain amounts of impurities in the electrolyte of a storage cell was studied to ascertain the effect on the electrical performance of the cell. The extent of the injury was determined by comparison of the electrical characteristics of the cells before and after contamination and by further comparison with normal cells included in the same series of tests. Of the metals tested only manganese and platinum produced intense injury when present in minute quantities. With these two exceptions, none of the impurities tested had a lasting effect on the cell voltages or on the ampere-hour capacity of the charged battery. In various amounts certain of the impurities were found to be injurious, either by increasing the rate of self-discharge or decreasing the life of the plates. Zinc, nickel and tin in small percentages were not detrimental to any of the electrical characteristics. The results of these tests indicate that, contrary to the general belief, most of the common metals and acids may be present in appreciable quantities without causing serious injury to the cell.

The Technical Man as a Citizen

Presidential Address by Acheson Smith

We expect shortly to print this admirable address in full and give here only a few excerpts. "This is the age of the engineer, but it is possible that we do not understand the full significance of that phrase. The present advanced state of civilization is mainly due to the technical men. In view of what has been accomplished by the engineer, it may sound strange to say that he is seeking recognition, but such is the case. What can the engineer do to procure such recognition? The leaders in the country are those who do a citizen's duty and a little more, over a term of years, and as a result find themselves the influential men in their community. Under a system of government where the illiterate and men of low ideals have an equal voice with the educated and men of high ideals, the only thing that can prevent liberty from destroying itself is intelligent leadership. Here is an opportunity for the engineer."

Saturday Sessions

Hydrogen and Oxygen

The first paper of the Saturday morning session was entitled "The Production of Hydrogen by the Use of Silicon and Sodium Hydroxide." The author, E. R. Weaver of the U. S. Bureau of Standards, described the generation of hydrogen by the "silicol" process, which has been found very adaptable for military and naval purposes. The non-combustibility of the materials used insures safety of transportation. The rate of reaction of ferrosilicon with sodium hydroxide, in the subsequent generation of hydrogen, depends upon the composition of the material, its fineness. the concentration of the sodium hydroxide and dissolved silicon in solution, and the temperature. The plant, of a small size, low cost and of high productive capacity, consists essentially of three parts: The solution tank, the generator and the washer. The merits of the process and comparative cost figures for materials were given.

The only considerable disadvantage of the method is its cost. With 85 per cent ferrosilicon costing $200 per ton and sodium hydroxide costing $4 per 100 lb., the cost of materials for 1,000 cu.ft. of hydrogen at 60 deg. F. and 30 in. pressure will be $4.60 for ferrosilicon and $1.50 for sodium hydroxide, a total of $6.10. When transportation and handling charges for the materials are added, the cost for materials alone is not likely to be less than $7 per 1,000 cu.ft. The labor and

capital charges on any plant which is used steadily become negligibly small. In any case they will probably be less than for any other method of generating hydrogen.

William G. Allan, research engineer of the Toronto Power Co., next presented a detailed account of the "Electrolytic Generation of Hydrogen and Oxygen, With Special Reference to the Utilization of Off-Peak Power." Mr. Allan discussed at length the economics of the problem and showed a series of curves which greatly facilitate cost computation. The utilization of "off-peak" power, for the purpose of generating these gases at cheap prices with a view to their use in large quantities in the chemical or other industries, was advocated. Special mention was made with a brief description and some illustrations of a new type of electrolytic cell, designed and developed by Mr. Allan. Basic constants and data used in calculations were given, and comparisons of the chief characteristics of the new cell with those of other existing types were submitted.

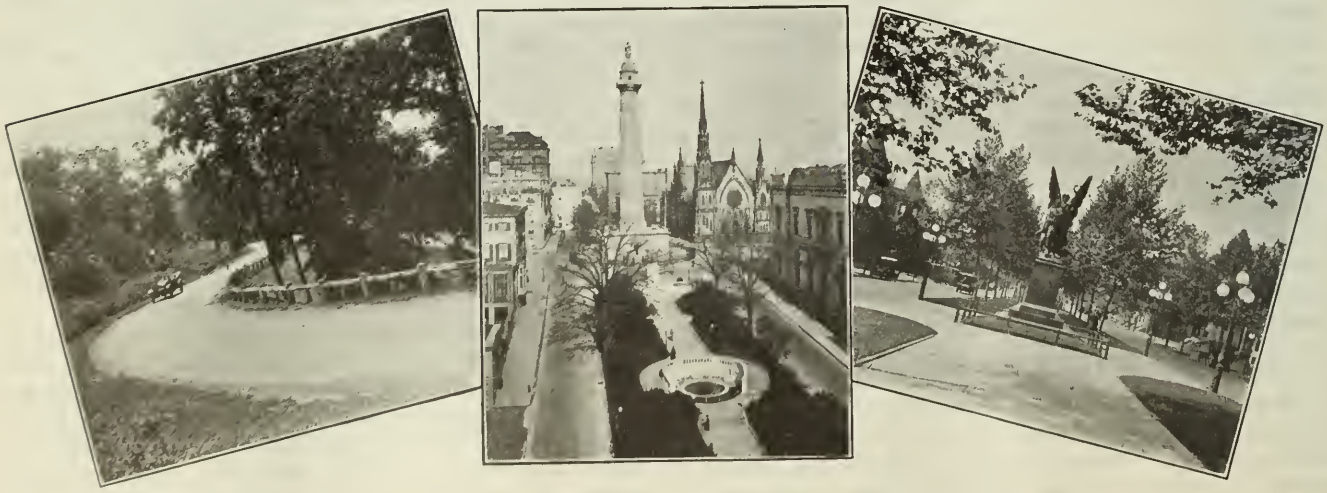
The Allan cell is adapted to operate under widely varying conditions of current density per square inch of projected electrode area, without too great a sacrifice of energy efficiency. It is thus adapted for operation at different rates of gas production, according to the cost of power at any particular time of a 24-hour day, during which it is conceivable that a power consumer has contracted for power under two or more different rates. The higher the rate of gas production the less the influence of the fixed charges in the total cost of the gases, while depreciation does not increase at a rate which is proportionate to the rate of gas production. As a result, at high current densities, the cost of power becomes the major item in the total costs of the gases, and where power is cheap, as in the case of "off-peak" power, the gases may be produced very cheaply, and many processes which up to the present have been excluded from consideration now come at least within the range of possibility, while others are definitely placed in the class of commercially feasible processes. Mr. Allan showed the influence and relative importance of the various items entering into the costs of the gases, and finally mentioned the many present and future possible uses of the two gases.

V. T. Stewart of Montclair, N. J., pointed out that the usefulness of hydrogen is greatly hampered by its outstanding property—namely, being the lightest known substance. He referred to the various applications of hydrogen, among others the use of the gas for certain metallurgical operations. Here hydrogen is of distinct advantage on account of its comparative inertness. In the annealing of ingot iron, the presence of an atmosphere of hydrogen modifies the properties of the metal enormously. An atmosphere of hydrogen is of distinct advantage in the cooking of certain kinds of paper pulp. The resulting stock is stronger and requires less bleach. Dr. Fink emphasized the importance of hydrogen as a reducing agent in many metallurgical operations. The high cost of electrolytic hydrogen as compared with coke or other carbonaceous reducing agents was often more than offset by the much lower operating and maintenance charges; due to the low temperatures at which many of the hydrogen reductions can be carried out, the furnace construction is simpler and less expensive and the labor costs are small.

Dr. Carl Hering of Philadelphia described experiments he carried out, electrolyzing acidulated water in a bomb. Pressures of about 34 atmospheres were attained. The potential dropped to 0.3 volt and apparently the gases at the electrodes were not evolved according to Faraday's law. Dr. Fred T. Kaelin of the Shawinigan Water & Power Co. emphasized the importance of Mr. Allan's contribution and mentioned many new uses for the gases H and O.

The Radium Content of Products of Low Activity

Dr. Victor F. Hess, chief physicist of the U. S. Radium Corporation, described a very ingenious but comparatively simple method he developed for the detection and estimation of radium when present at very low concentrations. Hess' method is a thousand times more sensitive than the best method known heretofore. When carnotite or other materials are filled into a space between two concentric spheres, the gamma ray effect in the center of the inner sphere can be calculated. This formula was taken as the basis of a direct method of determining the radium content of these substances. The samples were filled in wooden containers which were closed hermetically. The gamma ray electrometer was introduced into the center. The observed ioniza-



Photos by J. F. Hughes Co., Baltimore

VIEWS OF INTERESTING SECTIONS OF BALTIMORE

tion, expressed in absolute units (E.S.U.) reduced to normal pressure and temperature, multiplied by certain constants, gives directly the radium content per gram of material.

The method is sensitive enough to give correct figures for material with 10^{-10} grams radium per gram of material. It is very simple, and requires no chemical treatment of samples before the measurements.

The results on ore samples were compared with the results derived from the chemical analysis of the uranium content and were found to be in good agreement. In discussing Dr. Hess' paper, Dr. S. C. Lind, chief chemist of the Reno Station, Bureau of Mines, pointed out the great importance of possessing a method as sensitive as that devised by Dr. Hess. It finds practical application in the concentration of radium-bearing ores where chemical analysis and control fail. Furthermore the Hess method has a very wide application and does not require an expert, as in the case of the emanation method. Dr. Harlan S. Miner of the Welsbach Co. regretted that Hess' method was not applicable to thorium products.

Electromagnetic Motions in Electric Furnaces

Dr. Carl Hering discussed the new electromagnetic law he proposed some months ago. The new law is: In a system of electric current-carrying conductors any, and only such, mechanical motions of its conductors will tend to take place as will generate a counter e.m.f. somewhere in the electrical circuits. But whether or not this electrical version is the best one, the general law of nature on which it is based ought to apply to all electromagnetic systems as well, and it seems to follow in any case that our older restriction to only one possible force was unjustifiable. In general, according to the above law, any desired motion of the conductors (especially of the mobile liquid conductors or arc vapors in electric furnaces) can probably be produced electromagnetically by the current itself, if such a motion would produce a counter e.m.f. somewhere in the circuit, if the necessary freedom of motion exists, and if there is not also produced thereby somewhere else in the system an equal and opposite effect. The original source of energy must of course be able to provide the additional voltage to overcome this counter e.m.f.—that is, it must provide the energy for such motions. While theoretically there may be no limit to the intensity of the forces thus produced, in practice there is. A few pounds per square inch will, however, produce quite rapid motions of even heavy molten liquids. Strong forces require large currents, which tend to generate heat; such forces are, therefore, limited largely to furnaces in which this heat is useful.

Gas Pressures in Tungsten Vacuum Lamps

The Research Laboratory of the Westinghouse Co. has been studying the methods for the "Measurement of Pressures in Vacuum Type Electric Lamps." Dr. Duncan MacRae, research physical chemist, reported upon a new and simple method he devised for determining these low pressures.

The tip of the lamp is removed in an evacuated glass system by means of an iron plunger electromagnetically operated. The resulting pressure is measured with a McLeod gage and the pressure in the lamp before opening is calculated. The results of measurements on unflashed, flashed and life-tested lamps are given.

Dr. C. J. Thatcher, of New York, maintained that on the basis of his own experience red phosphorus does not combine with oxygen at very low pressures without "flashing" or ionizing the phosphorus. Accordingly the gradual rise in pressure after removing the tip cannot be accounted for by the reaction $2P + 5H_2O = P_2O_5 + 5H_2$. Dr. C. C. Paterson of the British General Electric Co., writing from London, suggested that this gradual rise in pressure was due to the formation of PH_3, on the basis of experiments carried out by his associates. "If Dr. MacRae's apparatus was not thoroughly dry before the tip of the lamp was broken, we should expect to find a generator of gas when it is broken." Dr. Paterson also emphasized the advantage of the Pirani over the McLeod gage.

Ortho-Amidophenol, Electrolytically Produced

The subject of organic electrochemistry has been interesting an ever-increasing number of members of the Society. Plans are under way for the formation of an organic electrochemistry division.

Oliver W. Brown and J. C. Warner, of the department of chemistry, Indiana University, investigated the commercial possibilities of the "Electrolytic Preparation of Ortho-Amidophenol."

All reductions of ortho-nitrophenol to ortho-amidophenol were carried out in caustic soda solutions and at a copper gauze cathode. Results of experiments show the effect of current density, concentration of caustic soda and ortho-nitrophenol in the cathode liquor, and temperature at different current densities on current efficiency and material yield. The quantity of amine produced was determined by a method involving diazotization with standard sodium nitrite.

As best conditions for the electrolytic preparation of *o*-amidophenol from *o*-nitrophenol in alkaline solution and at a copper cathode, the following conditions are recommended. Start the reduction with a cathode solution of 15 per cent NaOH containing 3 to 5 grams of *o*-nitrophenol per 100 c.c. Maintain a temperature slightly below the boiling point and use a current density of 10 amperes per sq.dm. When one-half of the *o*-nitrophenol has been reduced, add one-half the original amount of the nitro compound. After another such period, add a similar amount of *o*-nitrophenol. Continue the reduction with a current density of 10.0 amperes per sq.dm. until the concentration of *o*-nitrophenol has dropped to about 1.5 grams in 100 c.c., then lower the current density to 4 to 5 amp. per sq.dm. and the temperature to 60 to 70 deg. C. and continue the electrolysis until the concentration of *o*-nitrophenol has dropped to 0.8 gram per 100 c.c. Finish the reduction with a current density of 1 to 2 amperes per sq.dm. Under these conditions, a material yield and current efficiency of 97 to 99 per cent should be obtained.

Commenting upon Brown and Warner's method, Dr. C. J. Thatcher questioned whether it would be practical on a large scale, as it was very difficult to electrolyze at or near the boiling point. Furthermore, he knew of no diaphragm which would resist the destructive action of hot NaOH solutions for any length of time.

Electrodeposition of Metals

A very animated discussion was aroused by four papers dealing with electrodeposition. The first paper, by W. E. Hughes of London, was headed the "Idiomorphic and Hyp-idomorphic Structures in Electrodeposited Metals."

By idiomorphic structure is meant the structure

which results in a mass of rock or deposited metal when the crystals composing it have had the opportunity to develop their external forms freely.

By hyp-idiomorphic structure is meant the structure resulting from the fact that the component crystals (or the majority of them) have not had the opportunity to develop their faces and edges freely, but, owing to mutual interference, have been compelled to take their shapes from their surroundings.

It is suggested that these definitions are sufficient for indicative and descriptive purposes, though they may not be as exact as might be.

Microphotographs were shown of electrolytic copper, zinc and iron. One of the electrolytic iron photographs clearly demonstrated how upon increase in the free acid concentration of the electrolyte the crystal structure could be made to change from an idiomorphic to a fibrous one and then into a hyp-idiomorphic one by decreasing the acid concentration.

Briefly, the hyp-idiomorphic structure is that within the mass of deposited metal which corresponds to an idiomorphic structure on the surface. The former grows into, or becomes, the latter as deposition continually proceeds. The relation is analogous to that obtained between normal within and coarsely crystalline on the surface, or, again, between fibrous within and very finely crystalline, or apparently amorphous, on the surface.

"The Acidity of Nickel-Depositing Solution" was carefully investigated by M. R. Thompson of the Bureau of Standards. A simple method was applied to the quantitative measurement and control of the pH of nickel-depositing solutions by means of indicators. The pH characteristics of several types of nickel-plating solutions have been studied. Preliminary observations were made on the general effect of pH on the appearance and structure of nickel deposits and the range of pH used in commercial nickel plating was investigated. A plea was made for the inclusion of complete pH data in all future publications dealing with research on the electrodeposition of such metals as nickel, cobalt and iron.

Charles H. Proctor, of the Roessler & Hasslacher Co., heartily supported Mr. Thompson in his opinion that the pH values can be used as a control of nickel solutions. George B. Hogaboom, of the Scovill Mfg. Co., however, pointed out at length that the pH values were not always reliable and frequently very misleading. He found that pH readings are affected not merely by the hydrogen-ion concentration but also by the metal-ion concentration of the electrolyte. Two nickel sulphate solutions might give the same pH readings and yet their composition and the electrodeposits obtained be totally different.

Dr. E. A. Vuilleumier briefly described his contractometer[2]. A. K. Graham, of the University of Pennsylvania, commented upon the irregularity in the thickness of the deposit on the platinum plate of the contractometer and suggested that this irregularity might effect the bending of the plate. But Dr. B. E. Field of Niagara Falls maintained that such would not be the case. C. P. Madsen recited at great length the deceptive results obtained with the pH methods applied to nickel electrolytes. Impurities present in quantities as small as 1 part in a million were often enough to cloud the readings. Very much more important than the pH reading of a nickel electrolyte was a knowledge of the composition and properties of the anodes used. In defense of the pH method it was pointed out by Mr. Madsen and others that as a rule good and comparable results were possible with dilute solutions and not with concentrated solutions such as are used in plating operations.

Prof. W. G. Wood and T. Fuwa reported on an investigation carried out at the Massachusetts Institute of Technology on "The Throwing Power and Current Efficiency of Zinc-Plating Solutions." The subject is of great commercial importance. It was found that zinc-plating baths, the principal constituents of which are sulphate, fluoborate or zincate, show small throwing power, although satisfactory deposits may be obtained with sulphate baths when anode and cathode are plane and parallel to each other. Alkaline cyanide baths, having the composition

Sodium cyanide, grams	53.2
Zinc cyanide, grams	59.2
Sodium hydroxide, grams	43.8
Sodium carbonate, grams	9.5
Aluminum sulphate, grams	4.7
Lignol, grams	11.8
Water, c.c.	1,000

show high throwing power, moderately high efficiency, very low voltage and give continuously good results when operated under proper conditions. The proper conditions for operating the above alkaline cyanide bath continuously were determined and found to be as follows: C. D., 2 amp. per sq.dm.; temperature, 40 deg. C.; stirring, moderate; anode, composite of zinc and Duriron, the Duriron surface forming 30 per cent of the total anode surface. The use of an addition agent is necessary. Glue is fairly satisfactory, but "lignol" was found to be a better and cheaper material.

Mr. Hogaboom, in discussion, said that he, as a plater, interpreted the term "throwing power" to mean the ability of a solution to deposit metal in deep recesses. For example, certain nickel solutions will give a uniform deposit inside a shaving soap box (1 in. diameter x 3 in. deep) without an anode inside the box. Mr. Proctor found cyanide solutions better than sulphate solutions for zinc plating. Dr. Blum pointed out that there was a so-called primary distribution of the current which was practically the same for all electrolytes, no matter whether cyanide or sulphate. "Throwing power" refers to a deviation from this primary distribution. He felt that eventually we may be able to predict the throwing power of a solution on the basis of cathode potential current density and current efficiency of an electrolyte. Work along these lines is now being carried out at the Bureau of Standards. Copper cyanide is better than zinc sulphate. Agitation and heating of the electrolyte will decrease the throwing power. Mr. Proctor displayed an iron tube, about ½ in. in diameter, which had a uniform zinc plate on the inner wall. Mr. Hogaboom emphasized that with an electrolyte having good throwing power tubes would be plated evenly inside and out no matter how placed in respect to the electrodes.

Winnipeg as an Electrochemical Center

The concluding paper of the Saturday morning session was entitled "A New Hydro-Electric Power Development of Importance to the Electrochemical Industry," by M. C. Gilman of Winnipeg. An important low-cost hydro-electric power development is nearing completion in the Winnipeg district. Very soon there will be available 320,000 hp. and more than 250,000 hp.

[2]See *Mineral Industry*, October, 1921, p. 419; March, 1922, p. 109.

remaining for future requirements. The third plant, nearing completion, will represent an outlay of but $70 per horsepower, or decidedly less than at Niagara Falls. Raw materials for the production of abrasives, cyanamide, ferrosilicon, ferro-alloys, cobalt alloys, magnesium, aluminum, etc., are readily accessible. Copper and nickel deposits are plentiful. On one property 20,000,000 tons of this ore has been blocked out. Large deposits of gold-bearing molybdenite deposits have been located near High Lake. High-grade iron ore is also available within comparatively short economic rail haul.

Business Sessions

Dr. Hering Made an Honorary Member

At the meeting of the board of directors Dr. Carl Hering was unanimously elected an honorary member of the Society. Dr. Hering was one of the founders of the Society and has been one of the most active and loyal members ever since. He has a world-wide reputation as an electrical engineer. He was born in Philadelphia, March 29, 1860, and is a doctor of science of the University of Pennsylvania. He is a Chevalier Légion d'Honneur, past president of the American Electrochemical Society, of the American Institute of Electrical Engineers, of the Philadelphia Engineers Club and an honorary member of the New York Electrical Society. He has contributed lavishly to the scientific world and has published over 400 scientific and technical papers. He is the inventor of a number of electric furnaces and other apparatus. His "Conversion Tables" are an international handbook. His scientific interests are most diverse. He can discourse on the proper cultivation of mushrooms as freely as he can on the theory of Einstein or on the Steinmetz equations. The formal ceremonies, conferring the honorary membership on Dr. Hering, took place on the evening of April 27 at Johns Hopkins University, President Acheson Smith making the presentation.

CARL HERING
Honorary Member American Electrochemical Society

Joseph Richards Memorial Fund

Several members of the Society suggested raising a prize fund and devote the interest of it to the encouragement of original research and original contributions to the *Transactions* of the Society. A committee was appointed to investigate the matter and report back to the next board meeting.

New Subjects for Future Meetings

The following subjects were suggested for discussion at future meetings of the Society: For the fall meeting, Montreal, Sept. 21, 22 and 23. 1922, "Industrial Heating," which subject will be in charge of the Electrothermic Division, Bradley Stoughton, New York, chairman. The second subject for the Montreal meeting will be "Electrical Endosmosis," in charge of F. A. Lidbury, Niagara Falls. "Industrial Heating" will be largely concerned with the details in the construction and design of furnaces and ovens for low-temperature operation, such as are used in heat-treatment, glass annealing, ceramics, etc. The question of the selection of resistor, heat transfer, specific heat of materials, etc., will likewise be included. For the spring of 1923 meeting two subjects have been selected: "The Potential and Overvoltage of Aqueous Solution," in charge of Prof. W. G. Horsch, Massachusetts Institute of Technology; and "The Production and Applications of the Rarer Metals" (such as Zr, W, Mo, Ta, Co, Ti, etc.), in charge of the Electrothermic Division.

Election of Officers for 1922-1923

The new president of the Society is Dr. C. G. Schluederberg of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Dr. Schluederberg was graduated from the School of Electrical Engineering of Cornell University in 1902 and in that year entered the employ of the Westinghouse Electric & Manufacturing Co., taking up the company's college graduate apprenticeship course. After a year in the shops, he was transferred to the Pittsburgh sales office. In 1905 he entered upon company research work, doing electrochemical as well as post-graduate work at Cornell University. He continued at Cornell until 1908, when he completed this work and was awarded the degree of doctor of philosophy and a degree in chemistry. He also spent some time abroad on special investigations and subsequently became associated with the Carnegie Steel Company in electrical and metallurgical work. In 1910 Dr. Schluederberg returned to the Westinghouse company as commercial engineer in the supply department and from 1911 until 1915 was in charge of switchboard work. Since 1915 he has been assistant to the manager of the supply department, in charge of various phases of its work, including central stations, railways, syndicates, licenses and educational work. He is a member of a number of engineering and other societies and has been particularly active in the American Electrochemical Society. He has published a number of articles covering original research work on electrochemical activities and developments.

The new vice-presidents are H. C. Parmelee, editor of Chem. & Met.; Albert H. Hooker of Niagara Falls, and W. S. Landis of the American Cyanamid Co. The new managers are A. T. Hinckley of the National Car-

bon Co., W. M. Corse of the National Research Council, Washington, and William Blum of the Bureau of Standards. The new treasurer is F. A. Lidbury of Niagara Falls and the secretary is Colin G. Fink of 101 Park Ave., New York City.

Organization of the Divisions of Electrothermics and of Electrodeposition

At a meeting of the Electrodeposition Division plans were made for future meetings, members of the Council were selected and the following executives were inducted into office: Chairman, Bradley Stoughton, 10 East 44th St., New York; vice-chairman, John A. Mathews, Crucible Steel Co.; secretary-treasurer, Colin G. Fink, New York. Directors: George K. Elliott of Cincinnati, James H. Parker, Wyomissing, Pa., W. J. Priestley of West Virginia, and Dorsey A. Lyon of the Bureau of Mines.

The Electrodeposition Division elected the following officers: Chairman, George B. Hogaboom, 557 Stanley St., New Britain, Conn.; vice-chairman, Charles S. Witherell of New York; secretary-treasurer, William Blum, Bureau of Standards. Directors: Lawrence Addicks, New York; E. F. Kern, New York; F. C. Mathers, Bloomington, Ind., and O. P. Watts, Madison, Wis. Foreign representatives: W. E. Hughes of London and Bertram Wood, Melbourne, Australia.

Entertainments and Excursions

The local committee was very lavish with its entertainments and Messrs. Boynton, Rouse, Stone, Moore, Tillman, Boyles, Meade and others spared no effort in making the visit of the electrochemists a most enjoyable one. The weather man, too, smiled his best and accordingly the boat trip, the auto tours and the golfing were enthusiastically attended.

Thursday evening at Johns Hopkins University Prof. R. W. Wood delivered a most fascinating lecture on "Fluorescence," illustrating his remarks with many original experiments. Particularly interesting were the reproductions of tests made during the war in detecting secret messages in passports, etc. The nickel glass developed by Prof. Wood which will permit ultraviolet rays to pass through but not the visible was demonstrated and its value to convoys during the war pointed out.

Friday evening the members were the guests of the Engineers' Club of Baltimore. Prof. Roscoe R. Hyde introduced his troupe of trained red-eyed flies and guinea pigs and divulged to mere electrochemists the secrets and eccentricities of the Mendelian law. Of somewhat lighter texture was the spiel by Monsieur Cheval on "Rope as a Byproduct of the Yeast Industry." The whole trick lies in training the yeast bugs to multiply by addition instead of by division. Dr. Northrup introduced his famous "sneeze," Dr. Hering, assisted by "Lid," entertained the members with a selection of historical Section Q songs, and the climax of the "show" was the award of the Pickles Medal to H. C. Parmelee, master of the *Weekly Dope Sheet*.

Friday afternoon the committee had arranged for a glorious boat trip on the steamer Latrobe. It was an exceptional opportunity for "getting together" and making new friends. The weather was ideal and everybody was in the very best of spirits. Two stops were made on the way—the first at the United States Industrial Alcohol plant, the largest of its kind in the world.

DR. CARL G. SCHLUEDERBERG
President American Electrochemical Society

The storage capacity totals 18,000,000 gal. of molasses delivered at the plant in tank steamers. The daily production of alcohol amounts to 50,000 gal. of 96 per cent. As a byproduct, 3,000 lb. of carbonic acid is shipped per day. Formerly all of this gas was wasted. The fermentation tanks have a capacity of 138,500 gal. each.

The second stop of the Latrobe was at the plant of the Davison Chemical Co. Here the center of attraction was Dr. Patrick's silica gel. A number of very instructive demonstrations were made showing the wide commercial possibilities of the gel. Among the demonstrations was the manufacture of ice by the vacuum process, the drying of air for iron furnaces and the refining of oils.

For Thursday, trips had also been arranged for to many of the neighboring industrial plants—copper, oil refractories, glass and drugs. And, of course, there was golf. The Maryland Country Club is undoubtedly one of the very finest in the country.

Ladies' Entertainment

Mrs. Richard K. Meade, as chairman, with her staff of loyal helpers, gave the visiting ladies an exceptionally enjoyable time. Perfect weather contributed to the delight of an automobile trip through the Green Spring Valley, after which the ladies inspected Dr. Emerson's model dairy farm, where refreshments were served. After a lively card party at the Baltimore Country Club, the ladies were keenly interested to get a peek at Lord and Lady Astor, who were likewise being entertained at the club. Dancing at the Engineers' Club was enjoyed Thursday night, and a bounteous spread at the Hendler ice cream plant on Friday morning. A climax was reached Friday night, when at least forty ladies attended Fred Stone's inimitable play "Tip Top."

A Discussion of the Slip Interference Theory of Hardening

Hardness Caused by Dispersed Particles Is Due to a Dislocation in the Spacing of Surrounding Atoms Rather Than to Intrinsic Hardness of Particles Themselves—Maximum Hardness Does Not Involve Minimum Ductility—Extreme Cold-Work Actually Causes a Slight Softening

By PAUL D. MERICA
Research Department, International Nickel Co.

THE mechanism of the hardening of metals and alloys by cold-working has been much debated. I believe that the earlier of the two theories held widely at present was developed by Tammann and Heyn. They consider that as a metal is deformed cold—viz., below its equicohesive temperature range—it suffers internal slip along cleavage planes within each grain, first along those most favorably inclined to the direction of the applied stress, and subsequently and progressively along those planes less and less favorably inclined to this stress. As the deformation is progressively transferred to slip planes requiring applied stress, in consequence of their greater inclination to it, the metal is thus progressively hardened and its ductility exhausted by continued cold-working. Inasmuch as the adjacent grains have in general different orientations, the slipping cannot proceed in a parallel direction across them; each grain thus interferes with movement along the slip planes of its neighbor. Since this increases the resistance to slip, it increases the measured hardness of any such aggregate of grains.

However, the adherents of the so-called amorphous metal hypothesis, Beilby, Desch, Rosenhain and others, declare that the above explanation is not sufficient. They say that the increased hardness obtained by cold-working a metal is in part also due to the generation of a layer of relatively hard and viscous amorphous cement-metal along each plane at which slip has occurred, which amorphous metal acts to rigidify this plane and prevent further slip.

Limitations of Former Theories

Neither of these theories attempts to explain the natural hardening of metals—i.e., that by alteration in the chemical composition of alloys and obtaining in the fully annealed state. That is, however, the purpose of Messrs. Jeffries and Archer's hypothesis on the hardening of metals by slip interference.[1] Following more closely the former than the latter theory, they have taken a definite forward step and affirm that interference with slip along these cleavage planes within a grain may also be caused by the presence there of a second phase of any material either in atomic or in colloidal dispersion, these particles acting in a sense as keys. The increased hardness of solid solutions is thus explained by them. Furthermore, the hardness observed in steel, particularly manganese and high-alloy steels and in duralumin, seems to be imparted to a maximum degree when the hardening particles, cementite and $CuAl_2$ respectively, are present not in atomic dispersion but in molecular groups of perhaps colloidal size. They point out that the effectiveness of a certain per cent by volume of a keying material must in general increase as its degree of dispersion and fineness increases and are obliged to assume, in order to account for the phenomena observed in duralumin and steel, that this effectiveness, however, again diminishes when the particle has become so small as to lose its crystalline character. For this they give no explanation.

This theory has the advantage of presenting a readily visualized picture of the mechanism of hardening by dispersed particles within a metallic grain. It also agrees well with our experience in the effect of fineness of structure on hardness and strength. I believe that there can be no doubt that hardness in such cases is caused by the interference to slip caused by these particles and that in general this effect must increase with increased dispersion of a given volume of the particle material.

Messrs. Jeffries and Archer are inclined to think that the hardening action of dispersed particles when present in relatively small amount—from 1 to 10 per cent by volume—cannot be due to any added factor of cohesion introduced by the presence of the particles, but that these particles act merely to develop in a better manner the latent cohesion of the original metallic grain. They believe that this cohesion is entirely sufficient in all cases to account for the increased hardening observed. With this statement I cannot fully agree, although the modification of it which I should like to suggest is, I think, not fundamentally different from the sense of Jeffries and Archer in their development of this theory. My thought is that the added resistance to slip produced by the presence within the slip plane of a key particle is not literally due to the necessity of shearing this colloidal particle during the act of slip, but that from its presence there result additional atomic forces, chemical in nature, acting between this particle and the surrounding layers of atoms of the solvent grain.

Number of Keys Required to Lock Each Plane Once

That a strictly literal interpretation of the keying action is not desirable should be evident from the following considerations: In a round grain of metal (considered henceforth only in two dimensions for the sake of a simplification, which does not affect the results of the reasoning) of diameter D we may suppose that there are two systems of potential slip planes at right angles to each other, the individual planes being separated by a distance of 10^{-7} cm. It may readily be seen in Fig. 1 that all of these planes can be keyed by a double row of circular particles situated along a diametral line at 45 deg. to the planes; with particles to be

*Presented at a meeting of the Institute of Metals Division, American Institute of Mining and Metallurgical Engineers, Feb. 20, 1922.

[1] "The Slip Interference Theory of the Hardening of Metals," by Zay Jeffries and R. S. Archer, CHEM. & MET. ENG., June 15, 1921, vol. 24, p. 1057.

contiguous with one row staggered with respect to the other by half the diameter of the particle d. Furthermore this same number, n, of particles necessary to accomplish this could be arranged in practically uniform distribution within the grain in such a manner as still to key perfectly every slip plane once. We can regard this number of key particles, therefore, as the minimum necessary to key all slip planes and at the same time be present in uniform distribution. If p is the volume per cent (or, as we are taking it, area per cent) of the key particle material we have the following relations:

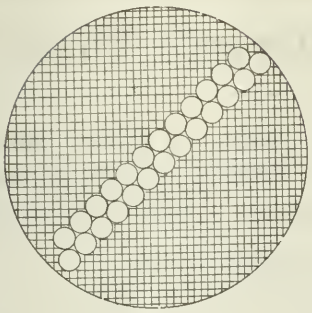


FIG. 1—DISTRIBUTION OF KEY PARTICLES TO KEY EACH SLIP PLANE ONCE

$$\tfrac{1}{2}nd = D \text{ and } \tfrac{\pi}{4}nd^2 = \tfrac{\pi}{4}D^2p$$

Let k be the number of times each slip plane is keyed. Consideration shows that k is identical with the ratio of half the length of the string of key particles to the diameter of the grain. Therefore $k = \frac{nd}{2D} = \frac{Dp}{2d}$

Now the force necessary to shear through all key particles on each slip plane, taking s equal to the unit shearing stress of the key material, is equal to $sdk = \frac{1}{2}sDp$, and is hence independent of the number of key particles on each plane and hence within the grain. This is not a reasonable conclusion if we require that the resistance to slip increase with the degree of dispersion, since it is not indicated.

Further, the order of magnitude of the particle necessary to properly key all slip planes is not convincing. Take the example of duralumin: In a grain 0.1 mm. diameter containing 5 per cent by volume of $CuAl_2$, all slip planes on any cross-section would be perfectly keyed as soon as the number of particles had increased to 800 with average diameter of 0.0025 mm., and on the above assumption further increase in dispersion would not involve any further increase in slip resistance. On this basis the particle size causing maximum hardness would also depend on the size of the aluminum grain, which does not seem reasonable.

Atomic Forces Also Required

I have preferred to ascribe the slip interference to atomic forces acting at the surface of the key particle and through one or more atomic layers of the surrounding matrix. Thus one can regard the particle as in a sense adsorbing the surrounding medium or solvent and surrounding itself with a film whose properties are markedly different than in the undisturbed atomic matrix of metal. In fact we must assume that within this film the cohesion is greater than without it and that it is to this added cohesion that the interference and consequent additional hardness is due. When you thus admit the strengthening of surrounding metal by means of surface film action, it is readily seen that with a small enough particle the whole mass of the grain could be so strengthened.

Thus, if m be the thickness of the film of metallic solvent adsorbed by the hardening particle, the volume of the grain so affected or adsorbed and strengthened is equal to

$$V = \frac{n\pi}{6}(d + 2m)^3$$

and

$$n = \frac{D^3}{d^3}p$$

From these expressions the ratio of this volume V to that of the grain is

$$k = p\left(1 + \frac{2m}{d}\right)$$

When the whole volume of the grain has been so adsorbed by the key particles and strengthened by their presence, $k = 1$ and

$$\frac{1}{p} = \left(1 + \frac{2m}{d}\right)^3$$

This requires that the particles of $CuAl_2$ to give maximum hardness in duralumin, following this condition, have an average diameter of about 10^{-6} cm., or 100 molecules, if we assume that the surface film of aluminum atoms adsorbed by each particle is 10^{-8} cm. in thickness. This seems a reasonable value and agrees well with that estimated by the authors.

I believe that this conception is not outside of or contrary to the sense of Jeffries and Archer's theory, although in one particular it differs from it in that it requires an actual strengthening effect exerted by each particle—either atom, or molecule, or group of molecules—on the atom layers of solvent immediately surrounding it and outside of its own limited volume. That we must grant that there is added cohesion in the case of at least some solid solutions I think we shall be obliged to admit after a consideration of the work which Mr. Bain[2] has been doing on the atomic structure of such solutions. Thus he finds that a copper lattice takes up zinc atoms to form high brass without alteration of the lattice, the zinc atoms merely substituting identically for the copper atoms. Now, since the lattice is not altered, we can scarcely in this case speak of a key action in a literal sense; nevertheless the hardness of the solid solution is greatly increased. In my opinion we are obliged to assume a different summation of atomic cohesions when the zinc atoms are in place than when they are not.

Adsorbed Atoms Involve Formation of Molecules

I am inclined to think that one cannot speak of an atom adsorbing surrounding atoms in the form of a film except in the sense that a new molecule is formed. Therefore the picture I have drawn above of the strengthening effect of small particles as due to the films of solvent metal formed around them must be considered as limited to molecules or groups of molecules. When the molecule is actually disintegrated into atoms and goes into atomic dispersion in true solid solution, this precise effect disappears and the resulting properties are due rather to the cohesion conferred simply by the atomic arrangement of the new atoms. It is conceivable that this cohesion may be much less than that due to molecule-groups with adsorbed solvent.

Thus it would seem that this slightly modified conception of the hardening theory is more elastic in that it more readily permits of an explanation of the less pronounced hardening effect of atoms of copper on aluminum than of molecule-groups of $CuAl_2$, and indicates that the reason for the apparent anomaly is in the

[2] "Crystal Structure of Solid Solutions," by Edgar C. Bain, read before the February, 1922, meeting of the American Institute of Mining and Metallurgical Engineers. Abstracted in CHEM. & MET. ENG., vol. 26, No. 14, p. 655, April 5, 1922.

nature of the field of force surrounding copper atoms and that surrounding the molecule or molecule-group of the compound. I may say that I am rather inclined to agree with Jeffries and Archer in their contention that in true solid solutions, both duralumin and austenitic steel, the copper and the carbon respectively are present in atomic dispersion.

Maximum Hardness Does Not Necessarily Involve Minimum Ductility

Another conclusion is drawn by Jeffries and Archer which does not seem to be quite in accordance with the facts, nor does it seem to be a necessary consequence of their theory. That is that maximum hardness is accompanied by minimum ductility. Now this is indisputably true in general, but I believe that there are exceptions to the rule. Of course we may dispute about the method of properly measuring ductility, and I for one must confess myself at a loss as to how that interesting property may be precisely measured. But accepting the current methods of its measurement, it is a fact that the hardening of duralumin during aging after quenching is often accompanied by an increase of ductility (as measured in the tensile test), particularly when the aging is carried out at lower temperatures. Furthermore, I recall some data presented some years ago by W. R. Webster[3] showing that the tensile test ductility of common high brass, a solid solution of zinc in copper, is greater than that of copper and of course it is also harder and stronger. In fact, it was striking to note that an addition of zinc to copper raised simultaneously the tensile strength and the ductility. Information from some of the brass manufacturers would be interesting as to whether high brass is actually more malleable and ductile in manufacture than copper. Looking at the matter from the standpoint of the slip interference theory, if the hardening is due merely to increased atomic force or bond on each potential slip plane, the slip planes remaining identically the same, there seems to be no reason for assuming anything in particular about how the ductility is affected by key particles. If anything is to be deduced, the conclusion would be that ductility is unchanged rather than that it is diminished.

I have for some time believed that our knowledge of hardness, both in practical and in theoretical respects, would be greatly improved if instead of measuring merely the hardness at one value of the plastic deformation, such as we do in the current methods, we should measure also the rate at which this hardness increases with deformation; we should determine in fact the "deformation rate of increase of hardness." For example, a comparison of this rate for aluminum and for quenched and for tempered duralumin would indicate whether the effect of the dispersed particles of copper or of $CuAl_2$ was merely to increase the force necessary to produce slip on each plane or whether they actually altered the mode of deformation. If the former, the ratio of the rate of hardening of any one of the materials to that of the other should be the same as that of any particular value of the hardness taken under corresponding conditions, whereas if the actual mode of deformation is altered by the presence of the copper there might not be such correspondence.

Softening by Extreme Cold-Work

The course of the hardness-deformation curve is known for many metals and alloys in the initially annealed state and it seems to be of the same general form for all which have been studied. And this is true whether we consider the stress-strain curve in a tensile test or the hardness of sheet after cold-rolling to greater and greater reductions. The unit force or stress required per unit of deformation (plastic or permanent deformation only is of course here considered) increases with progressive deformation, but at a progressively decreasing rate; finally—at least for copper and copper-nickel alloys—the rate passes zero and actually decreases. The cold-worked metal becomes softer. The latter phenomenon occurs in Monel metal, for example, after about 95 per cent reduction by cold-rolling.

Now this is certainly not what we might expect from a literal application of the theory of Tammann and Heyn. For in general the tensile stress required to produce slip on planes making an angle, θ, with the normal to the axis of the tensile stress is equal to $s \div \sin\theta \cos\theta$ when s is the shearing stress required to produce slip.

Now this stress is least when slip is occurring on the 45 deg. planes and is equal to $2s$, and it increases as the planes are affected, making a greater or a lesser angle, but its rate of increase is continually increasing, not decreasing, and it finally becomes infinite when the angle is either 0 or 90 deg. This conclusion does not fit the facts.

It is of course obvious that although an application of tensile stress equal to twice the shearing stress required to produce slip on each unit slip plane should produce slip on the 45 deg. planes of an aggregate of metallic grains, it cannot in general do so owing to the interference of grains whose slip planes do not lie in this particular direction. The stress required to start slip depends therefore on the arrangement of all of the grains composing the specimen and represents a statistical summation or average of the individual stresses required for each grain with its different orientation. Its application not only produces slip along some favorably inclined planes but along some which are less and even least favorably inclined and it serves probably also to rotate some grains bodily which could not otherwise take part in the deformation.[4]

We may consider then that each increment of applied load has to overcome the resistance of a certain combination of internal stresses, defined by the orientation and the size of the component grains, the total resistance amounting to the summation or integration over all of the infinitely small increments of resistance. What is the nature of these combinations? Whatever it may be, I think we may feel confident that there are combinations of varying probability of existence; thus one with all slip planes of all grains inclined at 45 deg. to the direction of the applied tensile stress is highly improbable, whereas one with all possible orientations and shapes of grain is the most probable. Now, although I am not in position to give this statement a rigid proof, it seems reasonable to assume since there is no type of unit grain resistance that is infinite (i.e., if a grain is so oriented that no internal slip is possible, the whole grain may be rotated by external pressure into a position in which this is possible), that the most probable combination of grains is

[3] *Proc.*, Int. Soc. Testing Materials, 1912, vol. 7, p. 6.

[4] See "Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformation," by Edgar C. Bain and Zay Jeffries, Chem. & Met. Eng., vol. 25, p. 775, Oct. 26, 1921.

characterized by the maximum integrated resistance to deformation. At least we can readily see that some, even many, other combinations, less probable, will have what may be seen as a minimum resistance.

If this be assumed to be true, we may derive the well-known form of the stress-deformation curve, since the number of combinations present of any arrangement is of course proportional to the probability of the arrangement. Therefore there are relatively few arangements present giving a low initial stress necessary to start slip, but as we increase the load to that characteristic of the most probable arrangement (assumed to require the maximum load to produce deformation) the number of arrangements or combinations present increases and in consequence the increment of deformation also increases, since each combination contributes a certain amount to the total deformation. The form of the stress-deformation curve should therefore be the same as that of one side of the probability integral, which indeed it is.

Now this is, of course, but a first approximation to the truth and is only perhaps valuable as a picture illustrating the statistical nature of deformation in metal grain aggregates. It neglects, for example, the plain fact that the very act of deformation alters the existing combinations for the next stage. But the explanation must lie in the latter fact that finally the metal becomes softer, the resistance of the combinations less to continued deformation. We must assume, I think, that finally the most formidable obstacles to ready slip are permanently removed by rotation, and the great amount of deformation already suffered has served to impart direction to the grains themselves, consequently increasing the number of less probable, less resistant combinations.

An interesting fact should be noted as a theoretical consequence of a statistical theory of deformation—namely, that the smaller the grain size (or more properly the smaller the ratio of grain size to size of test specimen) the greater should be the consistency of agreement between tests of the same material but different specimens. With test specimens involving few grains there should be quite marked variation noticeable, particularly in the yield point.

I believe that if we could by a sufficient study of the mechanical properties of single grains lay down the fundamental principles of grain slip and define the forces requisite to produce it, it would become possible to apply these principles by means of the statistical methods used successfully for gases to the consideration of the mechanical behavior of grain aggregates, and I have no doubt that this will one day be done. In that day metallography can properly lay claim to be as accurate a science as mechanics itself!

Cadmium Electroplating

The udylite process of cadmium electroplating covered by United States patents 1,383,174, 1,383,175 and 1,383,176, with other patents pending, embodies electroplating with the metal and subsequent heating in an oven for several hours at 150 to 200 deg. C., by which the cadmium coating is alloyed with the metal of the article coated. Late in 1921 this process was installed in eighteen plants and contracts were made for installations in nine more plants. This process has been applied to rustproofing locks, hardware, kitchen-cabinet and refrigerator trimmings and automobile parts.

New Customs Service Sugar Laboratory

The Bureau of Standards has been of assistance to the Customs Service of the Treasury Department in connection with the installation of the new laboratories for sugar analysis at Baltimore. This work, which is now practically completed, has included the installation of a chemical laboratory equipped with model benches with alberene tops, hoods and the necessary accessory equipment. A polarimetric laboratory has likewise been designed for the analysis of imported sugars.

Owing to the fact that the building which had to be utilized for this sugar laboratory was not equipped with all the appliances needed, it has been necessary to plan for the installation of a steam boiler, hot water heater, vacuum and compressed air outfit, as well as the necessary gas and electrical connections essential for work of this kind. By detailing a member of the staff of the bureau to Baltimore and through the loan of apparatus, it has been possible to carry out sugar testing at Baltimore even before the completion of the new laboratory. So far tests on the exchange samples of sugar for comparative purposes show satisfactory agreement between this and other laboratories of the Customs Service.

Tests of Various Types of Extinguishers for Zinc Dust Fires

Tests have recently been made by the Bureau of Mines on the effectiveness of water, sodium carbonate solution, carbon tetrachloride, silicon tetrachloride and a frothy mixture as extinguishers for zinc-dust fires. The frothy mixture extinguished the fire most quietly and effectively, so it was tested on a larger fire in 300 lb. of zinc dust. Three $2\frac{1}{2}$-gal. foam extinguishers smothered the fire, but danger of rekindling had passed only after lapse of several hours, due to retention of heat in the metal by the non-conducting foam blanket.

Thermal data show that water, carbon tetrachloride and carbon dioxide react with zinc with liberation of considerable heat, carbon tetrachloride producing most. However, no violent reaction occurred when red hot molten zinc was poured into carbon tetrachloride.

Although some fire extinguishing materials may be injurious or may be decomposed in fires to produce toxic gases or vapors, no especially poisonous gases or fumes are evolved from burning zinc itself or from the action of extinguisher material on the zinc.

To Investigate Paper Pulp Sources of Australia

According to a report which appeared recently in the *Industrial Australian and Mining Standard,* the West Australian Forests Products Laboratory and the Commonwealth Institute of Science and Industry have been authorized to carry on experiments on a semi-commercial scale, with a view to ascertaining whether it is possible to produce paper pulp from Australian timber. The federal government is to spend £2,490 a year in salaries and provide equipment for carrying on the investigations. In addition, the institute will spend a special appropriation in carrying out experiments. The Western Australian Government contributed £1,900 and certain newspapers £600, while other states have contributed £1,300. There was a private contribution of £100 from a Victorian paper manufacturing company. The Western Australian Government has offered £5,000 conditionally upon the Commonwealth Government finding a similar amount for the purpose of building a laboratory in Western Australia.

Handling the Finished Products of Industry—II

Preparing Yeast for the Market at the Plant of the Fleischmann Co. in New York City—Automatic Equipment Used for This Work—Principles of Handling Illustrated by This Installation*

By GRAHAM L. MONTGOMERY

THE FLEISCHMANN CO. has in New York City a plant in which yeast is compressed and wrapped in the various packages that are offered for sale. As yeast is used in baking and enters in other ways into food, it is necessary that the yeast and the plant in which it is handled be maintained in as absolute a state of cleanliness as it is possible to reach. In order to achieve this end in the best way it is necessary to use automatic machinery. The machinery originally installed was for mixing the yeast with water, compressing and forming it, cutting it into cakes of the desired sizes and wrapping and labeling these cakes. Conveyors have recently been installed to handle the yeast used in making the 1-lb. cakes which are supplied to bakers. This has worked a noteworthy improvement in this department.

The yeast is received from the manufacturing plant in Peekskill, N. Y., in a dry state, packed in paper cartons 14 x 15 x 11 in. and weighing 50 lb. each. Shipment is made by rail, motor truck and barge, the greater part coming by barge and being transferred at the pier from the barge to motor trucks which transport it the short distance to the plant.

Handling Bulk Yeast at the Plant

The yeast cartons are unloaded by hand from the motor trucks and then placed on a straight steel slide which leads from a hatchway in the sidewalk outside the building to a gravity roller conveyor in a basement storeroom as shown in the accompanying illustration. This conveyor runs across the upper part of this storeroom. It is hinged at one place so that an 8-ft. section may be raised to permit a clear trucking aisle. This gravity roller conveyor is of standard design, having ball-bearing steel tube rollers 1.9 in. in diameter, 16 in. long and spaced 4 in. on centers. The bed, rails and supports are of angle iron.

The cartons of yeast pass on this conveyor across the storeroom into the cold room. The conveyor enters and leaves the cold room through insulated refrigerator doors, which are kept closed when the conveyor is not in use, making it easier to maintain the required temperature of 22 to 24 deg. F. in this room. When yeast arrives at the plant faster than it can be used, it is unloaded by hand in this cold room and stored to await the time when it is needed in the packing room.

From the cold room the cartons pass out into the main basement of the packing building. The gravity conveyor leads by one 90-deg. bend directly to the intake of the vertical package elevator shown on the accompanying illustration. This elevator takes the cartons automatically from the gravity conveyor, one at a time, and raises them to the first floor, depositing them on another gravity roller conveyor. The construction of a vertical package elevator makes it necessary for the packages to be carried over the top of the elevator and lowered on the other side somewhat below the lowest part of the two head sprockets before a discharge can be made. This is due to the automatic discharging arrangement, which is made up of steel fingers. These fingers, stationary in location at the point at which it is desired to make the discharge, come opposite the spaces between the bars which make up the pivoted tray on which the carton or package is carried. As the tray is lowered it will be seen that the fingers of the discharger remove the package. It then slides down a short incline to be taken up by whatever means is there provided.

There is an advantage inherent in the fact that the elevator must deliver on the opposite side from that on which it receives its load in that it occasions no reversal of the direction of progress of the package through the conveying system and the resulting installation is cheaper and requires less space. In this particular case it is necessary to start the yeast in the packing process at a point near the ceiling of the room. For this reason it has been necessary to include in the system this additional elevating unit.

The short length of gravity roller conveyor at the outlet of the package elevator conveys the cartons to an inclined slat conveyor which elevates them to a sufficient height for the operations which the yeast is to undergo in the packing process. This will be seen by reference to the illustration. This inclined slat conveyor is 14 in. wide and 14 ft. on centers and is made up of roller chain and steel slats, the chain traveling in the guides provided in the frame for that purpose. The drive of this conveyor is by means of an electric motor mounted on the frame. This conveyor and the gravity conveyors at either end of it are suspended from the ceiling.

The cartons are discharged from this slat conveyor onto a gravity roller conveyor 12 ft. in length which conveys them around a 90-deg. bend and deposits them on the breaking table. Both the gravity conveyors on the first floor are the same in specification as that in the basement. When the carton reaches this point the yeast has completed the movements coming under class 1 handling as defined in the first paper of this series. Here it enters the forming and wrapping processes which come under class 3, as defined in that paper.

Preparation of the Yeast for the Wrapping Machines

At the breaking table the yeast meets with the first manual handling since it was unloaded from the truck in the street, except in cases where it has been held

*Part I of this series was published in Chem. & Met. Eng., vol. 26, No. 18, p. 823, May 3, 1922.

for storage in the cold room, in which case it had to be taken off the conveyor and put back on it by hand. Here it is dumped from the cartons against a steel plow situated in the middle of the entrance to a steel slide. As it strikes this plow it is broken up into smaller pieces. The steel slide takes these pieces down a short distance into the mixer. This mixer is a standard type of Werner & Pfleiderer dumping mixer of sufficient capacity to mix 200 lb. of yeast per minute. The yeast has reached this mixer in a dry and crumbly state. Here a certain amount of water is added and thoroughly mixed through the mass until it reaches the proper consistency for compressing.

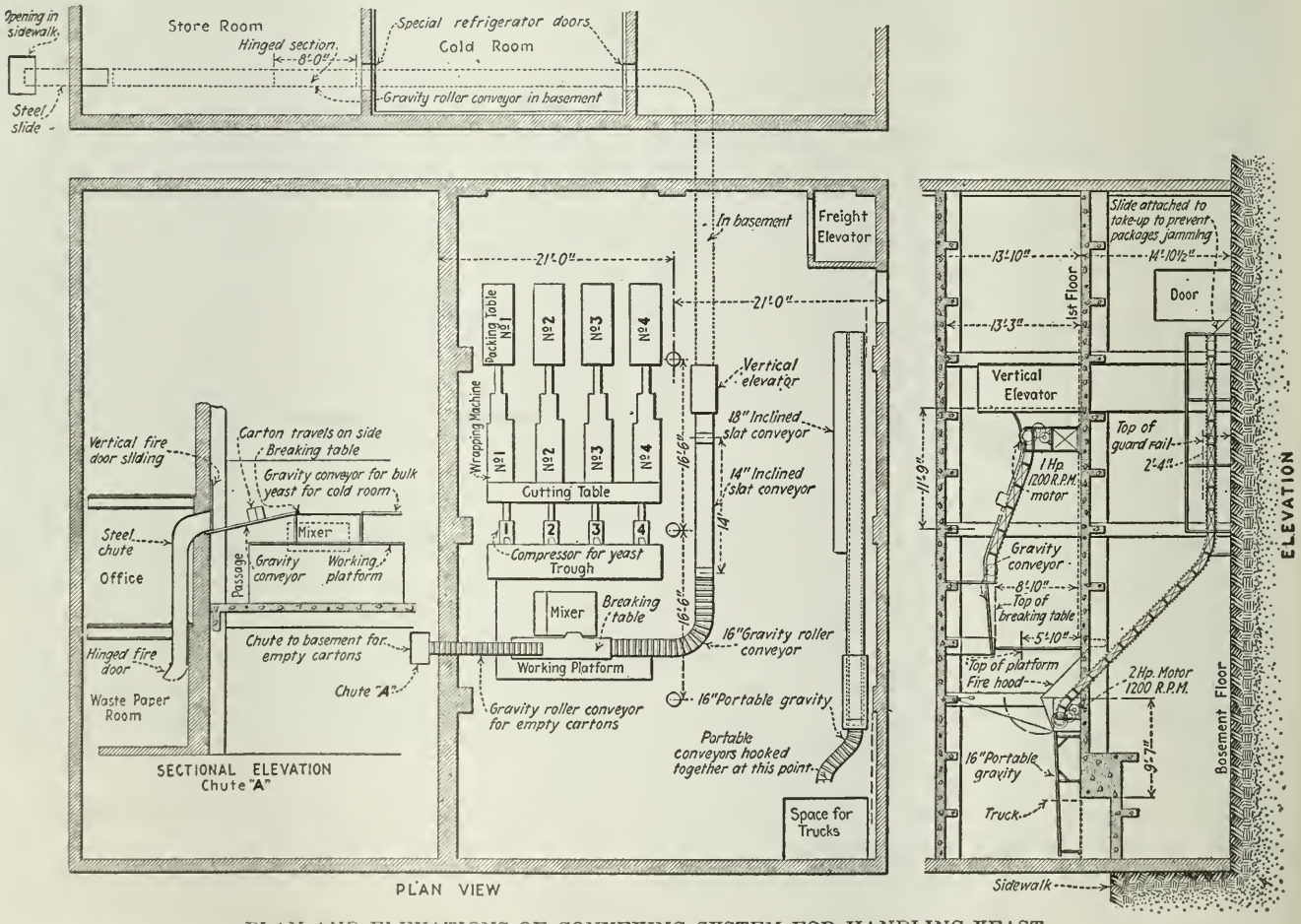
As soon as this mixing is completed, the yeast is dumped into the long trough marked on the accompanying drawing. There is not sufficient water in the yeast to cause it to flow readily and a worker stands here with a shovel and distributes the yeast in the trough to the four spouts which feed the four compressing machines. The yeast passes through these four spouts into hoppers which form part of the compressing machines. Under each hopper is a small screw conveyor which picks up the yeast and forces it into the compressing machine. From this it is extruded through a die in the form of an endless square bar with the exact cross-section required in the finished 1-lb. cake.

As the endless bar of yeast is extruded it passes onto a small flat belt conveyor, the forward motion of which is exactly timed with the rate of extrusion. This belt conveys the bar under the cut-off—at present operated by hand, but which without doubt will before long be mechanically operated. This cut-off is a tightly stretched wire mounted in a swinging frame with its plane of motion at right angles to the motion of the bar of yeast. When a measured length of yeast sufficient to weigh 1 lb. has passed under the cut-off it is operated and in this way uniform pieces of an exact pound in weight are obtained. The operator piles these on the table which is shown in the drawing as situated at the inlet end of the wrapping machine. Random samples are weighed on a scale mounted here in order to keep a running check on the operation.

Wrapping 1-Lb. Cakes of Yeast

The operator situated at the head end of the wrapping machine takes the cakes of yeast—both those from the pile on the table and those from the scale—and places them on the flat, feeding belt conveyor which forms the first part of the wrapping machine. They are put on this belt with their long dimension perpendicular to the axis of motion of the belt. This belt carries the cakes into the machine where each is wrapped and sealed in a transparent sheet of paraffined paper on which an appropriate label is printed. The wrapped cakes are then discharged from the machine onto a second flat belt, which conveys them to the packing tables. Here they are packed by hand in cartons for shipment. These cartons are placed, when filled and sealed with paper tape, on hand trucks and wheeled to the desired point for storage or shipment.

The wrapping machines, designed and patented by the Fleischmann Co., are extremely ingenious. They are simple in operation and have by far less parts than most machines which are built for this class of



PLAN AND ELEVATIONS OF CONVEYING SYSTEM FOR HANDLING YEAST

work. The capacity of each machine is fifty wrapped and sealed 1-lb. cakes per minute. The four machines installed in this plant thus have a total capacity in 1-lb. cakes of 48 tons for each 8-hour day.

Getting Rid of the Empty Bulk Yeast Cartons

The cartons from which the bulk yeast has been removed are placed by the workman at the breaking table on the empty carton conveyor. This is a gravity roller conveyor of the "sensitive" type. It is made up of 1⅛-in. diameter rollers spaced 2 in. on centers and 18 in. long. The rollers are carried by means of ball bearings on through shafts, these shafts being fastened in the angle iron frame of the conveyor.

The cartons are carried by this conveyor to the adjacent wall, where they pass into the 18 x 18-in. straight steel chute shown in section-elevation "A" on the accompanying drawing. This chute, provided with safety fire doors, held open by fusible links at its intake and outlet, takes the empties to the basement and discharges them on a receiving table. Here a workman collapses them and ties them in bundles for shipment back to the plant in Peekskill.

How the Product Is Handled in Shipping

As shown above, the wrapped cakes are packed in cartons directly adjacent to the wrapping machines and thus no handling is necessary there. All of these cartons which are for immediate shipment are wheeled directly to the shipping platform on the trucks on which they are placed when packed. This is possible because all these operations occur on the first floor of the building. Those which are to be placed in storage for future distribution are taken to the basement by freight elevator and placed in storage in the room in which the foot of the vertical package elevator is situated.

To take these packages from storage to the shipping platform an inclined slat conveyor 18 in. wide and 43 ft. on centers is provided. This conveyor starts with a horizontal run of about 20 ft. along the wall of the room in which the cartons are stored. This permits the loading of the conveyor through the entire length of this run. At the end of this straight run the slat conveyor raises the packages up through a hatch in the floor to a point somewhat above the level of the shipping platform. Here they are loaded into motor trucks for distribution by means of a length of portable gravity conveyor fed directly from the discharge of the slat conveyor. This handling in connection with the shipping is of the second class described in the first paper of this series.

Equipment Used in This Installation

The gravity roller conveyors used in this installation are all of standard design and size. The inclined slat conveyors are standard design, but these must always be built for the particular distance on centers and rise which the job requires. The vertical package elevator is a standard machine. The chutes, as with all chutes, are built to fit the job. All this equipment is painted with either aluminum paint or white enamel. This serves the purposes of cleanliness and also conforms well with the surroundings, for the rooms are finished in white enamel and white glazed tiles.

All the conveyors described above were furnished by the Dow Co., Louisville, Ky., except the vertical package elevator, which was furnished by the Robins Conveying Belt Co., New York City.

The decisive reason which makes the use of mechanical handling equipment and automatic machinery advisable in the installation just described is the fact that the product—a food product—must be kept scrupulously clean. While it may be possible with hand methods, it requires extreme care and much oversight to accomplish this end. The use of this equipment provides a much cheaper, quicker and less burdensome way of obtaining the desired result.

The combination of conveying equipment and automatic machinery here described has incidentally effected several other advantageous results for the plant. First, it has eliminated all possibility of confusion in the transportation of the yeast by preventing any crossings in the flow of material through the plant. Second, it has eliminated a number of workers who would otherwise have been employed and has thus made the work more economical. Third, it has lessened the burden of management in the plant because it is nearly automatic in operation. Fourth, by producing more completed packages in the same space, it has lessened the overhead of the operations. And fifth, because the cleanliness necessary has made a showplace of the plant, it has a distinct advertising value.

The writer wishes to acknowledge his indebtedness to L. L. Tieman, constructing engineer of the Fleischmann Co., and to H. Dunning of the Dow Co. for courtesies tion and drawings furnished.

Desulphurization of Cast Iron

It is commonly known that there are three practicable methods of reducing the amount or the effect of sulphur left in the pig iron coming from a blast furnace. In the first place, if sufficient manganese is present to form MnS with all the sulphur, this inclusion is not nearly so damaging as FeS existing in low-manganese pig. This expedient is the only one commonly used in the foundry. Secondly, if pig iron be kept molten in a mixer or other large container, MnS will float to the top and the sulphur burn off. Thus there is often a loss of one-third the sulphur between blast furnaces and steel furnaces from this cause, especially in high-manganese pig. Third, advanced foundrymen who have installed basic electric furnaces can produce irons containing as little sulphur as desired by correct refining under a carbide slag.

In the past there have been many rumors of substances which could be added to cupola metal in the ladle and sulphur forthwith vanishes. Many have been tried and found wanting. Speaking informally before one of the recent sessions of the American Electrochemical Society at Baltimore, Dr. Richard Moldenke said that a new physic of this sort (probably a potash compound) had attained a wide vogue in Germany, and he was anxiously awaiting receipt of a quantity of the material so it could be tested on American irons.

The method was said to be: After the hot cupola metal had been tapped into a ladle all the slag was carefully removed, and a small amount of the compound added. This readily alloyed with the iron, causing more or less violent circulation in the metal. In 4 or 5 minutes the currents had quieted down and a very thin slag appeared, which was absorbed by a little lime, and carefully skimmed. Analysis would then show that the metal, originally, say, 0.14 S, retained but 0.07 per cent. It it reported that half of this remainder could be removed by a second application.

Metallic Sodium—I

A Critical Review of the Development of the Metallic Sodium Industry—Wide Variety of Processes Based Upon the Electrolysis of a Molten Bath Consisting of or Containing a Sodium Compound Such as Caustic Soda or Salt

By HOWARD E. BATSFORD

In THE attempt to prevent a duplication of effort in the further development of metallic sodium work, and to provide an easy way for the beginner to get an insight into the practices of those men who labored very diligently in the field of alkali metal production, the author has made a summary of all the available data on this subject, condensing it in such a manner that there is very little repetition, except for comparison.

An attempt has been made to explain or comment on the important parts of each patent, with a view to showing why the particular patent is not now in commercial operation. The greatest fault of the inventor seems to be in trying to make the apparatus complicated, which instantly means greater cost, difficulty in construction, and finally costly operation and replacement of parts. In many cases the patent is not made in accordance with the actual apparatus in question, since the inventor felt compelled to disguise his real secrets so that they are unrecognizable.

Naturally, the largest share of the earlier work was carried out by chemical means, but in the early '90s electricity became more available and men turned to it as to a panacea for all ills. One of the greatest drawbacks to sodium reduction from its salts was the extreme temperature required; the electrolytic cell seemed to solve the temperature problem but introduced other difficulties such as metallic fog, contamination of other materials by selective depositions, and destruction of cell and electrode material. These evils have slowly been eliminated until today there are on the market, or rather available for commercial use, cells for making metallic sodium of high purity from either fused caustic soda or fused salt, at prices which make it profitable to manufacture, provided the market for the finished product is large enough.

Electrolytic Production of Metallic Sodium

There had been several attempts to make sodium electrolytically after Davy produced small quantities of it with his voltaic cell, but Matthiessen, following the lead of Bunsen, in 1855 succeeded in making it by electrolyzing a mixture of salt and calcium chloride in the proportions of 2 NaCl to 1 $CaCl_2$. This mixture had been dehydrated by heating with ammonium chloride and freed from basic salts.

The troubles encountered by the latter were noticed by Hopfner, who sought to avoid them by using soluble anodes such as copper or silver. These were expected to retard the losses due to solution of chlorine in the melt and the resultant reaction with the sodium, but proved of no avail, since the chlorine gradually passed through the electrolyte and attacked the sodium.

In 1890 Grabau made a cell in which he used bell-shaped compartments for collecting the sodium and chlorine. These were quickly destroyed and were replaced by the formation of solid electrolyte on the walls. His explanation was that the corrosion was due to leakage of current more than to the corrosive action of the electrolyte. The frozen layer was kept in condition by cooling the annular metal walls of the cell.

Grabau made further use of a mixed electrolyte for reducing the melting point of the bath, as Matthiessen and Bunsen had done before him. The bath used was 3(NaCl, KCl) + $SrCl_2$.

The sodium produced contained about 3 per cent of potassium but no strontium. Barium chloride does not melt so easily, and calcium chloride is so difficult to free from water that he preferred strontium chloride to the two others. The chief causes of failure seem to be the high voltage, frequent clogging of cells and necessity of careful attention.

Grabau figured that at the high temperature necessary for the operation great loss of metal occurred owing to formation of sub-chloride of sodium. This sub-chloride was partly oxidized at the surface of the bath and partly diffused to the anode, where it combined with the chlorine.

The Castner Process

In 1892 Hamilton Y. Castner made very important additions to the sodium industry by discovering a process by which metallic sodium could be made commercially from fused caustic soda. Fig. 1 shows the cell as described in U. S. Pat. 452,030; May 12, 1891.

This process consists in electrolyzing caustic soda constantly maintained at not more than 20 deg. above its melting point; also in using a gauze or screen between the electrodes and a superimposed dome for collecting the metal. The temperature must be kept low to prevent re-solution of sodium metal by the bath, and recombination, which takes place actively at higher temperatures.

Caustic soda melts at 308 deg. C. if pure, but down to 300 deg. C. if containing slight impurities.

It is electrolyzed preferably within 10 deg. of its melting point but never above 325 deg. C.

Within 5 deg. of its melting point almost the theoretical quantity of sodium is obtained, at 10 deg. above about 90 per cent, and this is the best obtainable in commercial practice. Above this the yield decreases very rapidly and at 20 deg. above its melting point recombination is as active as decomposition and the bath yields no metal, but lies "dead."

On commencing to pass the current through melted caustic soda, any water present is at first decomposed, evolving hydrogen and oxygen only until every trace of water is gone. After that sodium and hydrogen

Note: Complete references to all the work discussed will be found in the chronologically arranged bibliography at the end of the second part of this article.

together appear at the cathode and oxygen at the anode. These must be kept rigorously separated or re-oxidation of the sodium will occur, and the hydrogen will be oxidized, with an explosion.

Borchers made a study of the production of sodium and arrived at the following conclusions in 1894:

For best electrolysis:

1. Alkali metal must be deposited at a metallic (iron) cathode.
2. Cathode space must permit of collection and removal of metal without the latter coming in contact with reducible substances.
3. The anode must be of carbon.
4. The anode space must permit of the easy removal of the halogen, and its walls must be constructed of material capable of withstanding the action of halogens and haloid salts.
5. No metallic particles should be present in the melt between the poles.
6. All the parts of the apparatus must be constructed of fire-resisting material.

In 1902 Janeczeke made a special study of the decomposition voltages occurring in the electrolysis of fused caustic soda.

At temperatures corresponding to the melting point of caustic soda, as we have seen before, the sodium is absorbed during electrolysis, as is also oxygen; at slightly higher temperatures these products are absorbed so rapidly that there is no decomposition.

Hydrogen may be formed primarily by deposition at the cathode or secondarily by action through the sodium and water formed at the anode.

Janeczeke says that the following reaction takes place:

$$NaOH + Na = Na_2O + H$$

Therefore, there are present H-ions in small number in the fused anhydrous caustic soda.

The decomposition voltage was found to be about 1.3 v. for caustic soda; below 1.0 v. at the cathode a quite lively generation of hydrogen takes place, the oxygen generation taking place promptly at 1.3 v.

The second decomposition point in the voltage curve is at 2.1 v. At 2.4 v. stream lines seemed to go out from the cathode into the melt with flashes of gas. These were apparently sodium particles which reacted with the caustic soda. From this and other data it was assumed that 2.2 v. represents the point at which metallic sodium is formed.

Reactions During Electrolysis of Fused Alkalis

LeBlanc and Brode published in the same year (1902) the results of their observations in *Zeitschrift für Elektrochemie* on the electrolysis of fused NaOH and KOH, as follows:

At the anode oxygen and water are formed, this water reacting with the sodium freed at the cathode with the evolution of hydrogen.

Since one equivalent of water exists for two equivalents of sodium, a current yield of 50 per cent is the maximum obtainable in such a process as that patented by Castner. In fact, the yield generally runs around 40 per cent.

At high temperatures sodium dissolves in the melt, causing evidently strongly depolarizing properties in the melt at the anode. The depolarizing effect of the dissolved sodium was so great that only at high current densities could oxygen be formed. Under these conditions the gas formed at the anode was a mixture of equal parts of hydrogen and oxygen, or detonating gas mixed with hydrogen. This throws some light on happenings in the industry.

Sometimes the cell works badly, makes little sodium and almost every minute has an explosion. It is then too hot, the melt is dissolving too much sodium, it depolarizes partly the anode, it partly reacts with the moisture present, and forms rich mixtures of detonating gas which explode.

At a lower temperature, on account of the diminished solubility of the sodium in the melt, the depolarizing effect at the anode and the formation of detonating gas is reduced to a minimum. The Castner apparatus takes the hydrogen and leads it upward inside a wire gauze along with the metallic sodium, neither being permitted to pass across to the anode.

We have here the apparent paradox, that at low temperatures hydrogen is formed at the cathode and at high temperatures it occurs at the anode. Whether the gas evolution is visible or not at the higher temperature depends on the current density.

The anodic gas generation is not, as Castner believed, a result of the increased solubility of oxygen in the melt, but it is a result of the depolarizing action of the dissolved sodium. If the former were true, we would

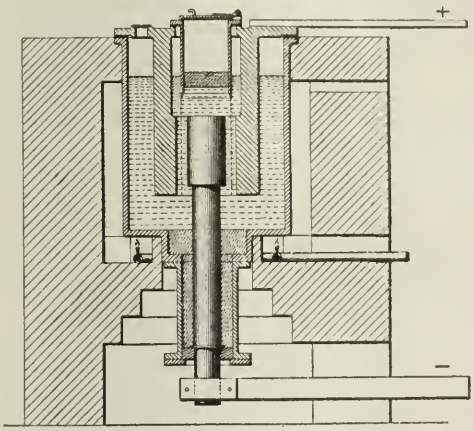


FIG. 1—CASTNER CELL

have anodic hydrogen, but with the latter we have free oxygen and the formation of water.

If sodium peroxide is dissolved in the melt, it has the same depolarizing action as the metallic sodium, but at the cathode.

In pure caustic soda melt there is nothing which exerts a depolarizing action at the anode or cathode, and on this account only small currents pass through the electrolyte at low terminal voltages.

There exist at the anode peroxide and at the cathode dissolved sodium, both of which act as depolarizer for the other electrode, and on continued electrolysis, the following reaction takes place:

$$Na_2O_2 + 2Na = 2Na_2O$$

With water at the anode the following reaction:

$$Na_2O + H_2O = 2NaOH$$

A part of the sodium also acts directly on the water. According to which reaction predominates, we have a melt saturated with sodium or sodium peroxide. Luckily we are able to get anodic or cathodic polarization at will, if we allow fresh electrolyte to flow either from anode to cathode or vice versa.

In order to get good yields of sodium, the following precautions are in order:

1. Do not let the water formed at the anode reach the cathode.
2. Get a good diaphragm.

Pure anhydrous caustic contains no H-ions or O-ions but only Na- and OH-ions, and is very hygroscopic.

In a later article by the same authors, nickel was selected as material for anode, since it does not behave as soluble anode. At least, the amount of dissolved nickel in the melt is insignificant in comparison with that which should be dissolved in accordance with Faraday's law. It is very small and easily within experimental error.

In the same year Thomas Ewan electrolyzed fused NaOH in a cell with a diaphragm of sodium aluminate or alumina or a mixture of both. A current of air (or a suitable gas) was passed over or through the electrolyte to remove water.

Acker Process

At the same time Acker patented his process for making caustic soda from fused salt, with the evident desire of finally producing metallic sodium. For this work he used graphite anodes, dipping into a bath of fused salt, which in turn covered the molten lead cathode. The lead, which was circulated through a subterranean chamber in the iron jacket of the furnace, absorbed the sodium with the formation of lead-sodium alloy. This alloy, entering another chamber in its circulation, was treated with live steam and caused to yield up its charge of sodium, with the formation of strong and pure caustic soda. The lead then returned to the cell for further sodium.

The chlorine gas left the furnace through a pipe at the top under a slight suction and was passed into lime liquor for the formation of chlorine products. It contained about 10 per cent chlorine and 90 per cent air.

The current used was 6,000 amp., the voltage 7 v. and the current density 2.9 amp. per sq.cm.

In 1903 Becker designed a cell for making sodium from a mixture of caustic soda and carbonate of soda. He kept the center of the cell molten and the walls frozen, thus keeping the walls perfectly insulated.

In 1904 C. F. Carrier reported some tests made with proportions of Na_2CO_3 up to 66 per cent. There was no improvement over the Castner process, and no evolution of CO_2 was detected between 330 and 630 deg. C.

Use of Alternating Current

Hambuechen made a study of the electrolysis of NaOH by alternating current with the following results:

The property of aluminum electrodes, which permit the electricity to pass in one direction only, is made use of for electrolyzing the caustic soda.

NaOH is fused in an aluminum vessel, in which is placed an aluminum electrode surrounded by an iron electrode; a perforated aluminum diaphragm is interposed, insulated from the aluminum electrode by a porcelain sleeve.

Alternating currents of 9 amp. at 4 v. gave a good yield of sodium under careful temperature regulation, with very little corrosion of the aluminum.

Cost Data on Castner Process

In 1906 C. F. Carrier published the following figures and facts concerning the Castner process:

Advantages:

Low melting point of bath.
Simplicity of the apparatus.

Disadvantages:

High cost of raw materials.
Low ampere efficiency.
Small size of the units.
Constant explosions during process.

Ampere efficiency is theoretically 50 per cent, since for every atom of sodium liberated an atom of hydrogen must also be formed.

The metal is removed in driblets by dipping out with a spoon, so the latter item may be a considerable factor.

COST FIGURES (1906)

Daily production	1 ton of sodium
Ampere efficiency	40 per cent
Fall of potential	5 v. per cell
Capacity of cells	1,200 amp.
Capitalization	$30,000

360 days per year; 24 hours per day.

COSTS PER YEAR

650 tons NaOH @ $45	$29,250
725 hp.-yr. @ $20	14,500
Thirty men @ $2 per day per man	21,600
Management and expert labor	9,000
Interest and depreciation (15 per cent)	7,500
General expenses and selling, 5 per cent of sale price	9,000
Miscellaneous supplies	1,000
Total	$91,850
Yearly production, 720,000 lb.	
Approximate cost per lb.	12.7c.

In 1905 Edgar A. Ashcroft invented a cell in which he electrolyzed fused soda in one compartment with graphic anode and molten lead cathode; in the second, to which the sodium alloy flowed, he used the above-mentioned alloy as anode and a nickel rod as cathode. By suitable means for controlling the temperature of the alloy, he claimed the possibility of running the process with a bath of molten caustic soda in the second cell.

His current density was 2 to 10 amp. on the anode surface and 10 amp. on the cathode surface; his voltages 8 in the first compartment and about 2 v. in the second. He claimed current efficiencies of between 80 and 100 per cent in both cells under properly regulated conditions.

The lead, after electrolytic separation of the sodium, entered the first compartment for a fresh charge. The idea was novel, but does not seem to be operating on a very large scale.

Fitzgerald described the Castner process as operated by the Niagara Electro Chemical Co. at Niagara Falls, N. Y., under the management of the Roessler & Hasslacher Chemical Co., pointing out particularly the manufacture of oxone from fused sodium peroxide. When treated with water 1 lb. of this substance yields 2.08 cu.ft. of oxygen gas, a fact which has led to its general use in hospitals as a reliable source of gas for resuscitation.

Carrier Fused Salt Cell

C. F. Carrier in 1906 patented a cell in which he electrolyzed fused salt. (See Fig. 2, taken from U. S. Pat. 830,051; Sept. 4, 1906.) For this purpose he had the anode compartment equipped with graphite anodes and the cathode compartment, which was on the other side of a division wall, equipped with a flat iron plate for cathode. The intermediate electrode was molten lead, which was caused to flow back and forth by the action of two heavy plungers.

The melt in the cathode chamber was fused caustic soda kept just a little above its melting point. The cell was started by piling a little salt around the anode, which was lowered almost to the lead (the latter being in molten condition). When an arc had been formed between graphite and lead, some of the salt melted from the intense heat, and by gradually drawing the anode away from the lead and feeding in salt the bath was built up. Care had to be exercised at this time not to pass the current through the cathode, otherwise the lead would be attacked due to absence of sodium.

When, however, the bath was partly built up, the current was put through the regular channels.

The sodium was deposited in the lead, which conveyed it to the cathode compartment, there to be set free at the iron cathode and collected under paraffine after its exit from the overflow pipe.

To prevent shorting of the current from cathode to

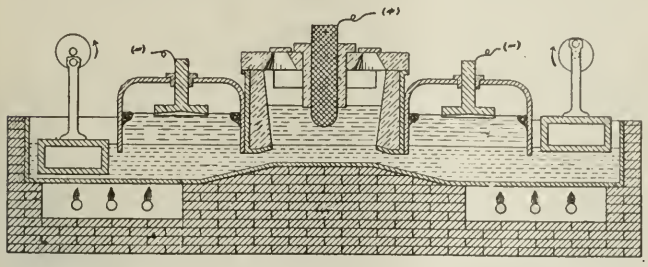


FIG. 2—CARRIER FUSED SALT CELL

bell-covering compartment, a water-cooling pipe was placed on the inner edge of the bell-shaped top of the cathode compartment. This permitted the bath to be kept in solid condition, and hence a good insulator.

One of the chief difficulties which seems apparent in this type of furnace is the control of temperature in the furnace. In spite of the inventor's claims to regulation by means of the water cooling, there still remains the fact that the temperature must drop from about 800 to 300 deg. C. in the space of a few inches. It has also been found that the iron castings do not hold lead tightly and are subject to deterioration, hence it seems like placing too many eggs in one basket.

Darling Process Using Sodium Nitrate

J. D. Darling had meanwhile invented a process for making metallic sodium from sodium nitrate, carrying on the experimental work at the Philadelphia plant of Harrison Bros. & Co., Inc. Fig. 3 represents the cell as described in U. S. Pat. 517,001; March 20, 1894.

For anodes he used carbon or platinum rods set in compartments with perforated inverted bell of aluminum enveloping them. This bell was fitted with perforations sloping down from the inside to prevent the outward flow of the gases generated during electrolysis. The iron pot served as cathode, air being excluded by a tight cover. Sodium nitrate was melted in the pot, the top cover and electrodes were set in place, and the current was turned on. The molten nitrate was reduced to nitrite of soda with the addition of sodium oxide, the latter dissolving in the nitrite of soda. The nitrite of soda and the sodium oxide were then decomposed, permitting the liberated sodium to float to the top of the bath and pass down through a suitable outlet pipe. Gaseous NO_2 and O_2 passed off through an opening in the top of the anode chamber and were led through absorption bottles containing water, thus forming nitric acid and permitting the oxygen to escape.

He later invented a porous diaphragm of portland cement and improved his cell, and attempted to market his process. Unfortunately the explosion hazard was too great a drawback, and the process was abandoned about the year 1905.

Mixed Baths Containing Fluorides

In 1907 Seward and von Kügelgen got out five patents covering bath mixtures and parts of apparatus for making metallic sodium from salt.

The first bath mixture consisted of 4 parts $CaCl_2$, 2 parts NaF and 1 part $BaCl_2$ and was considered a great improvement over previous mixtures, which included potassium salts, because the latter contaminated the sodium metal. This bath melted below a red heat and was advantageous because the alkaline earth metal was not decomposed by the potential used.

The second mixture was composed of 15 parts of calcium and sodium fluorides combined with 100 parts NaCl. It was found to have a much lower melting point than NaCl, and the fluorides had a higher decomposition voltage, hence were practically unconsumed.

The first cell consisted of an iron vessel containing a bath of molten salt. Instead of an iron bottom this pot had one of firebrick or magnesia brick. The anode consisted of the walls of the iron pot and the cathode was molten lead in the bottom of the brick furnace. Halfway down in the cell was an iron wire diaphragm set horizontally in the brickwork so as to separate the anode from the cathode compartment.

During electrolysis the sodium collected on the surface of the electrode and flowed down through an overflow pipe to an outside container; the chlorine attacked the lead, forming lead chloride, which, being heavier than salt, remained at the furnace bottom and was drawn off by a suitable pipe.

One of the main objections to this type of cell is the difficulty of construction and operation. The diaphragm is set rigidly in the furnace walls and cannot be removed

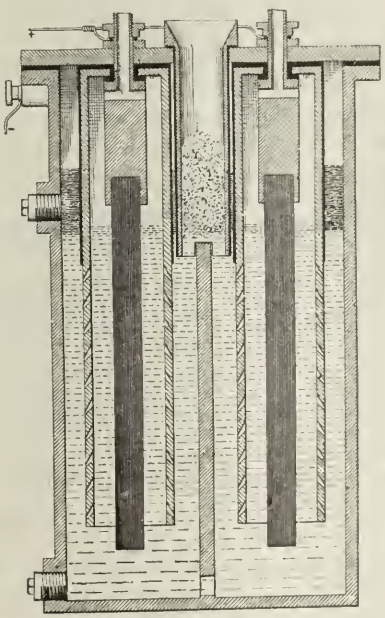


FIG. 3—DARLING CELL USING SODIUM NITRATE

without tearing down the furnace. There is always a large body of sodium on the surface of the bath, which is objectionable.

The second cell consisted of an iron pot as anode lined with magnesia brick at the bottom and fitted with graphite blocks at the top. The cathode is set in the center of the pot surrounded by a water-cooled casting, an arrangement which caused salt to remain molten on the walls of the cathode compartment and prevented leakage and corrosion.

In 1909 G. Van Hevesy made a study of the electrolysis of fused alkalis with especial reference to the

solubilities of the alkali metals in the melt, and arrived at the following tables:

SOLUBILITY OF Na IN NaOH

Temperature, Deg. C.	Grams Na in 100 g. NaOH
480	33.3
500	10.1
610	9.9
670	9.5
760	7.9
800	6.9

SOLUBILITY OF K IN KOH

Temperature, Deg. C.	Grams K in 100 g. KOH
480	8.0
700	1.0

In spite of the rapidly decreasing solubility of the Na and K at higher temperatures, the electrochemical efficiencies in electrolysis of NaOH and KOH rapidly decrease with rising temperature as a result of the increase of velocity with which the metal diffuses into the molten electrolyte.

Measurements show this velocity to be greater for sodium than for potassium, and in the former case to increase rapidly above 340 deg. C., at which point the efficiency for NaOH electrolysis sinks nearly to zero.

Action of Fused Caustic on Metals

At about the same time LeBlanc and Bergmann made a study of the influence of metals on fused caustic, which gave an idea to the chemical engineer as to what to expect in the construction of cells for electrolysis of this chemical.

For the tests they prepared NaOH which analyzed as follows: NaOH, 92.6 per cent; Na_2CO_3, 4.95; H_2O, 2.45. Minor impurities neglected.

The carbonate was not taken out, for the caustic in general use contained about 5 per cent and the tests were not to be made for a special product.

They found that:

Silver is attacked by NaOH.

Gold is not attacked.

Copper is not attacked by NaOH at 435 deg. C., but at 563 deg. C. there was a noticeable reaction which increased at higher temperatures.

Iron does not react with NaOH in a marked manner at 400 deg. C., but at 700 deg. C. the reaction is very lively. After cooling, the melt appears dark red and leaves a dark red precipitate on solution in water.

Copper, on the other hand, leaves a dark blue precipitate.

Nickel does not react with NaOH at 400 deg. C., but at higher temperatures it reacts with the formation of a green melt which yields a black residue in water.

Platinum does not react at 400 deg. C., but is somewhat soluble around 700 deg. C. The melt on solution in water leaves behind a black residue.

Zinc acts on NaOH with generation of water and the residue consists of $Zn(OH)_2$.

Aluminum is slightly attacked by NaOH at temperatures ranging from 450 to 500 deg. C.

Magnesium reacts with NaOH at 400 deg. C. in a nickel crucible in a very vigorous manner.

Sodium had to be tried in a nickel crucible, since gold is dissolved in molten condition. It reacts with NaOH at 450 deg. C. in a slight manner, and more vigorously at 550 deg. C. The water solution was made without any gas evolution.

Their results may be summarized as follows:

Caustic soda is easily dehydrated at 400 deg. C. in a gold crucible and atmosphere of nitrogen.

Of the metals investigated, gold alone did not act on NaOH in that temperature range on exclusion of air.

Silver and sodium react with hydrogen generation; platinum, copper, iron, nickel, aluminum, zinc and magnesium with hydrogen generation and splitting off of water.

This double reaction is explained in the simplest manner by the existence of the metal and sodium oxide compound from the reaction $Me + xNaOH = Me(ONa)_x$ with Na_2O, the final product, being a more or less complex one in which water is split off according to the reaction

$$2NaOH = Na_2O + H_2O$$

Danckwardt invented a cell in 1898 containing two compartments, the positive of which was double walled and provided with water cooling. He melted the charge of salt by means of fuel gas and air, or charcoal and air, removed the chlorine through a pipe with a damper in it, and permitted his sodium to rise to the surface in the cathode compartment and flow by gravity into a container. The apparatus was rather complicated and so far as known was not used on a large scale.

In 1910 R. J. McNitt (with whom the author was associated) patented a process for making sodium-lead alloy in the Acker type of furnace and then recovering the metallic sodium by distillation of the alloy under vacuum. This was partly successful and yielded a good grade of sodium.

In 1912 H. Mehner patented a process of reacting sodium carbonate with molten cast iron, which was not electrochemical but of scientific interest.

Marguet in 1913 obtained a French patent in which he said that neither the impurities of the caustic soda bath nor the depositions on the cathode constitute the cause of the drop in yield. It is caused solely by the excessive temperature rise occasioned by re-solution of sodium in the electrolyte.

Seward and von Kügelgen sought to improve their process by purifying the electrolyte before use in making sodium. They found that small masses of impurities in the salt tended to conduct the current between the poles of the cell and hence defeat the purpose of electrolysis.

By fusing the impure salt and subjecting it to a low current density and high potential, they were able to cause the less electropositive particles to separate out in the bottom of the furnace. The pure salt was then bailed out and used for the final bath.

Effect of Adding Sodium Carbonate

B. Neumann made some experiments on mixtures of NaOH and Na_2CO_3 in 1914, getting melting point curves showing the varying current efficiencies for his mixtures. The best yields of sodium (83 per cent) were obtained on the addition of 12 to 17 per cent Na_2CO_3, the melting point of the mixture being 280 deg. C.

He also made observations on mixtures of NaOH and NaCl, but the yields were lower than with Na_2CO_3 additions or with pure NaOH. In the best run only 39 per cent current efficiency was obtained, with 5.5 per cent NaCl and melting point of 285 deg. C. He stated that higher efficiencies in the production of sodium in technical practice could be obtained by the careful dehydration of the fused caustic before electrolysis, by the use of NaOH free from NaCl, by the addition of Na_2CO_3 to lower the temperature of the bath, by careful temperature measurements, which until now have been regarded as unnecessary, and by greater attention to the anodic separation of water.

The melting point drops from 296 deg. C. for pure NaOH to 280 deg. C. for the NaOH-Na_2CO_3 mixture containing 17 per cent Na_2CO_3, rising again to 297 deg. C. for 30 per cent Na_2CO_3.

The current efficiency rises from about 25 per cent at 2 per cent Na_2CO_3 to a maximum of 63.03 per cent at 17 per cent Na_2CO_3, decreasing again to 40 per cent at 27 per cent Na_2CO_3.

At the maximum current efficiency the range of temperature between freezing and overheating is also a maximum, being 16 deg. Above this concentration of Na_2CO_3 the temperature range gradually diminishes and a factory using these strengths can run with only low efficiencies, if at all. The voltage between the electrodes in this mixture amounted to an average of 6 v.

Caustic soda is found in the industries usually accompanied by some NaCl, sometimes up to 3 per cent. Naturally, in continued electrolysis the salt content increases in the cell, since the decomposition point of salt at 300 deg. C. (likewise that of Na_2CO_3) is about 1 v. higher than that of NaOH. The consequence of continued increase of salt content is poorer yields and the necessity for finally discarding the bath.

It was found that in mixtures of salt and caustic the melting point decreased from 289.3 deg. C. with zero salt to a minimum of 283 deg. C. with 7 per cent salt, then rose rapidly to 315 deg. C. with a 15.6 per cent salt content.

Von Wartburg found that no chlorine was generated at the anode with mixtures containing from 25 to 50 per cent NaCl.

In 1915 Ashcroft invented a cell in which he made sodium-lead alloy from mixed chlorides of sodium and potassium, and then extracted the potassium by addition of a sodium salt, NaCl or $NaNH_2$. The alloy was left with almost pure sodium, and was subjected to electrolysis in a second cell, where the sodium metal was recovered at an iron cathode, the alloy acting as the positive pole.

This was quite an ingenious invention, but, like a great many of the similar sort, very complicated. There were arrangements for stirring the molten salt by the swirl of the current, transfer of the alloy through an intermediate vessel to the second cell and return after impoverishing it of the sodium metal.

Acker in 1915 invented a new process in which he used Ashcroft's idea of the sodium-lead alloy as intermediate electrode, but substituted for NaOH as bath in the second cell cyanide or cyanamide of sodium. By this bath he claimed great improvements in efficiency.

Improvements in Fused Salt Process

Seward and von Kügelgen obtained patents on improvements in the production of sodium in which they used a shallow cell with graphite anodes set in a ring and stationary iron hollow cathodes set in the furnace bottom and projecting upward to the top of the anodes. (See Fig. 4, which is taken from U. S. Pat. 1,092,178; April 7, 1914.)

On the upper end of the cathode was a nipple for catching the sodium as it overflowed, and covering the cathode space was a head of cast iron suitably projected within the bath by salt maintained in frozen condition by a watercooler encircling the lower edge of the hood. In this way the sodium was prevented from oxidation and allowed to flow through the cathode to a container placed beneath the cathode. The pressure within the cathode hood and the container beneath was maintained the same by connecting the two with a pipe, and any excess pressure due to hydrogen formation was relieved through an oil seal.

A later development of the cathode was one consisting of a double jacket, joined only at the top, the space between being filled with asbestos wool or some other suitable material. This improvement was to avoid the magnetism caused by the current passing in one direction and holding the sodium against the side of the cathode. In the new cathode the current had to pass upward and then downward, thus destroying the magnetic effect.

Seward made a very thorough discussion of the process of making metallic sodium from fused salt, which is abridged as follows:

> For melting the bath in the furnace an alternating current is best, since it avoids the generation of sodium and chlorine gas, until the bath has been built up to the level of the sodium collector. In this way the bath is uncontaminated except from the impurities of the graphite, which may be burned off shortly after start of electrolysis.

An electrolyte melting at about 600 deg. C. was used preferably, with an operating temperature 630 to 679 deg. C., suitable fluxes being added to maintain this

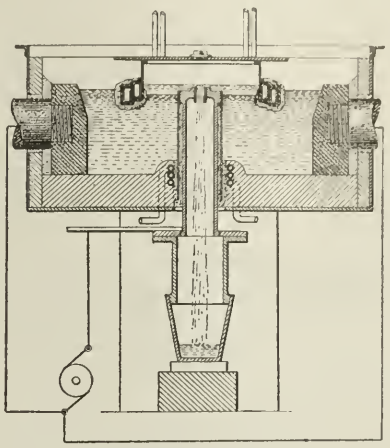


FIG. 4—SEWARD AND VON KÜGELGEN FUSED SALT CELL

melting point. Practically nothing but NaCl is electrolyzed, but after a long time there is some slight volatilization and decomposition of the fluxes, necessitating addition of fresh material. After the direct current has replaced the alternating current the output is poor until all moisture is eliminated from the lining, etc., and the electrolyte is completely dehydrated.

The process requires little attention beyond keeping the electrolyte at the proper level and temperature and periodically tapping the sodium from the receiver. Occasionally the appearance of sodium in the anode compartment indicates that the condition of the curtain or of the crucible bottom has become abnormal and corrective methods must be applied. The appearance of sodium outside of the curtain may also indicate that accumulated impurities on the crucible bottom have become active and are separating sodium so remote that it rises outside the sodium chamber. A preliminary refining of the salt, however, renders the accumulation of impurities so slow that this condition appears only at long intervals.

Developments Since 1916

J. Brode patented a cell in 1916 in which the anode compartment consisted of a pot lined with firebrick in which were set graphite anodes. The cathode compartment was a bell of iron submerged in the molten salt. The top was airtight, but the lower part was perforated to let the electrolyte circulate with the current. By maintaining a definite pressure inside the cathode chamber the sodium was permitted to rise to the top and flow down into a container which was under slightly less pressure. This apparatus runs into complications in

way of keeping the proper pressure and in being compelled to tear down the furnace to replace the diaphragm.

Pfleger and Ott patented a cell, which was a duplication of the Castner cell, in which they proposed to place a wall of solid salt between the anode and cathode chambers. This was maintained by passing a cool gas through a hollow partition wall which carried the diaphragm.

R. J. McNitt patented in the same year a furnace for making metallic sodium, in which he brought the sodium in molten state to the container by putting the top of the bath under pressure of a neutral gas, such as nitrogen. By this means he claimed to raise the boiling point of the sodium well above its normal value. Sodium boils normally very close to the melting point of salt, and consequently was very likely to be formed in a gaseous cloud during electrolysis. The sodium was permitted to rise inside a hood of iron which carried an iron diaphragm, and flowed down into an external container.

In 1917 McNitt took out a second patent in which he applied the pressure to the zone of electrolysis by means of a superimposed column of molten electrolyte. This cell, described in U. S. Pat. 1,219,808; Feb. 6, 1917, is shown in Fig. 5.

In 1920 Smith and Veasey at the Dow Chemical Co.'s plant in Midland, Mich., got out a process in which they used Na_2CO_3 with NaCl in the proportions of 35.6 parts NaCl to 64.4 parts Na_2CO_3, giving a melting point of about 600 deg. C.

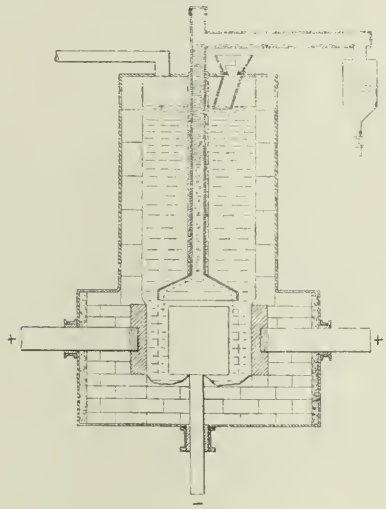


FIG. 5—McNITT CELL

During the years 1917 to 1919 the writer performed a series of experiments on the manufacture of metallic sodium from molten salt at the plant of the Semet Solvay Co. in Syracuse, N. Y., and built furnaces of various designs for the study of the different elements entering into sodium production.

Work along these lines is being investigated by many companies, and the future is bound to bring out new salt processes to compete with the old Castner process, which has almost reached its maximum efficiency.

Of recent years the general dislocation of price levels and labor rates has changed many commercial processes into uneconomical operations, and the production of metallic sodium is no exception. However, the writer believes that the salt process will eventually supersede the caustic soda process, on account of the cheapness and non-corrosiveness of the raw material.

Part II will be published in a subsequent issue.

Electrothermic Zinc Developments

By T. M. Bains, Jr.

SINCE the suspension of experimental work at East St. Louis[1] in 1917, little has been done in dry electrothermic smelting of zinc ores. Further research on zinc condensation was carried on at Case School of Applied Science by C. H. Fulton.

In the fall of 1920 the writer again took up some of the problems which baffled us at East St. Louis and last spring worked out the following improvements:

1. Use of one size of briquet for both cross-connectors and columns, of square or rectangular cross-section.
2. Twelve column set-up of these briquets, for single delta, double "Y" and double delta operation, three phase.
3. Electrodes entering the retort through the top, instead of bottom.
4. Elimination of the costly variable voltage equipment, replacing same by standard transformer equipment.
5. Use of refrax carborundum brick for heating of the condenser.

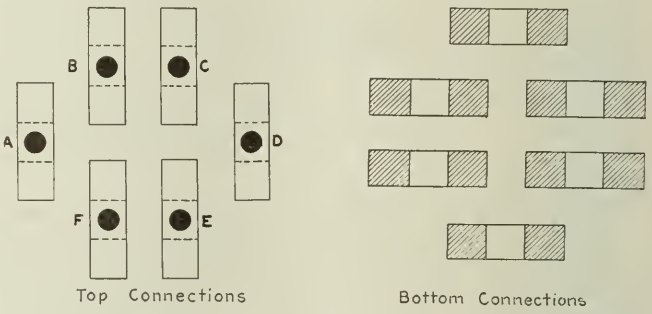


FIG. 1—SKETCH OF CONNECTIONS BETWEEN RESISTORS

By the first improvement, the set-up contains no Acheson graphite or carbon connectors or any material except the briquets. The large, costly graphite connectors used at East St. Louis shown in previous papers were therefore eliminated. By using square or rectangular briquets for cross-connectors and the same size briquets in the columns, a great improvement has been made. The new set-up is shown in Fig. 1. It will be noted that this set-up consists of twelve columns, connected both top and bottom. As the raw briquet on heating softens at about 150 to 200 deg. C. due to the melting of the pitch binder, a height of 6 ft. is probably the maximum limit that can be baked in place. So should a higher set-up be desirable, the baking must be done in two or more steps. The assembly could be considered as made up of "U"-shaped blocks; the lower set of six set bottom down, and the upper set of six set bottom up, on top but rotated through 90 deg. The upper and lower portions of the set-up are identical, except oriented 90 deg. on each other. Briquets of square cross-section are therefore preferable. With this design, the lower half after baking to about 400 deg. C. is strong enough to withstand the weight of the upper half. The latter can be baked in place on top of the lower half.

Electrodes of graphite or carbon are brought through the top of the retort hood and contact is made at the central part of each cross-connector. The base is therefore solid and smooth, instead of containing electrodes,

[1] "Electric Resistance Furnace of Large Capacity," by C. H. Fulton, *Trans.*, A.I.M.E., vol. 64, p. 188; Chem. & Met. Eng., vol. 22, p. 73; p. 130 (1920).

which must be prevented from oxidizing, when the distilled briquets are removed. Also the electrode "jacks" used at East St. Louis are eliminated.

By the use of six electrodes, one at the center of each of the top connectors, three different connections are obtainable in a three-phase furnace. These are, first, single delta, with four columns in series per phase by joining lines to *A*, *C* and *E*; second, double "Y," with two parallel circuits of two columns each per leg of the "Y" by joining lines to *A*, *C* and *E* and connecting *B*, *D* and *F* as a neutral point; and third, double delta, with two parallel circuits of two columns each across each phase of the delta by joining lines to *A*, *B* and *C*, and connecting *A* to *D*, *B* to *F*, and *C* to *E*. By changing from one set of connections to another and with standard transformers, with 2,300-volt primary and 115/230-volt secondary, from 5.6 to 133 amp. would flow through the briquets, assuming each briquet has a resistance of 1 ohm and that the primary 2,300-volt potential is held constant. The automatic control of current and voltages has been worked out by L. F. Woolston, of the General Electric Co.

Heating the condenser above the melting point of zinc, 418 deg. C., has been a difficult problem. Zinc vapor attacks all metal so far tried, and thus electrical resistors of the nichrome type cannot be used. Carbon and graphite heating elements have been failures. Refrax carborundum brick is not affected by zinc vapor and has been successfully used here. This type of heater was described in the *Engineering and Mining Journal-Press* of April 1, 1922.

Experiments in producing sponge iron from refractory ores high in iron have shown that the residue from the distillation of the zinc contains all the other metals in the form of alloys, principally as ferrosilicon. By crushing this residue and adding it to a $CuSO_4$ solution, slightly acidified, the metals in the residue are thrown down with the cement copper and can thus be regained with the copper. It is simpler, however, to use the residue as part of the charge to the lead or copper blast furnace direct.

Prospects of Polish Steel Industry

The future of the iron and steel industry of Polish Upper Silesia, while apparently assured after a few years, is not regarded as optimistically for the immediate future as that of the coal industry, says Colonel A. B. Barber, technical adviser to Poland, in a statement received by the Department of Commerce. This is due to the fact that a considerable part of the production must at present seek its market in Germany, while in the German market there is the difficulty which existed even before the war of meeting west German competition, chiefly on account of the long distance the greater part of the iron ore must be hauled to Upper Silesia and on account of the inferior strength of Upper Silesian coke when used in blast furnaces (200 tons being a maximum charge as against over 400 tons with Westphalian coke). It is reported that today Westphalian pig iron can be laid down in Upper Silesia at a price lower than Upper Silesian pig iron. The Polish Silesian iron and steel industry will therefore for some time be dependent upon the condition of the industry in Germany, and to secure the Polish market will at times require protection by customs barrier against the German industry.

For the future, however, the prospects of the entire Polish iron and steel industry depend fundamentally upon the development of an increased demand for iron and steel in ex-Russian Poland, Galicia and neighboring territories (Russia, Rumania, etc.). Before the war the Russian tariff against pig iron was $15 a ton and against semi-finished iron products $85 a ton. The annual consumption of iron products in ex-Russian Poland was less than 20 kg. per inhabitant. The use of iron products in Galicia shows only a little less retarded development. The per capita consumption in ex-Prussian Poland, on the other hand, amounted to 80 kg. per annum, in France 90 kg., in Germany 140 kg. and in the United States 300 kg. It seems that an increased demand for iron and steel is likely to develop and if this should reach 60 kg. per inhabitant for all of Poland the amount of iron and steel required annually would be 1,700,000 tons. This is more than the entire production of Poland, including Polish Upper Silesia, leaving out of consideration the demand from Russia and other neighboring countries.

Iron-Ore Production Diminishing

While the iron and steel production of Upper Silesia as a whole during the past decade has been constantly in the neighborhood of 1,250,000 tons per annum (of which 70 per cent on the Polish side), the Upper Silesian iron ore production is rapidly becoming insignificant, having fallen to 53,000 tons in 1920. In 1912 the production was 165,000 tons, having decreased steadily from 706,000 tons in 1891.

Upper Silesia has always had to import the essential high-grade ore from Sweden or south Russia, and in recent years, owing to the exhaustion of the Silesian ores, has imported the greater part of her low-grade ores from Germany, together with up to 300,000 tons annually of scrap iron. Polish Upper Silesia will have to continue importing her high-grade ores, but it is expected that within 2 or 3 years the production of ore in the part of Congress Poland lying just to northeast of Upper Silesia (region of Czestochowa and northwest thereof), where the reserves are estimated at 300,000,000 tons, will be sufficiently developed to take the place of the exhausted Upper Silesian and imported German low-grade ores. During the intervening years, before the supply of iron ore from Polish and south Russian mines can be developed and the use of scrap iron replaced by the use of iron ore, the greatest difficulty for the iron and steel industry in Polish Upper Silesia will be to provide the necessary ore and scrap iron to maintain the production at the present rate. However, it is expected that, in the convention now being negotiated in accordance with the Geneva decision, Germany will undertake for a limited period to continue the supply of the necessary German ores and scrap iron.

Zinc and Lead Industry

The future of the zinc and lead industry, all of which is on the Polish side, is limited by the ore available, which will be exhausted in a few decades. In 1913, the greatest zinc year, Upper Silesia produced half of Germany's zinc and one-seventh of the world's supply. Now, however, the ore production has fallen from 508,000 tons in 1913 to 266,000 tons in 1920, and this has rendered superfluous a certain portion of the capacity of the reduction plants. A few of the plants have entirely shut down, while the others are working at less than 50 per cent capacity. Despite reduced output Upper Silesia should be able to supply all Polish requirements and leave a large surplus for sale to Germany and elsewhere.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Yeast Cultivation.—The parent specification, Br. Pat. 174,625, covers the cultivation medium for distillation yeast. Nitrogen for the growth of yeast is supplied in the form of ammonium salts, or salts of amides or amines, the solution being neutral or very slightly acid. The yeast is aërated during cultivation. A suitable solution contains sugar and ammonium lactate, with sufficient lactic acid to neutralize not more than 0.3 c.c. normal soda solution per 20 c.c. of filtered culture medium.

The addition of oxidizing enzymes is covered by Br. Pat. 174,627. In cultivating yeast in a solution containing compounds of amines or amides as described in the parent specification, oxidizing enzymes are added. A suitable solution contains sugar, carbamide and oxidase. The amides or amine compounds are not necessarily added in a pure state; liquids containing them such as urine and waste waters can also be employed.

The fourth specification of the series describes the addition of the nutrient solution to a vessel containing aërated and fermenting yeast at such a rate that the nutritive substances and the alcohol produced are consumed as fast as they are supplied or formed, the concentration remaining approximately constant. Suitable solutions are (1) a wort formed from mashed maize, malted barley and malt germs, (2) a solution of beet sugar, ammonium lactate, biphosphate of potassium and magnesium sulphate. Br. Pats. 174,625 to 174,628 inclusive. Not yet accepted. N. Muskovits, Nagyvárad, Rumania. March 29, 1922.

Tanning.—Hides and skins are tanned by treatment with aqueous acid solutions of the sulphonated products obtained by condensing a carbohydrate with an aromatic hydrocarbon or carbazol or halogen substitution products thereof, the sulphonic acid groups being introduced either by effecting the condensation in the presence of sulphuric acid or by using a sulphonic acid of the cyclic component as reacting material. Natural vegetable tanning agents may also be present. According to the examples, the tanning bath consists of a sulphuric-acid solution of the sodium salt of (1) the product resulting from the condensation of naphthalene, anthracene, phenanthrene, α-chlornaphthalene, or naphthalene-β-sulphonic acid with cellulose in the presence of sulphuric acid, with or without the addition of oakwood extract, (2) the product of the condensation of cellulose and benzene or carbazol in the presence of oleum, or (3) the product obtained by condensing naphthalene with starch, dextrine or grape sugar in the presence of sulphuric acid and anhydrous sodium sulphate. According to the provisional specification, the cyclic component comprises aromatic compounds, or derivatives thereof which are free from hydroxyl. Specification 173,881 is referred to. (Br. Pat. 174,700. Badische Anilin- und Soda-fabrik, Ludwigshafen. March 29, 1922.)

Purification of Anthraquinone.—Anthraquinone is purified by solution in cresol or other homologs of phenol and crystallizing. The process may be applied to crude anthraquinone, dry or moist, or to anthraquinone made from phthalic anhydride or by oxidation of anthracene in the presence of a catalyst. The product melts at 287 deg. C. or higher. (Br. Pat. 174,784. British Alizarine Co., London, March 29, 1922.)

Ammonium Sulphate.—Neutral ammonium sulphate of good color is obtained by passing ammonia free from sulphuretted hydrogen into mother liquor drained from crystals removed from a saturator in quantity sufficient to neutralize the acid in the mother liquor and the acid in the crystals, oxidizing the solution, for instance by air, and filtering, then stirring the crystals with the purified mother liquor. The crystals are separated by settling and the mother liquor is decanted with suspended impurities and may be returned to the saturator. (Br. Pat. 174,878. South Metropolitan Gas Co., E. V. Evans and P. Parish, Bromley, England. March 29, 1922.

Sodium Hydroxide, Carbonate and Thiosulphate.—Hydrated sodium sulphide, reduced to powder, reacts with air or oxygen at ordinary temperatures, in the presence of finely divided active charcoal, to give a product containing chiefly caustic soda and sodium thiosulphate. Charcoals sold under the registered trade marks "Eponit" and "Norit" are very active, but fine anthracite coal, animal charcoal and charcoal obtained by the low carbonization of wood, coconut shell, etc., after being activated by treatment with air or steam at low temperatures, are also suitable. If air is employed, the residual nitrogen may be collected as a by-product. After the reaction, the resulting mixture is treated in one of the following ways: (*a*) The solution obtained by extraction with water is filtered, concentrated and cooled when crystals of thiosulphate and a mother liquor of caustic soda are obtained. The charcoal, after washing, may be used again. (*b*) The product is leached with alcohol to extract the caustic soda, and then with water to extract the thiosulphate. (*c*) The solution obtained by lixiviation with water is treated in the cold with carbon dioxide to precipitate the bicarbonate and leave a solution of thiosulphate ready for crystallization. If the carbon dioxide is passed into the hot solution, a mixture of sodium carbonate and thiosulphate is obtained, which is separated by fractional crystallization. (*d*) The solution, containing from 10 to 40 per cent of sodium compounds, obtained by extraction with water, is electrolyzed, when a solution of caustic soda is obtained at the cathode, and a dilute solution of sulphuric acid and a loose precipitate of sulphur are obtained at the anode. In an example, sodium-sulphide crystals are ground and well mixed with an equal quantity of active charcoal, in an apparatus provided with a water-jacket to prevent the temperature exceeding 100 to 200 deg. C. Steam is evolved and the reaction is allowed to proceed until lead acetate gives a white precipitate with the solution of the product. The latter is extracted with water and subjected to fractional crystallization. (Br. Pat. 174,653. E. E. Naef, W. Bridgford, England, March 29, 1922.)

Reducing Manganese Ores.—A process for the production of manganese or manganese alloys low in carbon and silicon from ores in which the principal manganese content is of a higher degree of oxidation than MnO comprises first smelting the ore with such a proportion of carbon that the manganese is reduced to the form MnO, whereafter the ore is finally reduced with silicon, which may be used in the form of silicomanganese or ferrosilicon. Other oxides such as iron oxides present in the ore may be reduced in the first stage by increasing the amount of carbon. Phosphorus may be similarly reduced, iron being added, if necessary, to combine with it. The amount of manganese in the slag formed on reduction with silicon may be diminished by adding lime with the silicon, or by adding lime or limestone to the ore before smelting with carbon. Silica also may be added. (Br. Pat. 174,923. Not yet accepted. Aktiebolaget Ferrolegeringar, Stockholm. March 29, 1922.)

Borax and Boric Acid.—A mixture of sodium pentaborate and a sodium salt is treated with ammonia, borax being formed and crystallized. The borax in the mother liquors serves to liberate the ammonia for re-use with formation of boric acid, which is drawn off and the remaining ammonia (if any) liberated by addition of lime. Calcium borate is recovered as usual. In examples, the theoretical amounts of pentaborate and sodium chloride are dissolved in water at 40 deg. C. and the theoretical quantity of ammonia added. The borax is then either crystallized as much as possible by cooling and the ammonia recovered by lime, or the theoretical amount of borax required to liberate the ammonia is left in solution and the latter boiled, the boric acid separating out. (Br. Pat. 175,201. A. Kelly and R. B. R. Walker, London. April 5, 1922.)

Tanning.—Mineral-tanned leather is retanned with organic tanning agents in three stages. After rinsing to remove any uncombined mineral salts, the leather is placed in an organic tanning solution of about 50 deg. Bé., the acid formed in the reaction being continually neutralized with alkali until permanent neutralization is obtained. The second stage consists in treating the product with a solution of an alkali salt of an organic tanning matter until it is thoroughly saturated. The substances incorporated in the leather are finally precipitated by reaction with a corresponding quantity, ascertained by analysis or otherwise, of a solution of neutral or alkaline chromium, iron or aluminum salts, so that the final product does not contain any uncombined metal salts. The leather thus obtained is allowed to rest for a few days, is then rinsed and treated in the usual manner. (Br. Pat. 173,508. Not yet accepted. J. Byston, Holstein, Germany. Feb. 22, 1922.)

Purifying Lactic Acid.—The lactic acid or lactate to be purified is first converted into magnesium lactate either by effecting the lactic acid fermentation in presence of magnesium compounds such as carbonate, hydroxide or oxide, or by double decomposition of the more easily soluble lime compound or other soluble lactate with a suitable magnesium compound such as sulphate. The acid is then liberated either by direct acidification with sulphuric acid and extraction with acetone, ether, etc., or the magnesium lactate is suspended in acetone or ether and then agitated with sulphuric acid when magnesium sulphate separates and the solution of lactic acid is evaporated. The product in each case may be purified with bone-black. In examples, commercial lactic acid is treated with magnesia and the resulting lactate treated by each of the above-described methods. (Br. Pat. 173,479. Not yet accepted. J. Schatzkes, Berlin. Feb. 22, 1922.)

Celluloid Sheeting as Glass Substitute.—A sheet material applicable as a substitute for glass is made by incorporating a cellulose ether, such as ethyl or benzyl cellulose, or a composition containing the same, with an open-meshed metallic or textile fabric, or with wires, cords, strips, etc. The cellulose compound may be in solution or melted at a temperature of 180 to 200 deg. C. (Br. Pat. 173,021. H. Dreyfus, London. Feb. 8, 1922.)

Alkali Cyanides.—Alkali cyanides are produced by passing hydrocyanic acid or gases containing it into a solution of an alkali salt and mixed with lime, the acid radical of the salt being one that forms an insoluble calcium salt. Sodium carbonate and sulphate are suitable, and it is preferred to use a small excess of lime. (Br. Pat. 174,364. Not yet accepted. Deutsche Gold- und Silber-Schneide Anstalt vorm. Rössler, Frankfort-on-Main. March 22, 1922.)

Hydroquinone.—Hydroquinone is manufactured by reduction of quinhydrone by heating either with aqueous ferrous sulphate and an alkaline earth carbonate, or with metallic iron and water. Quinone may be half reduced in the ordinary way and the reduction then completed as described above. (Br. Pat. 174,554. W. Carpmael, London. March 22, 1922.)

Book Reviews

MATERIALS OF CONSTRUCTION, THEIR MANUFACTURE AND PROPERTIES. By the late *Prof. Adelbert P. Mills.* Second Edition. Edited by *Prof. Harrison W. Hayward,* Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc., 1922. Price $4.

Six years ago the reviewer was faced with the problem of teaching metallurgy to engineering students. He assumed that the subject would appeal to them better if presented from the viewpoint that metals are very important materials of construction, and wide differences in properties and general dependability result from differences in the smelting processes, in the chemical analysis and the physical constitution. Young engineers can easily be convinced that they should know something of these things in order to make intelligent selection of materials which they will some time build into bridges, transmission lines, lathes or autoclaves.

That decision made, the next thing was to find a text book which described both the metallurgy of metals and alloys in the light of modern scientific developments, and their physical properties. Fortunately, Mills' "Materials of Construction" was just off the press; it seemed to cover both the ferrous and non-ferrous alloys in a comprehensive and accurate manner; in fact, it was a veritable godsend.

Now comes the second edition, delayed by Prof. Mills' untimely death. Prof. Hayward has taken great pains to correct the scattered errors in the first edition. Most of the text has been reset. A 30-page chapter on the proportioning, mixing, placing and waterproofing of concrete has been written by Dean Peabody, Jr., while about the same space is occupied by Prof. G. B. Haven in new sections on fiber and wire rope and mechanical fabrics. These are about the only additions. All the text has been gone over with a long blue pencil, so that the new edition has 450 pages against 650 for the first—a cut doubtless necessary to enable the publishers to reduce the selling price to $4. Such a reduction may give the book a greater sale and thereby increase its usefulness, but will not tempt the owner of the first edition to replace it with a copy of the second.

Since nearly three-quarters of the text is devoted to metallic materials of construction, this portion has suffered most from condensation. At the outset it must be said emphatically that what there is of it is good. It contains very few archaic ideas or incorrect statements such as "Cold-working is beneficial because it closes up the grain of the metal; it also increases the cohesion and adhesion of the crystals," "Most blast furnaces are now equipped with air-drying plants," and that the Domnarfvet and Heroult (California) furnaces are the same. Fortunately, also, the admirable section on non-ferrous metals and alloys has not been compressed very much, and some notes on new alloys like duralumin have been added.

It is too bad, however, that, since the text was to be reset, opportunity was not taken to discriminate between the steels now being used and those which have not yet been adopted. Prof. Mills' concise text seems merely to have been more highly compressed. If space was desired, is it not a shame to get it by cutting down alloy steels to twenty pages, and yet give three to the basic bessemer process, and a few more to details of Stassano and Kjellin electric furnaces? Certainly such widespread and increasingly important materials as alloy steels should not be slighted in favor of foreign processes and furnaces of interest only to expert metallurgists.

Alloy steels have made great advances in the 8 or 9 years since Prof. Mills prepared his original manuscript. He then had to rely largely upon published studies of alloy systems for his data; many of these analyses have not yet found a place in industry. This new edition has not made use of the voluminous literature appearing since that time, and seemingly assumes that all these analyses have, or will have, considerable use, and thus gives the student an entirely erroneous impression on the present state of the art. For instance, considerable space is given to chromium steels ("chrome steel" in the text), while the more important nickel-chromium steels are confined to a half-page tabulation of physical properties of various analyses in the "normal" and "quenched" condition—no indication of the tremendous possibilities of correct heat-treatment. Again, tungsten steels are discussed as though they were used alongside of nickel steel, and only the merest hint that their real importance is as cutting tools, in which, of course, tensile strength is only of minor importance. Furthermore, molybdenum steels containing 1 to 8 per cent Mo are described, whereas the important commercial steels contain less than 1 per cent.

Unfortunately, the only real shortcoming of the first edition has not been corrected. Whereas steel in the abstract is discussed in considerable detail, giving clearly the effect of different impurities, constituents and heat-treatments, nothing is given about those particular kinds of steels which enter into engineering construction in great quantity. Millions of tons of rails, structural shapes,

plates, pipe, steel castings, drop forgings and galvanized sheet are made every year; but not a word can be found about any of these things; no information on the analysis, heat-treatment and properties of steel castings, or on the qualities desired in steel rails or bridge members and how to get them. And until college text books and college instructors talk a lot about steel in particular, as well as steel in the abstract, construction projects will be 10 years behind metallurgical progress, civil engineers will design shapes which cannot possibly be rolled of sound metal, and specifications such as the following will continue to be written (copied):

"Bridge pins over 7 in. diameter shall be forged and annealed; if over 9 in. diameter they shall have a 2-in. hole bored through the center"! E. E. THUM.

* * *

THE ELEMENTS OF FRACTIONAL DISTILLATION. By *Clark Shove Robinson.* International Chemical Series. New York: McGraw-Hill Book Co., Inc. 205 pp., 41 figures. Price, $2.50.

At least once a year the industries ask the question, "Why do not our universities turn out capable chemical engineers?" The question has been answered in a hundred different ways, but there is one answer that persists year after year. It is, "There are only a few teachers with fundamental knowledge of the subject and with the ability and courage to work out the essential principles and publish the facts."

Prof. C. S. Robinson of the Massachusetts Institute of Technology has had the opportunity to work in the field of distillation. He has realized the need for basic research and with a nice appreciation of the underlying principles he has made a genuine contribution to the science of chemical engineering.

It is true that Prof. Robinson's book on distillation is not a complete work, but it is a solid foundation upon which to build and it is the first time that a book of its kind has ever been written in any language. There are times when, perhaps, the reader wishes a little more could be said on some phase of the subject, but like a wise host, Prof. Robinson does not allow his guest to leave the table with a stuffed feeling but rather with a comfortable feeling of satisfaction and a desire for more.

It is a book you want to own and not a book that you are pleased to see reposing on the dust-covered shelves of a public library. It is a book that answers your questions why and how. It leaves you with the same feeling toward your next distillation problem as the little mouse had who after swallowing two drops of strong liquor, rose on his hind feet and cried loudly, "Now bring on that damn cat!"

There are several typographical errors and a few awkward descriptions that the reviewer has found—mistakes that the average reader can easily rectify for himself. The sub-titles are not as well placed as they might have been, but this does not detract from the value or interest of the book.

A brief outline of the contents can best be expressed in the words of the author:

"In general it has been divided into five parts. The first part deals with fractional distillation from the qualitative standpoint of the phase rule. The second part discusses some of the quantitative aspects from the standpoint of the chemical engineer. Part three discusses the factors involved in the design of distilling equipment. Part four gives a few examples of modern apparatus, while the last portion includes a number of usual reference tables which have been compiled from sources mostly out of print and unavailable except in large libraries."

The first part, dealing with the phase rule, may seem too elementary for some, nevertheless it will be welcomed by others. In a book of this type very little should be taken for granted, otherwise the field for the book will be restricted.

In the second part an attempt is made to derive a few fundamental equations to be used later as a basis for design. Here the reader is led slowly up to the conclusions; he is not jumped from the gas laws to some complicated expression involving calculus. Many of the equations developed are used in actual calculations in order that the reader will have a clearer vision. There are no mysteries in this book; every attempt is made to simplify the ideas and expressions, in order that the reader will not become puzzled and disgusted. Perhaps the subject matter is made a little too simple; some readers might get the impression that the art of distillation is a finished problem. This class of reader never respects anything the theory of which he can grasp. There is another type of reader that will evaluate correctly this theoretical portion of the book. He will see it only as a foundation to build on; it will act as a catalyst for his own ideas. This is one of the valuable features of the book, it opens up new fields of research to the student.

The third part, to many readers, will contain the "meat" of the text. In this part principles of design based on sound theory and long experience are clearly and simply stated. Every chemical engineer in this country will be interested in this part; they have waited a long while for this and they will not be unappreciative.

The fourth part discusses examples of fractional distillation such as the purification of ammonia and alcohol. Principles of design are illustrated by these examples. It is here that one wishes a little more could be said, a few more suggestions offered.

The fifth part, the appendix, contains several tables of data that have been collected and placed in the book because they are useful and are difficult to find and not because they might be useful and are easy to find.

It is hoped that this is a forerunner of more specialized works by other capable men on various fundamental subjects in chemical engineering. If we could have something similar on filtration, on heat transference, on drying, on grinding, etc., our young chemical engineer would rise more rapidly, our executives would cease their grumbling, and the chemical industry would be materially advanced.

It is not often that the reader discovers a refreshing bit of unconscious humor concealed in a highly technical treatise, but when he does his appreciation is sincere. The last lines of Prof. Robinson's text are as follows:

"The waste liquor from the bottom of the column *D* flows through the recuperator *B* and then to the sewer."

A masterpiece of clearness and a very clever ending. O. Henry could have done no better. D. B. KEYES.

* * *

MODERN GASWORKS PRACTICE. By *Alwyne Meade.* Second Edition. Rewritten and greatly enlarged. London: Benn Bros., Ltd. 814 pp. 74 illustrations. Price, 55 shillings net.

This second edition represents a 50 per cent increase over the first edition published 5 years ago. This great increase has been necessitated by the many new developments in British gas-engineering practice. The volume is an up-to-date and therefore particularly valuable summary of English gas works equipment and methods.

The practice in English gas works has varied much more in the 5 years past than in the United States. The necessity of war-time fuel economy particularly was a factor necessitating change in quality of gas produced and hence modification in much of the equipment and in methods of operation. The present work emphasizes many of these new practices—for example, devoting a whole chapter to complete gasification of coal and another to cyanogen recovery.

The book deals with production problems only. The author covers these very thoroughly from the retort and generator through to problems of gas holders and storage. Great emphasis is laid upon the mechanical engineering and structural detail. These features are presented very clearly by means of numerous well-selected illustrations.

American gas engineers who plan works or who decide upon matters of technical policy will find much useful material. The work as a whole is rather a text book than a book of reference, and as such it will be appreciated, especially by those who desire to get a broad working knowledge of the engineering tendencies of the day.

R. S. MCBRIDE.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Voting Begins on Chemical Schedule—King Assails Tariff and Monopolies

Voting on the items in the chemical schedule of the tariff bill began on May 2. On that date the real discussion of the chemical items began. Prior to that time the reference to the chemical schedule had been of a general character, although the first item, acetic acid, was the basis of extended discussion. It was brought about by a statement on the part of Senator McCumber to the effect that the action of the committee on that commodity permeated the entire bill. The discussion, however, was more political than technical in its character. When it came to a vote, there was no objection to the adoption of the committee's amendment to the first item in the bill. The next item, acetic anhydride, proved to be a snag as well. In the course of the discussion, Senator Smoot mentioned that the existing embargo applies to all synthetic organic chemicals. This seemed to come as a surprise to Senator Jones of New Mexico and to Senator King of Utah, who thereupon proceeded to denounce the dye and chemical control vigorously. Senator King declared that the majority party drove the measure through Congress, claiming it to be necessary to save the dye industry, and in the interest of the national defense. Under this guise, he said, the embargo was made to apply to all the synthetic organic chemicals, which, he declared, was a "patent fraud upon the people."

King Disregards Dye Investigation Findings

It is very apparent that the evidence before the Shortridge sub-committee has made little impression on Senator King. He is repeating the charges of monopoly in the dye and chemical industry generally in his remarks on the floor of the Senate. In addition, he characterizes the whole tariff bill as absurd, foolish and reactionary. It is sheer madness, he told the Senate, to strike at our foreign trade with such high schedules as are carried by the bill.

"If under the Underwood law," Senator King said, "imports are limited, as they are today, it is hypocrisy to charge that such limited imports menace our industrial and economic security. It is conclusive evidence that the purpose is to cut off all imports, regardless of the effect upon our exports. In the fourth year since the conclusion of the war the balance of trade in favor of our country is relatively greater than before the war. Imports represent an insignificant proportion of the American consumption. The chemical schedule imposes duties upon about 300 different items, covering a wide range of commodities of primary importance. The rates are designed to protect in the sense that they are to be prohibitory, and are intended to operate as an effectual embargo. The rates cannot be warranted from any standpoint of revenue, because the imports in many cases are negligible, not comprising 1 per cent of the domestic production.

Advocates World Market

"As a matter of general policy," continued Senator King, "the endeavor ought to be to permit the industries of the United States the widest possible range for the selection and procurement of the raw materials of the respective trades, particularly in the field of primary chemicals and chemical compounds. There is scarcely a chemical of wide general use and consumption which we do not produce in superabundant quantities. The surplus must find an outlet in the markets of other countries.

"The aim of the American producer is a large production of standardized products. In the pursuit of this purpose he has been willing to remit to the foreign technicians the development and the production of the more refined and complex chemical compounds of small relative consumption, for which a wide world market alone warrants the investment of capital for their composition and production."

After citing instances to show that the increases of duty in the chemical schedule range as high as 700 per cent over the present rate, Senator King declared these rates were made in the interest of companies of very large capital. He then proceeded to list a number of chemical companies and to comment on their financial strength.

Opposition to Potash Schedule

Senator Harris, of Georgia, has introduced an amendment to the tariff bill placing potash on the free list, on the ground that as nearly all potash imports are used in the manufacture of fertilizer the duty proposed in the bill will increase the cost of fertilizer to farmers. The Senate Finance Committee proposed duties for 5 years after enactment of the law, and thereafter the free entry of the product, but the Harris amendment will place the product on the free list immediately.

An amendment by Senator Jones of New Mexico reducing the duty on boric acid from 1½c. to ¾c. a pound was defeated in the Senate by a vote of 26 to 47.

A.C.S. Committee on Society Procedure Appointed to Improve Organization

At the meeting of the Council of the American Chemical Society during the recent sessions at Birmingham, Ala., a motion was passed to the effect that the president of the society be authorized to appoint a committee of seven to consider various suggestions looking toward improvements in Society procedure, such as the method of election of members, the geographical distribution of directors, the status of the advisory committee and the advisability of intersectional meetings.

President Edgar F. Smith has appointed the following committee to cover this matter: A. V. H. Mory, chairman, 634 Hearst Building, Chicago, Ill.; George L. Coyle, L. C. Drefahl, Graham Edgar, H. C. Parmelee, J. N. Swann and R. E. Swain. The committee will be known as the committee on progress in society procedure and its term is to extend to April, 1923.

The committee will welcome suggestions from members on ways and means of improving society procedure along the above-mentioned lines or on other subjects that might fall within its jurisdiction.

Dye Investigation Report in Preparation—Hearings Not Officially Closed

The report which will represent the views of the Shortridge sub-committee which has conducted the investigation of the dye industry is being formulated and will be submitted to the full committee immediately on its completion, which probably will be the latter part of this month. It is practically certain that this report will state that the charges of monopoly in the dye industry have not been substantiated.

Senator Shortridge has made it clear that while there must be an end to the investigation, he does not want to stop taking testimony if there is any one else who cares to be heard. Before the investigation is officially closed, H. E. Howe will appear to explain the chemical exhibit in the committee room.

Substitute for Stanley Patent Bill Proposed by Chemical Engineer

Realizing that compulsory working of patents along the lines suggested in the Stanley bill is too strongly opposed to permit of its becoming a law, Henry Howard, president of the American Institute of Chemical Engineers and chairman of the executive committee of the Manufacturing Chemists' Association, has suggested a substitute. The substitute has been accepted by Senator Stanley.

Mr. Howard's proposal would grant jurisdiction to any United States Circuit Court of Appeals to conduct an investigation upon request of any citizen or firm. Requests for investigation could be made 2 years after the issuance of the patent in cases where the patent is being worked in foreign countries, but not in the United States. The text of the proposed bill is as follows:

> That 2 years after the issuance of any United States patent, or at any time after the expiration of that period, if it is shown that the invention covered by such patent is being worked in a substantial manner in a foreign country, and that the owner thereof has failed to work it in the United States, and has refused or refuses to grant licenses thereunder upon such reasonable terms as would make it practicable to practice the patent in the United States, then on the petition of any reputable American citizen, corporation or partnership, exclusive jurisdiction is hereby granted to any United States Circuit Court of Appeals in whose district or circuit the last known residence of the owner of the patent is located, and in the case of an alien the Court of Appeals of the District of Columbia, to investigate upon proper hearing, all the pertinent facts, and the burden of proof shall be upon the owner of the patent to show that he has been and is using reasonable diligence in bringing about the bona fide working of said patent, either himself or through the aid of licenses in the United States, on a scale sufficient to show a bona fide establishment of the industry therein, and upon failure to make such showing, the court shall order a non-exclusive license granted to the petitioner upon such terms as it shall determine to be equitable. The costs therein to be adjudged to be paid by the party against whom the decree is entered.
>
> After the expiration of 3 years of the granting of a license as herein provided and upon the petition of either party in interest, the court which granted the license shall hear the parties with a view to investigating existing conditions and making such changes in the rate of royalty as in its judgment conditions warrant, the expenses of such proceedings to be charged to the party against whom the decision is made; provided, however, that nothing in this act shall be construed to prevent the parties to such a license from agreeing among themselves as to the royalties to be paid.

Trend of Modern Organic Research Discussed by New York Section

In a delightfully informal and interesting manner, J. F. Norris, professor of organic chemistry at Massachusetts Institute of Technology, addressed the New York Section of the American Chemical Society on May 5 on "The Trend of Modern Organic Research." Prof. Norris remarked that the trend of organic research is shown by the establishment of modern research laboratories by so many companies. It is a significant fact that in a great many cases, professors of organic chemistry have been chosen as directors of these laboratories, showing an appreciation of a need for a complete knowledge of the fundamentals of the subject and of the value of pure scientific research. Another modern indication of this trend is shown by the establishment of research fellowships in various universities by some of the large companies, the recipient being free to choose his subject.

Prof. Norris emphasized the importance of arousing the interest of students in the important developments that grow out of pure science. He declared that the trend of modern research is evidenced by the work of Americans particularly in the field of organic catalysts and accelerators. Developments of increasing industrial significance were discussed such as the hydrogenation of oils, the production of tetra hydro-naphthalene by catalysis, the hydrogenation of drugs such as glucine, strichnine, etc., the production of anthraquinone by catalysis, the preparation of maleic and succinic acid from benzene, anti-knock compounds of tellurium ethyl, etc., production of butyl alcohol and acetone by fermentation, the synthesis of organic compounds with enzymes and organic synthesis through plant life and photochemistry. In petroleum chemistry the trend is to make petroleum the basis of a series of compounds just as benzene is.

In the discussion which followed L. H. Baekeland emphasized the point that the United States spends more money on research than any other country. He deplored the fact that the research chemists were considered as "dead wood" when business depression came and called this a short-sighted policy. R. H. McKee said that he had observed the average time for research work to bear fruit is about 10 years and in view of this fact entered a protest against a 5-year working clause in the patent laws. G. F. Richmond emphasized the demand in industry for men who are well grounded in organic chemistry rather than its specific applications. M. T. Bogert remarked that growing co-operation is evident both on the part of industries and universities in working with an appreciation of the other's viewpoint.

Rochester Meeting, Institute of Metals and American Foundrymen

Following is a list of papers on non-ferrous metallurgy to be presented before the joint meeting of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers and the American Foundrymen's Association, to be held in Rochester, N. Y., June 5, 1922.

Institute of Metals Division Papers

"Cracks in Aluminum-Alloy Castings," by Robert J. Anderson.

"The Effect of Impurities on the Oxidation and Swelling of Zinc-Aluminum Alloys," by M. M. Pierce and Mr. Brauer.

"Temperature Problems in Foundry and Melting Room," by John P. Goheen.

"Core-Oven Tests," by F. L. Wolf and A. A. Grubb.

"Occurrence of Blue Constituent in High-Strength Manganese Bronze," by E. B. Dix, Jr.

"Gas Absorption and Oxidation of Non-Ferrous Metals," by Bruno Woyski and John W. Boeck.

"Some Interesting Unsolved Problems of the Foundry," by W. M. Corse.

"Foundry Difficulties," by Adolph Bregman.

"Physical Properties of Cartridge Brass," by C. Upthegrove and W. G. Harbert.

"Effects of Impurities on Electrolytic Zinc," by G. D. Scholl.

"Mechanism of Metallic Oxidation at High Temperatures," by N. B. Pilling and R. E. Bedworth.

"Extreme Sensitiveness of the Action of Reducing Atmospheres Upon Heated Copper," by T. S. Fuller.

"Some Electrical Properties of Nickel and Monel Wires," by F. N. Sobast, M. A. Hunter and A. Jones.

American Foundrymen's Association Papers

"Aluminum and Aluminum-Alloy Melting Furnaces," by R. J. Anderson, Bureau of Mines, Pittsburgh, Pa.

"Melting Aluminum for Rolling Into Sheet," by J. A. Lange, Western Springs, Ill.

"Use of Secondary Aluminum Ingot in Foundry Practice," by W. M. Weil, National Smelting Co., Cleveland, Ohio.

"Technical Control of McCook Field Foundry," by E. H. Dix, Jr., McCook Field, Dayton, Ohio.

"The Use of Secondary Metal in the Brass Foundry," by C. T. Bragg, Michigan Smelting & Refining Co., Detroit, Michigan.

"Porosity of Non-Ferrous Metals," by R. R. Clarke, Pittsburgh, Pa.

"An Investigation of Segregation With a View to Preventing Its Occurrence in Castings Made of High-Lead Bronze," by Prof. R. E. Lee, Allegheny College, Meadville, Pa.

"Two-Part Castings Made in Three-Part Molds," by W. H. Parry, Brooklyn, N. Y.

National Research Council Appoints Division Officers for Coming Year

E. W. Washburn, professor of ceramic chemistry and head of the department of ceramic engineering of the University of Illinois, has been selected as chairman of the Division of Chemistry and Chemical Technology of the National Research Council. His term will begin July 1. He succeeds F. G. Cottrell, who has served as chairman during the current fiscal year. Dr. Washburn will serve as editor-in-chief of the Critical Tables of Physical and Chemical Constants. This work will be the principal project of the division during the coming year. Dr. C. J. West will be associated with the division as its executive secretary and as managing editor of the Tables.

Charles L. Reese was selected as vice-chairman of the division. In addition to the chairman and the vice-chairman, the new executive committee is to consist of Wilder D. Bancroft, R. B. Moore, W. C. Geer and Edgar F. Smith. To the members at large of the division were added the names of W. C. Geer, Lauder W. Jones and Edgar F. Smith. Dr. Smith is to complete the term of Dr. Washburn. Acheson Smith, of Niagara Falls, N. Y., was selected as the representative of the American Electrochemical Society.

Division of Research Extension

M. M. Corse was selected to succeed H. E. Howe as chairman of the Division of Research Extension. W. A. Hamor, assistant director of Mellon Institute, was chosen as vice-chairman of the division. In addition to the chairman and the vice-chairman, the new executive committee of the division will consist of C. E. K. Mees, George C. Stone and F. K. Richtmyer. E. D. Wallen, of Boston, and W. H. Tutwiler, of Philadelphia, were selected to fill vacancies among the members at large of the division.

Officers of Other Divisions

Louis A. Bauer, director of the department of terrestrial magnetism of the Carnegie Institution of Washington, was selected as chairman of the executive committee of the American Geophysical Union. Robert M. Yerkes is continued as chairman of the Research Information Service. William Duane, professor of biophysics of Harvard University, was selected as chairman of the Division of Physical Sciences. Alfred D. Flinn was continued as chairman of the Division of Engineering. Frederick P. Gay was selected as chairman of the Division of Medical Sciences. F. R. Lillie becomes chairman of the Division of Biology and Agriculture.

Fellows Elected

Eleven applicants were elected to Fellowships in physics and chemistry at the meeting of the Division of Physical Sciences of the National Research Council, held in Washington April 23. This is in addition to the thirty-two Fellows who did active work last year and who were reappointed. This work is conducted under the $500,000 appropriation made to the National Research Council by the Rockefeller Foundation to promote fundamental research in physics and chemistry. These Fellowships are awarded students who have had training equivalent to that represented by the Doctor's degree, and enable numerous exceptional students to continue with research work when otherwise they would have to seek gainful employment.

Chemists' Club Continues Employment Bureau

As a result of the action of the Council of the American Chemical Society in declining to take over the employment bureau of the Chemists' Club of New York, the latter will continue to operate the bureau as usual. Employers will find here lists of chemists for work in the plant, laboratory or class room, and unemployed chemists will be able to learn of openings in the profession. A moderate fee is charged to applicants but no charge is made to employers. Prof. Herbert R. Moody is in charge of the bureau at 52 East 41st St., New York City.

Preliminary Program Announced for U. S. Chamber of Commerce Meeting

A preliminary program for the tenth annual meeting of the Chamber of Commerce of the United States to be held in Washington, D. C., May 15 to 18 gives details of the scheduled treatment of the general subject, "European Conditions and Their Effect on American Business." It is predicted that between 4,000 and 5,000 business men will be in attendance.

Monday, May 15, will be devoted to National Council meetings and secretaries' meetings. The latter includes meetings of the National Association of Commercial Organization Secretaries and of the American Trade Association Executives. The former will be addressed by Secretary Hoover, while the trade association men will hear Magnus W. Alexander, managing director, National Industrial Conference Board.

Among the speakers before the general meetings of Tuesday and Wednesday are Joseph H. Defrees, president of the Chamber of Commerce of the United States; Arthur Balfour, vice-president of the Associated Chambers of Commerce of Great Britain; Herbert Hoover, Secretary of Commerce; John R. Howard, president American Farm Bureau Federation; Dwight W. Morrow of J. P. Morgan and Co.; Silas H. Strawn, Montgomery, Ward & Co.; A. C. Bedford, vice-president of the International Chamber of Commerce of the United States, and Albert Thomas, director of International Labour Bureau, Geneva, Switzerland. Each of these speakers will cover a phase of the general topic, so that the symposium should thoroughly cover the economic, financial and industrial aspects of the European situation in respect to the business of America.

The group on foreign commerce, meeting Tuesday and Wednesday afternoons, will hear Frank Taylor, president of the S. S. White Dental Co., on "German Competition" and Julius Klein, chief of the Bureau of Foreign and Domestic Commerce, on "Markets of the Future for Specialties and Staples."

The group on natural resources production is scheduled for a symposium on coal, including mining, labor, selling and transportation problems. A discussion on the extent to which American industries producing raw materials are dependent upon European markets will be led by addresses by C. H. MacDowell, president Armour Fertilizer Works; Sidney J. Jennings, vice-president American Smelting & Refining Co.; J. Leonard Replogle, Empire Steel Co.; Ben B. Woodhead, president Beaumont Lumber Co., and George M. Dexter, president of Dexter & Carpenter, New York City.

Other group meetings include those on civic development, domestic distribution, fabricated production, finance, insurance and transportation and communication.

A.C.S. Petroleum Research Committee Appointed

The Petroleum Section of the American Chemical Society at the recent Birmingham meeting approved the research outlined by Van H. Manning, director of research for the American Petroleum Institute, and also authorized the appointment of a special committee to co-operate with Dr. Manning in the promotion of research on petroleum. W. A. Gruse, of Mellon Institute, who is secretary of the Petroleum Section, has recently announced that the following chemists have been appointed to serve as members of this committee: W. F. Faragher, chairman, Mellon Institute, Pittsburgh, Pa.; R. E. Wilson, Massachusetts Institute of Technology, Cambridge, Mass.; R. P. Anderson, United Natural Gas Co., Oil City, Pa.; N. A. C. Smith, Bureau of Mines, Pittsburgh, Pa.; C. E. Waters, Bureau of Standards, Washington, D. C.; R. R. Matthews, Roxana Petroleum Co., Wood River, Ill., and E. W. Dean, Standard Oil Co., 26 Broadway, New York City.

It will be recalled that in the general meeting at Birmingham, Dr. Manning presented a paper based on the compilation of about seventy problems of the industry which were indicative of the character and scope of research work which he felt should be undertaken by the petroleum chemists.

Chemical Problems of the Felt Hat Industry Outlined Before Milwaukee Section, A.C.S.

Problems of interest to chemists and chemical engineers were emphasized by Alan G. Wikoff, industrial editor of CHEM. & MET., in discussing the felt hat industry before the Milwaukee Section of the American Chemical Society, April 28.

Fur is almost universally used as raw material for felt hats. Contrary to popular impression, no wool is used except perhaps in some of the cheapest hats. In the preparation of the fur for the felting operation, it is dampened, and brushed with a solution of mercuric nitrate, and the treated skin dried quickly in heated ovens or chambers. This operation, which is essential to the development of satisfactory felting properties in the fibers, offers a most interesting field for chemical investigation. The mercuric nitrate acts upon the scales on the surface of the fur fibers in such a way that they stand out sharply and thus present a much rougher surface for the interlocking process which produces felt. However, mercuric nitrate is a dangerous poison and since it is dried on the fibers its effects are felt not only in the carroting department but in many of the subsequent operations. Indeed, mercurialism in the form of "hatters' shakes" has long been associated with this industry. It would seem that a careful study of the swelling and shrinking action of different reagents on protein material might lead to the discovery of an efficient but less harmful substitute.

While there is scarcely a department which does not offer problems of interest to the chemist and chemical engineer, those in the carroting room, the dye house and the stiffening room are most evident.

"Informashow" Offers Interesting Features for Rochester Meeting of Purchasing Agents

The entire group of buildings of Rochester's famous "Exposition Park" has been engaged for the annual convention and exhibition of purchasing agents in that city in order to house a representative exhibition of products. Among the interesting exhibits will be an immense booth planned by the Eagle-Picher Lead Co., showing a complete plant in miniature, engaged in manufacturing sublimed white lead. It is also expected that one of the leading makers of writing paper will have a paper-making plant in operation with a completely equipped laboratory as an educational feature.

This is the first time in the history of the association that the purchasing agents have invited the selling agents to meet them on common ground at an exhibition in connection with their convention. The occasion promises to be unique, as here the manufacturer and his salesmen may display and demonstrate their products to the largest buyers in the country.

Besides the speakers of national reputation who will address the convention on such subjects as "Commercial Bribery," "Arbitration," "Standardization of Coal Contracts," "State and Municipal Purchasing Methods," etc., the group meetings and technical demonstrations will cover many subjects such as iron and steel, cotton, lumber, wool, paper, etc. These group discussions will be led by experts in the various lines.

Favor Revival of Patent Convention With Germany

After having reviewed the arguments for and against the revival of the patent convention with Germany, the State Department is understood to be inclined to revive the treaty under the authority conferred by the Senate.

The Senate Committee on Patents has reopened its hearings on the working clause bill.

Oil Chemists' Meeting Postponed

Owing to serious flood condition of the Mississippi River, the annual meeting of the American Oil Chemists' Society, which was to have been held at the Grunewald Hotel, New Orleans, on May 8 and 9, has been postponed to June 5 and 6.

Recent Oil Developments in Canada

A syndicate which includes Senator N. Currie of Nova Scotia, W. M. Butler of the Canadian Car Co., M. J. Norcross of the Canadian Steamship Lines, General J. W. Stewart of Vancouver and R. N. Wolvin of the British Empire Steel Corporation has been formed to explore a large area of oil lands in the vicinity of Hay River, Alta. Boring operations for oil and natural gas will be started on an extensive scale during the coming summer.

NEW BOOM IN MANY ISLAND DISTRICT

A heavy flow of wet gas was struck recently in a well that was being sunk by the Medicine Hat Development Co. in the Many Island district, 25 miles northeast of Medicine Hat. The gas was struck at a depth of 1,640 ft., and was so "wet" with gasoline that it had the appearance of steam. The strike has caused such a rush for leases that people stood all night outside the Dominion land office, at Lethbridge, to be among the first to file leases in the morning.

The Canadian Government has recently made some changes in the regulations governing oil and natural gas permits and leases in the Northwest territories. Applications for permits must be accompanied by fees at the rate of 50c. per acre, the rental to be computed on one-half of the area of the location. The time limit on which a permitee must have a drill on the ground located has been extended to 4 years from the previous time limit of 2 years. Rentals for the second, third, fourth and fifth years are placed at $1 per acre yearly, but provision is made for certain refunds according to the amount of boring that has been done on the location.

American Society for Testing Materials Announces Program for Atlantic City Meeting

Advance notices of the twenty-fifth meeting of the American Society for Testing Materials have been issued. It will take place at the Chalfonte-Haddon Hall, Atlantic City, N. J. Aside from committee meetings, the various sessions will be as follows:

Tuesday, June 27. Morning: On Non-Ferrous Metals, Metallography and Corrosion. Afternoon: On Wrought, Cast and Malleable Iron. Evening: Presidential address and entertainment.

Wednesday, June 28. Morning: On Steel. Evening: On Impact Testing.

Thursday, June 29. Morning: On Fatigue of Metals and Methods of Testing. Afternoon: On Coal, Coke, Timber and Shipping Containers. Evening: Simultaneous session on Preservative Coatings, and on Concrete Aggregates, Road Materials and Waterproofing.

Friday, June 30. Morning: Simultaneous sessions on Lime, Gypsum and Ceramics, and on Petroleum Products, Insulating Materials, Textiles and Rubber. Afternoon: Golf and tennis tournaments. Evening: On Cement and Concrete.

Warner-Klipstein Merger Reports Unfounded

Recent rumors and statements in the daily press to the effect that the Warner Chemical Co. interests have taken over the E. C. Klipstein & Sons Co. are entirely without authority and without foundation, according to officials of both companies. The Warner interests never have had nor have they now any financial interest in the E. C. Klipstein & Sons Co., it is stated. There has been no change in the friendly relationship between the companies concerned. The working arrangement between the various companies will continue as heretofore.

Public Conference on Muscle Shoals

The Southern Commercial Congress has arranged for a series of public meetings at Florence and Sheffield, Ala., May 22 to 24 to consider the projects for the disposal of Muscle Shoals. Delegates from all over the country are expected. In view of the decided sentiment through the South in favor of the acceptance of Ford's offer, it is probable that the influence of the conference will be exercised toward that end.

Tacoma Chemical Club Forms Council for Service to Community and Profession

A significant step toward a more widespread appreciation of the chemical engineering profession was taken recently by the Olympic Chemical Club of Tacoma, Wash. At the regular meeting on April 11, the club adopted a charter creating an active body of five members to be known as the Chemical Engineering Council which will co-operate with other civic organizations in the up-building of the community. The personnel of the first Council is made up of the following: T. J. Porro, J. E. Berkheimer, S. A. Huntington, Douglas Stewart, R. E. Chase and W. Stedman, ex-officio member.

The purpose of the Council, as stated in the charter, is to promote the general welfare of the community in matters pertaining to chemistry and also to promote the welfare of the chemical profession. The duties of the Council include aiding in the development of desirable new industries, assisting in the proper development of established industries, educating and protecting the public in matters pertaining to chemistry and raising the professional ethics of professional chemists and chemical engineers. It is emphasized that the Council will not attempt to give free consulting advice or encroach upon the field of qualified experts.

The Council plans to meet once a week and has already begun to carry out its duties in accordance with its charter, giving evidence of filling a real need in the community.

Chemical Expenses of Government Reduced—C.W.S. Shows Savings in Varied Fields

Expenditures of government departments dealing with chemistry have been reduced during the year which closes June 30 next, according to a report of the Budget Bureau of Congress. A saving of $32,000 in expenditures in the Bureau of Chemistry of the Agricultural Department is noted, while larger savings are reported for the Chemical Warfare Service of the army, totaling $224,431, not counting $354,380 saved by abandonment of the branch of the service at Lakehurst and its consolidation at Edgewood, Md. At Edgewood there was in addition a saving of $261,215 by developing more economical operation of the power plant.

In co-operation with the navy in the manufacture of gas masks the Chemical Warfare Service saved the navy $129,960. The Service is co-operating with other government departments by use of its facilities, resulting in savings. This co-operation includes aid to the Treasury in fumigating ships, assistance to the Bureau of Mines in producing gas masks for industrial purposes, extermination of harmful insects for the Agricultural Department, measurement for the Bureau of Standards of the flow of gas in large meters used in the natural gas fields, and destruction of locusts for the Insular Bureau in the Philippines and of rats in the sugar cane fields of Hawaii.

Newly Organized Railroad Will Connect Muscle Shoals With Gulf

The Muscle Shoals, Birmingham & Pensacola R.R., organized in Pensacola and charter for operation of which has been granted in Florida, has formally qualified with the Secretary of State of Alabama to engage in business in that state. The proposed railway will connect Muscle Shoals with the Gulf of Mexico, extending from Pensacola northward to a point near Muscle Shoals, with a branch line between Gateswood Junction and Gateswood in Baldwin County. Within the State of Alabama over 300 miles of main track will be constructed, with sidetracks totaling 29 miles.

The railway company is capitalized at $2,500,000, and under the articles of incorporation filed in Tallahassee, Fla., its indebtedness must not exceed $25,000,000. The officers of the company are John T. Steele, Buffalo, N. Y., president; Hubert C. Mandeville, Elmira, N. Y., vice-president, and Roscoe C. Greenaway, secretary. No announcement has been made as to when construction work on the railroad will be started.

Potash Found in New Area in Texas

The discovery of potash in notable amounts in a new area in Texas is announced by the United States Geological Survey. The new discovery is brought to light through the analysis by the Survey of drill cuttings collected from the Santa Rita No. 1 well, drilled by the Texon Oil & Land Co., in the southwest corner of Reagan County, Texas. Most of the samples contained no potash worth noting, but the sample which, according to the driller's log, was taken from bailings after drilling from 1,150 to 1,165 ft., contained the equivalent of 2.46 per cent of K_2O; that from 1,175 to 1,182 ft., 5.63 per cent; 1,155 to 1,265 ft., 5.65 per cent; 1,265 to 1,275 ft., 2.50 per cent; 1,275 to 1,283 ft., 6.38 per cent; 1,283 to 1,293 ft., 7.88 per cent; 1,293 to 1,300 ft., 4 per cent; 1,310 to 1,316 ft., 2.05 per cent, and 1,316 to 1,325 ft., 8.29 per cent K_2O. This, the richest of the samples, indicates 10.78 per cent of K_2O in the soluble salts when 1 gram of the dry rock is dissolved in 100 c.c. of water.

The well was drilled by standard rig. Accordingly the amount of salt taken in solution by the water used in the process of drilling and bailing is not known. Therefore these cuttings, while significant as disclosing the presence of potash salts in this region, which is 120 miles from the Means No. 1 well in Loving County and 55 miles from the Bryant well in Midland County, where also, according to previous announcements of the Survey, potash deposits are present, do not furnish adequate information as to either the precise thickness of the potash beds or the richness of any considerable thickness of salts penetrated by the drill. Core drilling is needed to furnish definite information.

Wisconsin Plans Colloid Research and Symposium During Summer Semester Under Svedberg

The University of Wisconsin announces that Prof. The Svedberg, of the University of Upsala, will be in residence for the second semester of the scholastic year 1922-23 and the summer session of 1923.

The chief interest of Prof. Svedberg while at the University of Wisconsin will be the organization and direction of research in colloid chemistry. In addition to this work he will also deliver a series of lectures on the general subject and will conduct seminaries for those who are interested in special applications of colloid chemistry.

It is planned to hold a general symposium on colloid chemistry at Madison in June, 1923. Prof. Svedberg will be in charge and papers will be presented and discussed by a number of the leading colloid chemists of America. It is hoped that many who are in the teaching profession and in industrial work may find it possible to attend the symposium and the following 6 weeks of lectures, seminaries and research. The summer session opens June 25, 1923, and closes Aug. 3.

Second Conference on Commercial Engineering Points Out Need of Engineering Training

The second public conference on commercial engineering was held at the Carnegie Institute of Technology, Pittsburgh, Pa., on May 1 and 2, under the direction of the committee on commercial engineering of the United States Bureau of Education. The sessions were featured by a number of addresses by prominent engineers and educators and the discussions were participated in freely by those in attendance.

In a statement embodying the principles which the conference believes to be expressive of proper aims and purposes of educational institutions and industrial organizations, the importance of imparting to engineering students a conception of the breadth of the field was stressed. The desirability of introducing some engineering training in the curricula of schools of commerce and business and of economics and business subjects in engineering schools was emphasized. Better co-operation with the industries in shaping the courses to meet the needs of business for technical executives was recommended.

English Chemists' Exhibition Scheduled for June

Announcement is made of the twenty-third Chemists' Exhibition, to be held at the Central Hall, Westminster, facing Westminster Abbey, London, S.W., on June 19-23, 1922.

The exhibition will consist of a most comprehensive display of drugs, chemicals and allied goods. It is attended each year not only by the pharmacists of Great Britain and overseas dominions, but by a number of representatives of the drug and chemical trades from other countries.

Anyone interested in this field visiting London during the exhibition week will be assured of a hearty welcome.

New Steel Development in South Africa Proposed

A group of capitalists in England and South Africa has sent a mining engineer to thoroughly investigate the report that there are important deposits of first-class iron ore and an abundance of coal in South Africa within reasonable distance of each other that might make it profitable for at least one good steel plant. He is just returning to England and states that his investigations have been eminently successful. Deposits of high-grade ore have been proved of sufficient quantity to carry on the industry for 50 of 60 years, while other sources are expected to be developed practically without limit. It is proposed not only to manufacture iron and steel but also to recover tar, sulphate of ammonia, benzene and other byproducts of coke.

Personal

WILLIAM J. BURGESS has resigned from the Electric Storage Battery Co., Philadelphia, Pa., to accept the position of chemical director of the Pennsylvania Coal Products Co.'s plant at Petrolia, Pa.

THOMAS F. COLE has been elected president of the Seneca Copper Corporation, New York, N. Y., succeeding J. Parke Channing, recently resigned.

F. A. J. FITZGERALD announces that the FitzGerald Laboratories, Inc., has been dissolved. He is continuing his consulting practice at Niagara Falls, N. Y.

LENNART VON FRIESEN, assistant chief engineer of Jernkontoret, the Swedish ironmasters' association, is in the United States for a stay of several months, during which time he hopes to inspect many American metallurgial plants.

C. J. GOODWIN, chemical engineer of London, England, left the end of April for a business tour of Europe. He plans to visit France, Belgium, Switzerland, Austria, Germany and Italy.

W. S. GREENE of Los Angeles is leaving for Mexico, having been engaged as designing engineer by Cía. Minera Mexicana Los Tejones, Yaga, Nayaritt, on the construction of its 250-ton cyanide plant.

Dr. FRANKE HAVENS of the Atlantic Products Co., Philadelphia, Pa., has been elected president of the Philadelphia Chemical Club for the ensuing year. JOHN STUTT, of E. I. du Pont de Nemours & Co., has been elected vice-president; CHARLES A. WAGNER, of the Charles A. Wagner Co., is secretary, and WILLIAM THORN, of Innes, Speiden & Co., is treasurer.

Dr. KUNO B. HEBERLEIN, president of the International Process and Engineering Corporation, New York, is in Europe on an extended business trip.

O. P. HOOD, chief mechanical engineer of the Bureau of Mines, is to spend the summer in Europe investigating recent developments in fuels. He will give special attention to the problems of lignite processing and utilization, in order that the bureau may take account of the latest European developments in planning further work on its special program on lignite.

Prof. J. H. JAMES, head of the department of chemical engineering, Carnegie Technical Institute, and Prof. H. C. BASHIOUM, head of the same department at the University of Pittsburgh, Pa., spoke at the recent meeting of the Pittsburgh Section of the Society for the Promotion of Engineering Education, at Carnegie Tech., on "Chemical Engineering Curricula as They Should Be."

T. A. KLEINFELTER, superintendent at the Tottenville (Staten Island) plant of the Atlantic Terra Cotta Co., resigned May 1, to become general manager at the plant of the J. L. Mott Co., pottery branch, Trenton, N. J. He will be succeeded at the Tottenville works by Frederick Parsons.

Prof. H. R. MOODY of the College of the City of New York has been made director of the department of chemistry in that institution in place of the late Dr. Baskerville.

W. W. ODELL, of the Bureau of Mines fuel division, will spend the summer in North Dakota on a further co-operative agreement between the bureau and Prof. Babcock of the university. It is planned to build another lignite retort for manufacture of lignite char, and the work during the coming summer will deal with the behavior of this new retort and the character of the products which can be made from a low-cost installation. The work is based on the assumption, demonstrated by recent investigations of the bureau, that lignite char can be used direct in certain types of stoves and furnaces without briquetting.

JOHN ORTELL, superintendent of safety at the plant of the Carnegie Steel Co., Pittsburgh, Pa., spoke at the recent annual meeting of the Eastern District of the Portland Cement Association, Allentown, Pa.

Dr. LESTER A. PRATT, who has been in charge of the research laboratory of the Merrimac Chemical Co. for the past 6 years, has been made director of research for the company.

D. A. PRITCHARD, until recently electrochemical superintendent of the United Alkali Co. in England, has been appointed works manager of the Canadian Salt Co., Windsor, Ont., Canada. Mr. Pritchard recently arrived from England and assumed his new duties.

CHARLES L. ROBINSON has become general superintendent of the Simes Leather Co., which has recently taken over the A. H. Walton plant at Bridgton, Me.

HERVEY J. SKINNER, of Skinner, Sherman & Esselen, Inc., sailed for Cuba on April 28 on a trip of inspection of the sugar properties of the United Fruit Co. He will probably be occupied on this work about a month.

Dr. W. R. WHITNEY addressed the Denver Section of the American Chemical Society on May 6, 1922. Members of the American Institute of Electrical Engineers, the Colorado Scientific Society and the Teknik Club were also present.

R. E. ZIMMERMAN, director of the research laboratory of the American Sheet & Tin Plate Co., has been appointed assistant to S. A. Davis, vice-president in charge of operations, succeeding the late Robert Skemp.

Obituary

PHILIPPE AUGUSTE GUYE, professor of theoretical and technical chemistry at the University of Geneva, Switzerland, died on March 27, 1922. The following biographical data are taken from the *Tribune de Geneve*, March 29: Prof. Guye was born in 1862 at Geneva. At the age of about 30 he discovered the process for the manufacture of nitric acid from atmospheric nitrogen and in 1894, in collaboration with his brother Eugene and Gustave Naville, patented the electric furnace now classic and known as the "four Genevois" for the industrial realization of his discovery. In 1896 he became professor of physical chemistry at the University of Geneva and later professor of theoretical and technical chemistry, the chair he occupied at the date of his death. His most important contribution to chemical science is the study on atomic weights. He was the founder and editor of the *Journal de Chimie Physique* and edited also the magazine *Helvetica Chimica Acta*.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Foreign Trade and the Business Cycle

The increase in foreign trade during March is regarded as a particularly significant factor in the movement toward business recovery. Exports, which totaled $332,000,000 in March, represent an increase of 32 per cent over the February figure as against a usual seasonal increase of 2 per cent. Imports in March amounted to $258,000,000, a 19 per cent increase over the preceding month. According to the Harvard Economic Service, this advance, which is well in excess of the average seasonal rise of 11 per cent, "shows that imports have probably 'turned the corner.' When seasonal influences and long-time trend are eliminated, October, 1921, appears as the low point; the trend since that time has been upward and the increase from January to March has been substantial. This movement is significant, since imports move with the business cycle, and their upturn at this time corroborates the evidence from other sources that substantial business improvement is under way."

Imports and Exports of Chemicals

Imports of dutiable chemicals in March, 1922, were valued at $3,389,512. The imports of chemicals on the free list were valued at $5,288,365. The figures for March, 1921, were $2,241,914 for the dutiable chemicals and $8,250,542 for free list chemicals. The figures for February, 1922, are $2,713,180 for dutiable chemicals and $4,044,647 for those on the free list.

The value of imports of coal-tar products during March of this year is $681,388. While this is an increase of $250,000 over February imports, it is more than $800,000 less than the imports of these products in March, 1921.

The imports of gums continue to increase. March imports aggregated 9,807,459 lb. This is 2,500,000 lb. greater than the February imports and more than 5,000,000 lb. greater than the imports of March, 1921. Imports of specific items which show important variations are as follows:

	March, 1921 Lb.	March, 1922 Lb.
Oxalic acid	336,114	
Muriate of ammonia	37,514	485,159
Sulphide of arsenic	376,945	1,254,481
Calcium acetate, etc.	22,020,963	4,325,176
Benzene	151,774	
Synthetic indigo	1,471	16,726
Gum arabic	228,654	1,059,626
Synthetic camphor	43,691	161,550
Copal	1,142,267	2,923,715
Shellac	1,530,668	2,009,148
Chloride of lime	319,214	1,000,634
Nitrate of potash	1,061,620	
Cyanide of soda	158,003	1,642,786

The total value of chemicals exported in March was $5,389,386. This compares with $3,803,768 in February and $4,974,194 in March, 1921. Exports of pigments, paints, and varnishes in March, 1922, were valued at $1,057,347. This is an increase of nearly $300,000 over February and exceeds substantially the rate of exportation in March of 1921. There was a slight increase in the exports of fertilizers and fertilizer materials in March of 1922. The increase amounts to about 15,000 tons as compared with February, but is only 2,000 tons in excess of exports in March of last year. There was a very decided increase in explosives exports. The total in March reached 2,113,796 lb., more than double the rate in February. Comparative figures covering a few of the exports are as follows:

	March, 1921 Lb.	March, 1922 Lb.
Benzene	10,809,450	13,164,479
Sulphuric acid	673,314	1,003,128
Acetate of lime	681,050	2,541,897
Calcium carbide	576,442	1,106,905
Copper sulphate	231,171	915,482
Glycerine	164,765	717,833
Magnesium sulphate		178,958
Soda ash	1,000,013	2,411,745
Caustic soda	1,265,411	18,612,225
Bicarbonate of soda	409,525	1,377,158
Zinc oxide	239,403	535,442

Increased Earnings During First Quarter of 1922

Hercules Powder Co. — The quarterly statement of the Hercules Powder Co. for the 3 months ended March 31, 1922, is very encouraging. This company's gross receipts during the first quarter of the current year were $4,243,-659.17, as compared with $2,828,237.70 during the same period of last year. The net earnings from all sources after deducting expenses incident to manufacture and sale, maintenance and repair, depreciation, taxes, etc., was $375,847.20 in the first quarter of 1922. During the first quarter of 1921 the Hercules company had reported a loss of $62,400.80.

Air Reduction Co.—The gross income of the Air Reduction Co. during the first quarter of 1922 was $1,369,673.57. After subtracting operating expenses of $908,718.58 and interest and payment to reserves of $262,889.77 as well as extraordinary charges to profit and loss of $5,784.94, the net earnings of the Air Reduction Co. on its outstanding stock of 153,110 shares amounted to $192,270.28.

Changes in Freight Rates on Lead Pigments

The Interstate Commerce Commission has decided that the proposed reductions in freight rates on sublimed lead and certain other pigments from central territory to Eastern points are not justifiable. Reduced rates on red lead and litharge were approved, however, effective May 8.

Equipment in the Wood-Distillation Industries

The wood-distillation industries have gone through a number of stages of development in their technology, and this is well reflected in the type of equipment now in use in those industries. The old wasteful charcoal pits were first replaced by brick kilns from which condensable vapors could be recovered. This equipment is still being used, but a great forward step was noted when the use of iron retorts, built in pairs, was inaugurated. A still later improvement followed the introduction of large rectangular ovens, which in many of the larger plants have completely replaced the smaller iron retorts.

The number of retorts, ovens and kilns used by the hardwood distillation industries in 1919 and the steam extraction equipment used in softwood distillation are shown

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	159.77
Last week	158.41
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

The continued but gradual rise in the prices of three chemicals of basic importance—viz., caustic soda, caustic potash and soda ash—and the sudden strengthening of the linseed oil market are directly responsible for the unusual increase in this weighted index number.

TABLE I—EQUIPMENT USED IN WOOD-DISTILLATION INDUSTRIES, 1919

(Data from Bureau of the Census)

State	Aggregate Capacity (Cords)	Kind and Capacity of Equipment: Retorts Number	Retorts Total Capacity (Cords)	Ovens Number	Ovens Total Capacity (Cords)	Kilns Number	Kilns Total Capacity (Cords)	Steam Extractors Number	Steam Extractors Total Capacity (Cords)
United States	16,088	824	3,140	243	2,008	167	10,070	132	870
Hardwood distillation	14,684	628	2,676	232	1,938	167	10,070	...	...
Michigan	9,482	160	1,102	20	180	130	8,200	...	...
New York	665	188	279	47	386	...	.....	...	...
Pennsylvania	2,118	214	686	159	1,312	12	120	...	...
Wisconsin	1,832	10	82	...	.....	25	1,750	...	...
All other states*	587	56	527	6	60	...	.....	...	...
Soft wood distillation	1,404	196	464	11	70	...	.....	132	870
Alabama	160	20	10	...	.....	...	.....	60	150
Florida	420	18	30	11	70	...	.....	40	320
Georgia	669	76	306	...	.....	...	.....	22	363
Louisiana	57	32	40	...	.....	...	.....	8	17
All other states †	98	50	78	...	.....	...	.....	2	20

* Includes Alabama, Connecticut, Kentucky, Mississippi, Missouri, Tennessee and West Virginia.
† Includes Michigan, Mississippi, North Carolina and Texas.

in Table I, which is adapted from the recent bulletin of the Census Bureau on Forest Products.

The production of these industries during the last census year was as follows:

Hardwood distillation products	Quantity
Crude wood alcohol, gal	*9,103,996
Acetate of lime, lb	168,956,432
Charcoal, bu	46,354,432
Tar, gal	552,124
Tar oils, gal	222,398
Wood creosote, lb	945,605

* Includes a small amount of wood alcohol manufactured from softwoods.

Softwood distillation products	Quantity
Rosin, bbl. (280 lb.)	234,030
Turpentine, gal	1,534,333
Tar, gal	2,125,757
Tar oils, gal	581,042
Charcoal, bu	1,702,103
Wood creosote, lb	207,050

New York Market

NEW YORK, May 8, 1922.

A continued active inquiry for solid caustic soda has kept the chemical market in a moderately firm condition during the past week. It is extremely difficult to book any May shipments of standard brands and June contracts are practically sold up. Prussiates have also shown some notable advances, the sodium salt recording a net advance of ½c. per lb. Consuming inquiries have been quite plentiful for copper sulphate and the market throughout the week has shown a decided firmness, with very little prime stock obtainable. Barium products have maintained their recent strength and the market is in relatively light supply at the present time. Small lots of caustic potash are attracting considerable interest and the market has shown a better tone. The chlorates are meeting with a better demand, especially chlorate of soda. Bichromates are moving rather slowly and without any important price variations. Acetate of soda is also considerably stronger. Citric and tartaric acids continue firm, with the latter showing a fractional change. The general market may be summed up as making slow but steady progress in the face of unceasing labor difficulties, the uncertainties surrounding a readjustment of the tariff schedules and the disturbing influences of the coal strike.

General Chemicals

Acetate of Soda—Recent buying of this chemical has noticeably affected spot supplies and sales were reported up to 5c. per lb. Very little material was available and the market was quoted firm at 5@5¼c. per lb.

Amyl Acetate—Sales are reported on the basis of $2 per gal. and quotations are heard at $2@$2.25, depending on quantity. The movement is irregular with no special feature to trading.

Caustic Potash—Numerous inquires have reached the market for the 88-92 per cent, and quite a number of small-lot orders have been booked. Several leading sellers quote 6@6¼c. per lb. The tendency is for higher prices.

Caustic Soda—Firmer conditions have developed in the export market and higher prices were noted. Offerings for nearby shipments are very scarce, while the demand is extremely active for consuming requirements in South America, Japan, Germany and Italy. Outside brands of caustic were held at $3.75@$3.80 per 100 lb., May-June shipment. Dealers report sales for domestic consumption at 3¾@4c. per lb. Producers quote contracts at 2½c. per lb., basis 60 per cent, carload lots, f.o.b. works. Ground and flake caustic were offered at $3.65 per 100 lb., f.o.b. works, carload quantities.

Chlorate of Potash—Several sales were reported up to 6½c. per lb. for the powdered, while in other directions 6¼c. could still be done. Crystals are rather scarce and as high as 8¼c. per lb. was quoted. Producers continue to quote 8c. per lb. for immediate shipment.

Fusel Oil—Leading sellers quote the crude at $1.30@$1.40 per gal. with some trading reported at the lower figure. Refined is quoted at $2.15@$2.50 per gal., depending on quantity. Demand is moderate.

Sal Soda—Producers are booking business on the basis of $1.20 per 100 lb. in barrels, f.o.b. works. Sales at New York were reported at $1.40 per 100 lb. Kegs are quoted at ¼c. per lb. higher. Demand is not very active.

Coal-Tar Products

The continued strength in phenol has been the feature of the coal-tar market during the past 2 weeks. Spot material toward the end of last week was extremely scarce and the market presented a very firm appearance. Buying conditions in the benzene market continue exceedingly strong, with producers able to quote for future shipment only. Naphthalene is moving quietly with very little change reported. Sales of phthalic anhydride were reported somewhat lower at 35c. per lb. Lower prices were heard for monochlorbenzene, and several sales have gone through as low as 9c. per lb. Producers of salicylic acid reported an advance of 1c. per lb. on both grades. It may be stated in general that business in this market is somewhat irregular and confined mostly to specialties. The tone throughout the list, however, is much steadier than noted a few weeks ago.

Beta Naphthol—First-hand sales of the technical grade are reported at 26c. with the general range around 26@27c. per lb. The demand is moderate, with trading mostly in small lots.

Beta Naphthylamine—The technical grade is reported quiet at $1@$1.05 per lb. The sublimed grade is quoted at $1.50@$1.60 per lb., depending upon seller and quantity.

Cresylic Acid—First-hand sales of the 97-99 per cent are going through at 53@55c. per lb. The 95 per cent dark is moving on the basis of 48c. per gal. The market is reported firm, with a moderate amount of business transacted in small lots.

Phenol—Spot material is quoted by dealers at 13½c. per lb., and it is doubtful if better than this price could be done on any available stocks. The demand is very active, with a pronounced tendency of prices going to higher levels.

The Chicago Market

CHICAGO, Ill., May 4, 1922.

Nothing of interest developed in the industrial chemical market during the past week. Buying is still on a small scale and there is but little evidence of anyone anticipating requirements. Nearly all factors report a fair volume of small business and speculative interests are accumulating stocks of a few commodities. Foreign offers continue to be higher and it is noticeable that the quality is falling off. With these advancing foreign prices it is to be hoped that domestic producers will again be able to operate, but on many items the present selling price is far below the domestic cost of production. The local market as a whole may be characterized as very firm with no one complaining.

General Chemicals

Alkalis showed an increased firmness, with spot stocks more or less depleted. *Solid caustic soda* in small lots was available at $3.80@$4 per 100 lb. and the *ground* at $4.35 @$4.50. *Caustic potash* showed no signs of weakening and only small lots were available at 6¾c., while some houses were asking 7c., basis 88-92 per cent. *Soda ash* was firm at $2.20@$2.30 per 100 lb. for 58 per cent material in cooperage.

Alums were moving in a routine way and lacked quotable change. *Potash alum* was available at 4½@5½c. for the technical lumps and 6@6½c. per lb. for the U.S.P. powder. *Barium* compounds were exceedingly firm in price and very scarce. *Barium chloride* was quoted in small or moderate quantities at $110@$130 per ton. *Copper sulphate* continued to be in a firm position, although one factor was offering small lots at $5.75 per 100 lb., city delivery free. *Furfural* was quoted by first hands at 50c. per lb. for quantities in excess of 100 lb. *White arsenic* moved in a small volume at 7½@8c. per lb. The 7½c. material was reported as nearly all absorbed and the general quotation was on the 8c. basis. *Formaldehyde* was dull and neglected at 10c. per lb. for barrels. This figure could very likely have been shaded with a quantity order. *Glycerine* was somewhat easier and it was possible to produce c.p. material at 16c. per lb., bulk basis.

Bichromate of potash moved slowly in consuming channels at 11¾@13c. per lb. *Soda bichromate*, likewise, moved only in a routine way and was unchanged at 9@9½c. per lb. *Red prussiate of potash* was still unavailable on the spot market and offerings for future delivery were scant. *Yellow prussiate of potash* was scarce and very firm at 32@35c. per lb. *Potash permanganate* was neglected and imported U.S.P. crystals were available at 16c. per lb. *Hyposulphite of soda* moved in a fair volume at $3.95 per 100 lb. for the pea crystals in single barrel lots.

Linseed Oil

Linseed oil was reported to be moving in a good volume. Competition was very keen and it was possible to shade regular quotations a cent or two with a good sized inquiry. The boiled oil was offered today in single barrel lots at $1 per gal. and the raw oil in similar lots at 98c.

Turpentine

A good movement of *turpentine* to the paint trade continued during the week and the market was somewhat firmer. Single barrels were quoted today at $1 per gal., with the usual reductions for larger quantities or drums.

The Iron and Steel Market

PITTSBURGH, May 4, 1922.

On the whole, the volume of turnover in the steel market has decreased farther, but in some lines, notably in merchant bars, demand is approximately as heavy as at any time. A general decrease was to be expected from the strong pace of March and the fore part of April, for the rate of buying then was far in excess of both production and consumption.

The demand now seen in the market is of an insistent character, the buyers desiring early deliveries. In not a few instances delivery premiums are offered of, say, $2 or $3 a ton, but the tonnage involved is small. The condition makes a striking comparison with the condition of only a couple of months ago, when all divergences from regular prices were downward. As usual, it is the mills that were formerly most disposed to cut prices that are now most disposed to demand premiums.

It is plain that the influence of the coal strike, on the whole, is helpful to the steel market, tending to stiffen prices and to stimulate demand. Buyers seem to have no uneasiness that they may overbuy, but are exhibiting much uneasiness lest they may not receive sufficient deliveries. Through realizing that production is unlikely to increase much in the next 2 months if at all, mills are very firm in their price views, firmer than would have been expected at a time when production in the steel industry as a whole is at only about 70 per cent of capacity.

Production Heavy

The rate of steel ingot production is probably between 36,000,000 and 38,000,000 tons a year, or slightly heavier than on April 1. The phenomenal increase in production observed in the first 3 months of the year has been largely arrested, but the present rate is likely to continue. Production in December was at a shade under 20,000,000 tons a year, the rate rising to about 30,000 000 tons on March 1 and to 35,000,000 tons on April 1.

Since April 1 production of pig iron and steel in the immediate Pittsburgh district has decreased a trifle, but has been above the average of March. The Mahoning Valley and the Wheeling district have lost a trifle in production, while the Chicago and some other districts have had sharp gains.

The Carnegie Steel Co. has been operating thirty-two blast furnaces in the past fortnight, against thirty-four on April 1. The company's steel ingot production last week was 75 per cent of capacity, against 71 per cent the preceding week.

The regular market on steel products is as follows: Bars, shapes and plates, 1.50c.; bands, hoops and hot-rolled strips, 2c.; standard steel pipe, 71 per cent basing discount; blue annealed sheets, 2.40c.; black sheets, 3.15c.; galvanized sheets, 4.15c.; tin plate, $4.75; plain wire, 2.25c. On nails there are two prices, the independents holding to $2.50, according to their advance about 3 weeks ago, and the American Steel & Wire Co. adhering to the old price of $2.40, at which price it is carefully selecting its bookings. In occasional instances higher prices than quoted here are being paid, but only on small lots.

Billets and sheet bars are not obtainable at prices commensurate with those ruling on finished products, as the mills are not regular sellers, feeling that their previous commitments together with current sales of finished products will absorb all their possible production. Sheet bars might possibly be picked up at $33, but $35 seems a more probable figure, comparing with $29 in March. Report has it that 1,000 tons of billets have been bought at $32.50 Pittsburgh.

Pig Iron Market

There can scarcely be said to be any regular demand for pig iron, and there is no clearly defined market. Buyers know in general approximately what they would have to pay on forced purchases and are quite unwilling to consider such prices. They will exhaust their stocks before making any commitments, in the hope that meanwhile conditions will ease off. It chances that the strikes in the Connellsville region have affected the operation of merchant furnaces in Pennsylvania and Ohio more than the operation of steel works furnaces. Not many were in blast and some of these have had to bank, the result being that furnaces are not openly quoting prices at all. A guess is that about $24, valley basis, would have to be paid on a forced purchase of bessemer, basic or foundry, which compares with prices ruling April 1 of $19.50 on bessemer, $18 on basic and $19 on foundry, valley basis.

Connellsville coke is offered in a very limited way and there is likewise a very limited demand, on account of high prices. The market is quotable 25c. higher than a week ago, at $6.25 for furnace and $6.75 for foundry coke.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0 38 – $0 40
Acetone	lb.	$0 08 – $0 09	09¼ – 10
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9 00 – 9 50	9 75 – 10 00
Boric, crystals	lb.	.11 – .11½	11¾ – .12
Boric, powder	lb.	.11 – .11½	11¾ – 12½
Citric	lb.	—	45½ – 46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	11 – 12
Lactic, 44 per cent tech	lb.	09½ – .10	10 – 12
Lactic, 22 per cent tech	lb.	.04 – .04½	04½ – 05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		—	—
Nitric, 40 deg.	lb.	.06 – .06¼	06¾ – 07
Nitric, 42 deg.	lb.	06½ – 06¾	07 – 07¼
Oxalic, crystals	lb.	.11½ – .12	12½ – 13
Phosphoric, 50 per cent solution	lb.	.08 – .08½	08¾ – 09½
Picric	lb.	.22 – .24	24½ – 30
Pyrogallic, resublimed	lb.	—	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	11 00 – 12 00	—
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	—
Sulphuric, 66 deg., tank cars	ton	17 00 – 17 50	—
Sulphuric, 66 deg., drums	ton	20 00 – 20 50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20 00	—
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23 00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	—	60 – 75
Tannic (tech.)	lb.	.40 – .45	46 – 50
Tartaric, imported crystals	lb.	—	.27 – 28
Tartaric acid, imported, powdered	lb.	—	.28 – 30
Tartaric acid, domestic	lb.	—	— 30
Tungstic, per lb. of WO	lb.	—	1 00 – 1 10
Alcohol, ethyl	gal.	—	4 75 – 4 95
Alcohol, methyl (see methanol)		—	—
Alcohol, denatured, 188 proof No. 1	gal.	—	32 – 34
Alcohol, denatured, 188 proof No. 5	gal.	—	32 – 34
Alum, ammonia, lump	lb.	.03½ – 03¾	04 – 04¼
Alum, potash, lump	lb.	.03¾ – 04	04¼ – 05
Alum, chrome lump	lb.	07½ – 08	08¼ – 08½
Aluminum sulphate, commercial	100 lb.	1 50 – 1 65	1 70 – 2 25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	03 – 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	08 – 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	31 – 33
Ammonium carbonate, powder	lb.	.07 – 07½	08 – 09
Ammonium nitrate	lb.	.06 – .06½	06¾ – 07½
Amylacetate tech	gal.	—	2 00 – 2 25
Arsenic, white, powdered	lb.	.06¼ – 07	07¼ – 07½
Arsenic, red, powdered	lb.	.12 – .12½	12½ – 13
Barium chloride	ton	108.00 – 110 00	111 00 – 115 00
Barium dioxide (peroxide)	lb.	.20 – 21	21½ – 22
Barium nitrate	lb.	.06½ – 07	07½ – 08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – 04	04¼ – 04½
Blanc fixe, dry	lb.	.04 – 04½	—
Blanc fixe, pulp	ton	45 00 – 55 00	—
Bleaching powder	100 lb.	1 60 – 1 75	1 80 – 2 75
Blue vitriol (see copper sulphate)		—	—
Borax	lb.	.05¼ – 05½	.06 – .06¾
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	27 – 28	28½ – 35
Calcium acetate	100 lbs.	1 75 – 2 00	—
Calcium carbide	lb.	04¼ – 04½	05 – 05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01½ – 01¾	02 – 02¼
Calcium peroxide	lb.	—	1 40 – 1 50
Calcium phosphate, tribasic	lb.	—	15 – 16
Camphor	lb.	—	79 – 81
Carbon bisulphide	lb.	.06½ – .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	10½ – .12
Carbonyl chloride, (phosgene)	lb.	—	.60 – .75
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	—
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	—
Chalk, precip.—imported, light	lb.	.04¼ – .05	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	05½ – .06
Chloroform	lb.	—	37 – 40
Cobalt oxide	lb.	—	2 00 – 2 10
Copperas	ton	15 00 – 16 00	16 50 – 30 00
Copper carbonate, green precipitate	lb.	.19 – 20	20¼ – 21
Copper cyanide	lb.	—	58 – 60
Copper sulphate, crystals	100 lb.	5.50 – 5 60	5 65 – 6 15
Cream of tartar	lb.	—	24 – 26
Epsom salt (see magnesium sulphate)		—	—
Ethyl acetate com. 85%	gal.	—	60 – 65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	—	90 – 95
Formaldehyde, 40 per cent	lb.	.08½ – .09	09¼ – .10
Fullers earth, f.o.b. mines	net ton	16 00 – 17 60	—
Fullers earth—imported powdered—net	ton	30 00 – 32 00	—
Fusel oil, ref.	gal.	—	2 15 – 2 50
Fusel oil, crude	gal.	—	1 30 – 1 50
Glauber's salt (see sodium sulphate)		—	—
Glycerine, c. p. drums extra	lb.	—	15 – 15½
Iodine, resublimed	lb.	—	4 05 – 4 15
Iron oxide, red	lb.	—	12 – 18
Lead acetate	lb.	—	09⅝ – 12
Lead arsenate, powd.	lb.	.14 – 14½	14¾ – 15½
Lead nitrate	lb.	—	15 – 20
Litharge	lb.	.07½ – .08	.08½ – 08½
Magnesium carbonate, technical	lb.	.07 – .07½	07¼ – .08
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	—	1 00 – 1 80
Methanol, 95%	gal.	—	57 – 58
Methanol, 97%	gal.	—	59 – 60
Nickel salt, double	lb.	—	11 – .11½
Nickel salt, single	lb.	—	11 – .11½
Phosgene (see carbonyl chloride)		—	—
Phosphorus, red	lb.	.45 – .46	47 – .50
Phosphorus, yellow	lb.	—	.30 – .35
Potassium bichromate	lb.	10⅛ – .10¼	.10½ – 13
Potassium bromide, granular	lb.	—	.17 – .20
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – .05¼	.05½ – .06
Potassium chlorate, powdered and crystals	lb.	.06½ – .06¾	.07 – .08¼
Potassium cyanide	lb	—	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6.25 – 6 40	6 45 – 7.00
Potassium iodide	lb.	—	3.10 – 3.15
Potassium nitrate	lb.	.07⅜ – .07½	.08 – .09
Potassium permanganate	lb.	.15 – .15½	.16 – .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	28½ – .29	.29¼ – .29½
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07¼ – 07½	.07¾ – .08
Salsoda	100 lb.	1.40 – 1.45	1 50 – 1.80
Salt cake (bulk)	ton	18.00 – 20.00	—
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.90 – 2 00	2 10 – 2.50
Soda ash, dense	100 lb.	1.95 – 2.05	2.10 – 2.60
Sodium acetate	lb.	.05 – .05½	.05½ – .06
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07½ – .07¾	.08 – .08½
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5 50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06½ – .07	.07¼ – .07¾
Sodium chloride	long ton	12 00 – 13 00	—
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09½ – .10	.10¼ – .10½
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.80 – 3.85	– 3.90 – 4.15
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	– 4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	– 4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03¼	.03½ – .03¾
Sodium nitrite	lb.	.08¾ – .09	.09¼ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¼ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	—	.18 – .21
Sodium prussiate, yellow	lb.	.18 – .18¼	.18½ – .18¾
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.25
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.00 – 1.15	1.20 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04 – .04⅝	.04 – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 – 20.00	—
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	—	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	—	2.00 – 2.75
Talc—imported	ton	30 00 – 40 00	—
Talc—domestic powdered	ton	18.00 – 25 00	—
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	—	.37 – .38
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran.	lb.	.05½ – .06	.06¼ – .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08¼
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.16 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1 30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb.	.75 — .85
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97 %, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00½
Beta-naphthol, sublimed	lb.	.55 — .60
Beta-naphthol, tech	lb.	.26 — .28
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.38 — .40
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — 24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.50 — 2.60
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	.12 —	.15
Ortho-tolnidine	lb.	.16 —	.20
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.14 —	.16
Paranitroaniline	lb.	.75 —	.77
Para-nitrotoluene	lb.	.60 —	.70
Para-phenylenediamine	lb.	1.50 —	1.55
Para-toluidine	lb.	1.05 —	1.15
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.13½ —	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls	lb.	.25 —	.25½
Salicylic acid, U. S. P	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

All quotations same as previous report

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.15 —	$5.20
Rosin E-I	280 lb.	5.25 —	5.30
Rosin K-N	280 lb.	5.35 —	6.50
Rosin W. G.-W. W	280 lb.	7.00 —	7.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	86 —	86½
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.37 —	....
Rosin oil, second run	gal.	.39 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Prices remain quotably unchanged

Crude Rubber

Para—Upriver fine	lb.	$0.19 —	.19¼
Upriver coarse	lb.	.13¾ —	.14
Upriver caucho ball	lb.	.14 —	.14¼
Plantation—First latex crepe	lb.	.16½ —	.16¾
Ribbed smoked sheets	lb.	.16½ —	.16¾
Brown crepe, thin, clean	lb.	.14 —	....
Amber crepe No. 1	lb.	.16 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10¼ —	$0.10½
Castor oil, AA, in bbls	lb.	.11½ —	.12
China wood oil, in bbls	lb.	.14 —	.14½
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.09½ —	.09½
Corn oil, crude, in bbls	lb.	.11½ —	.11¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.09¾ —	.10
Cottonseed oil, summer yellow	lb.	.12 —	.12¼
Cottonseed oil, winter yellow	lb.	.13¼ —	.13
Linseed oil, raw, car lots (domestic)	gal.	.90 —	.91
Linseed oil, raw, tank cars (domestic)	gal.	.86 —	.87
Linseed oil, in 5-bbl lots (domestic)	gal.	.93 —	.94
Olive oil, denatured	gal.	1.15 —	1.17
Palm, Lagos	lb.	.07¼ —	.07½
Palm, Niger	lb.	.06¼ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09¼ —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.86 —	.87
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11¼ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¾ —	....

FISH

Light pressed menhaden	gal.	$0 54 —	....
Yellow bleached menhaden	gal.	57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$750 00	$900.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	60 00	—110 00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	14 00	— 17 50
Barytes, ground, white, f.o.b. mills	net ton	17.00	— 23 00
Barytes, ground, off color f.o.b. mills	net ton	13 00	— 21 00
Barytes, floated, f.o.b. St. Louis	net ton	23 00	— 24 00
Barytes, crude f.o.b. mines	net ton	8 00	— 8.00
Casein	lb.	.10½	— .12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6 00	— 8 00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8 00	— 9 00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12 00	— 20 00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8 00	— 12 00
China clay (kaolin)ground, f.o.b. Virginia points	net ton	13 00	— 20 00
China clay (kaolin), imported, lump	net ton	14 00	— 20 00
China clay (kaolin), imported, powdered	net ton	30 00	— 35 00
Feldspar, No. 1 pottery grade	long ton	6 50	— 6 75
Feldspar, No. 2 pottery grade	long ton	5 75	— 5 90
Feldspar, No. 1 soap grade	long ton	7 00	— 7.50
Feldspar, No. 1 Canadian, for mill	long ton	21 00	— 22 00
Graphite, Ceylon lump, first quality	lb.	06	— 07
Graphite, Ceylon chip	lb.	.04½	— .05½
Graphite, high grade amorphous crude	ton	15.00	— 30.00
Kieselguhr, f.o.b. mines, Cal	per ton	40 00	—
Kieselguhr, f.o.b. N. Y	per ton	55.00	— 60.00
Magnesite, calcined (crude)	per ton	8 00	— 12.00
Pumice stone, imported	lb.	.03	— .05
Pumice stone, domestic, lump	lb.	.05	— .05½
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	.79	— .80
Shellac, orange superfine	lb.	.81	— .82
Shellac, A. C. garnet	lb.	.72	— .73
Shellac, T. N	lb.	.78	— .79
Silica, glass sand, f.o.b. Indiana	per ton	1.25	— 2.25
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	— 4 50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16 00	— 16 00
Silica, building sand, f.o.b. Pa	per ton	2.00	— 2 75
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	— 12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	— 20.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per 1,000	$130.00
Carborundum refractory brick, 9-in	1,000	1100 00
Chrome brick, f.o.b. Eastern shipping points	net ton	40–41
Chrome cement, 40-50% Cr_2O_3	net ton	30–32
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b., Eastern shipping points	net ton	30–32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	32–35
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	27–30
Magnesite brick, 9-in. straight (f.o.b. works)	net ton	53
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	30–32
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	33–35
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	27–30

Ferro-Alloys

Quotations remain same as previous report

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Coke, foundry, f.o.b., ovens .....net ton $6.50
Coke, furnace, f.o.b., ovens.....net ton 6.00

All other prices same as previous report

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	13.00
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	5 50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32 00
Monel metal, ingots	35.00
Monel metal, sheet bars	38 00
Tin, 5-ton lots, Straits	30.875
Lead, New York, spot	5 25
Lead, E. St. Louis, spot	5 125
Zinc, spot, New York	5.475
Zinc, spot, E. St. Louis	4.975

OTHER METALS

Silver (commercial)	oz.	$0.70½
Cadmium	lb.	1.00–1.10
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1 15
Platinum	oz.	85.00@ 90 00
Iridium	oz.	150.00@ 170.00
Palladium	oz.	55.00@ 60.00
Mercury	75 lb.	55.00

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

SANTA BARBARA—The City Council is planning for extensions and improvements in the water system, including filtration apparatus, etc., estimated to cost about $240,000. Fred L. Johnston is city manager.

Connecticut

NEWFIELD—The Tuttle Brick Co., Middletown, Conn., has acquired the brick-manufacturing plant of James C. Lincoln at Newfield, including about 75 acres of adjoining property, for a consideration said to be $60,000. The new owner will operate the plant, and plans for a number of extensions and improvements.

Delaware

SMYRNA—Extensions and improvements will be made to the plant and system of the Smyrna Gas Co., recently acquired by John V. Postles and associates. A company has been organized to operate the plant.

Georgia

CONCORD—The R. H. Strickland Co. has plans under way for the rebuilding of its fertilizer plant, recently destroyed by fire, with loss approximating $75,000. G. E. Strickland is in charge.

Indiana

HAMMOND—The Jones & Laughlin Steel Co., 3rd Ave., Pittsburgh, Pa., has completed the purchase of property at Hammond, totaling about 1,000 acres of land, for a consideration approximating $750,000. It will be used as a site for a new steel works, estimated to cost in excess of $10,000,000. Plans are under way for the initial structures; no announcement has been made regarding the time of erection.

HAMMOND—Fire, April 25, destroyed a portion of the plant of the Wanner Malleable Iron Co., manufacturer of iron castings and kindred products, with loss estimated at about $80,000, including equipment. It is planned to rebuild at an early date.

Iowa

DES MOINES — The Des Moines Gas Co. is planning for the construction of a new gas plant, with gas holder of about 2,500,000 cu.ft. capacity, and general manufacturing equipment. The estimated cost has not been announced.

Kansas

LEAVENWORTH—The Great Western Mfg. Co., manufacturer of machinery, has preliminary plans under way for the construction of a 2-story and basement addition at 2nd and Choctaw Sts., to be equipped as an enameling plant. W. P. & M. K. Feth, Leavenworth, are architects.

Louisiana

ALEXANDRIA—The Old Dominion Glass Co. has commenced the rebuilding of its plant, recently destroyed by fire. New equipment will be installed.

ALEXANDRIA—The City Council is arranging for a special election to vote bonds for $110,000 for a municipal gas plant and system.

HOUMA—John O. Trahan, Houma, is organizing a company to construct and operate a local plant for the manufacture of paper products from sugar cane refuse. A sugar mill will also be erected.

Maine

PHIPPSBURG—The Basin Quarries, Inc., Portland, Me., recently organized, has acquired a local tract of feldspar property, comprising about 100 acres, and plans for the installation of a mining and refining plant, including crushing, grinding, pulverizing and other equipment. Joseph F. Perry, Portland, heads the company.

Maryland

BALTIMORE—The Rennous-Kleinle Division of the Pittsburgh Plate Glass Co., 3221 Frederick Ave., has awarded a contract to the Consolidated Engineering Co., Calvert Bldg., for the erection of its proposed new 4-story and basement plant, 62 x 95 ft., estimated to cost about $50,000. Work will be commenced at once.

CUMBERLAND — Fire, April 26, destroyed the chemical works and laboratory of Alexander Sloan, located in the building at Baltimore and Center Sts., with loss estimated at about $30,000.

EASTON—The Easton Gas Co. is arranging for extensions and improvements in its artificial gas plant and system. The property is operated by Kitzmiller Brothers, Shippensburg, Pa. The work has been ordered by the State Public Service Commission.

Massachusetts

CAMBRIDGE—Fire, April 27, destroyed a section of the plant of the Whittemore Brothers Corp., Albany St., manufacturer of polishes, with loss estimated at about $65,000, with machinery. The bulk of the damage was confined to the mixing department. It is planned to rebuild at an early date.

LYNN—Fire, April 28, destroyed a portion of the plant of the Ryan Ideal Stain & Blacking Co., Washington St., with loss estimated at about $50,000, including equipment.

Michigan

CHEBOYGAN—The Cheboygan Brick & Tile Co. is considering a proposition for the sale of its plant to other interests. It is said that the prospective owners will resume operations at an early date, and plan to make a number of improvements.

Mississippi

LAUREL—The Continental Turpentine & Rosin Co. has preliminary plans under way for the rebuilding of the large portion of its plant destroyed by fire, April 25, with loss estimated at about $100,000, including equipment.

Missouri

IRONTON—The Iron Mountain Co. is planning for the construction of a new iron ore works, including crushing, separating and other departments, estimated to cost about $500,000, including machinery. It is purposed to develop a capacity in excess of 5 cars per day.

POPLAR BLUFF—The Poplar Bluff Rubber Co., recently organized with a capital of $100,000, has plans under way for the construction of a new local plant for the manufacture of inner tubes for automobile tires, and other rubber products. Roy E. Nieman and J. J. Wehlgemuth, Maplewood Postoffice, St. Louis, Mo., head the company.

POPLAR BLUFF—The Iron Exploration Co., a subsidiary of the St. Louis Coke & Chemical Co., Granite City, Ill., is considering the installation of a new crushing and washing plant, with crusher, grinding and other equipment. Plans will be prepared at an early date.

New Jersey

TRENTON—The Ajax Rubber Co., Breunig Ave., manufacturer of automobile tires, etc., has filed plans for the erection of a 1-story addition.

NEWARK — The H. G. Mooney Co., 356 Mulberry St., paper products, has completed plans for the construction of a new 1-story building at Frelinghuysen Ave. and Willow St., to cost about $30,000.

New York

NIAGARA FALLS—The Paper Converting Corp., Royal Ave., is considering the erection of a new 2-story building at its plant, 50 x 80 ft. Plans will be prepared at an early date.

NEW YORK—In connection with the recent acquisition of the West India Oil Refining Co. of Kentucky by the Standard Oil Co. of New Jersey, 26 Broadway, the latter organization will secure an oil refinery at Havana Harbor, Cuba, and has plans under way for extensive operations at this point, with proposed plant improvements.

NORTH TONAWANDA—The Board of Water Commissioners is completing plans and will soon call for bids for the erection of a new filtration plant at the municipal waterworks, to cost about $250,000, with equipment. J. N. Chester, Union Bank Bldg., Pittsburgh, Pa., is engineer.

BATAVIA—The Gypsolite Co., Buffalo, a Delaware incorporation, has filed notice of organization to operate in this vicinity with a capital of $1,000,000. Plans are nearing completion for the construction of a complete gypsum works on local site, comprising crushing, grinding and other departments, to cost about $100,000, including equipment. J. F. H. Haggerty, 66 Bedford Ave., Buffalo, heads the company.

North Carolina

ELKIN—The City Council has completed plans for the construction of a filtration plant in connection with a general waterworks system, and will commence work at an early date. Pegram & Reynolds, Winston-Salem, N. C., are engineers.

MARSHALL—The Town Council has plans under way for extensions in the municipal waterworks to cost about $50,000, including chlorine sterilizer plant. T. A. Cox, 78 Patton Ave., Asheville, N. C., is engineer.

Ohio

YOUNGSTOWN—The Paul J. Kalman Co., 22 West Monroe St., Chicago, Ill., manufacturer of steel bars, etc., will proceed at once with the construction of its new steel-fabricating plant on Cypress St., near Poland St., which has recently been held in temporary abeyance. The plant will cost about $200,000, including equipment. A general contract for completion has been let to the Heller-Murray Co., Furnace St., Youngstown.

Oklahoma

MUSKOGEE—The Oklahoma Producing & Refining Corp. has plans under way for the construction of a new storage and distributing plant to include oil stills, tanks and operating equipment estimated to cost about $250,000 complete. The engineering department of the company is in charge.

TULSA—In connection with a new water development project at Mohawk, near Tulsa, the City Council will install an aerating and sterilizing plant, with complete filtration equipment. The work is estimated to cost in excess of $5,000,000. J. D. Trammell, Fort Worth, Tex., and the Holway Engineering Co., Tulsa, are engineers.

Oregon

PORTLAND—The Columbia Tire Co., 1401 Northwest Bank Bldg., will soon break ground for the construction of a new 2-story plant, to cost about $100,000, with equipment. It will be used for the manufacture of automobile tires and other rubber goods. The Rasmussen Grace Co., 919 Chamber of Commerce Bldg., is engineer in charge. R. A. Wurzburg is head.

Pennsylvania

PHILADELPHIA—H. Swoboda & Son, Inc., 1027 North Bodine St., has completed plans and will soon commence the erection of an addition to its leather-manufacturing plant, to be located at North Bodine and American Sts.

PHILADELPHIA—The Fibre Container Co., Fountain and Nixon Sts., is considering plans for the rebuilding of the portion of its plant, destroyed by fire April 27, with loss reported in excess of $500,000, including equipment.

WAYNESBORO—The Frick Co. will soon call for bids for the construction of a new 1-story foundry, 300 x 600 ft., at its agricultural machinery works, estimated to cost approximately $200,000, with equipment. A. J. Frick is in charge.

CLAIRTON—The Carnegie Steel Co., Pittsburgh, is completing plans and will commence foundation work immediately for the construction of an addition to its local by-product coke plant, estimated to cost close to $20,000,000, including ovens and other equipment. It is planned to double the capacity of the present works.

PITTSBURGH—The Fleischmann Co., 701 Washington St., New York, N. Y., manufacturer of yeast, has tentative plans under consideration for the construction of a new local plant.

Tennessee

MEMPHIS—The City Council plans to call for equipment bids during June for extensions and improvements in the municipal waterworks, including a new filtration plant, estimated to cost in excess of $1,500,000. Fuller & McClintoch, 421 Produce Exchange Bldg., Kansas City, Mo., are engineers.

Texas

FORT WORTH—The Moco Monkey Grip Co., Oklahoma City, Okla., has acquired the local plant of the Texas Motor Car Association for a consideration of about $295,000. The new owner will take immediate possession and plans for the installation of equipment for the manufacture of automobile tires. Employment will be given to about 850 men for initial operations.

Virginia

RICHMOND—The Virginia Carolina Rubber Co., 10 North 19th St., has awarded a contract to E. L. Bass & Brother, 708 Bainbridge St., for the erection of a new 1-story plant, 100 x 125 ft., to cost about $25,000.

Washington

PORT ANGELES—The Union Oil Co. has commenced the erection of its proposed new storage and distributing plant on 2nd St., to have an initial capacity of about 100,000 gal. Three buildings will be constructed, 40 x 50 ft., 26 x 32 ft. and 12 x 15 ft., with steel tanks and other apparatus.

West Virginia

FAIRMONT—The Dixie Co., recently organized, has perfected plans for the construction of a new plant on Speedway St., for oil storage and distribution, to include a complete chemical laboratory. A number of buildings will be erected, with steel tanks and operating equipment. The initial works will cost about $30,000. Walter Smith is general manager.

Wisconsin

MILWAUKEE—The Red Star Yeast & Produce Co., 79-83 Buffalo St., has awarded a contract to the Edward S. Steigerwald Co., 3012 Cherry St., for extensions and improvements in its yeast-manufacturing plant on 27th St. A. N. Graw is president.

Canada

MONTREAL, QUE.—The John Cowan Chemical Co., Ltd., 179 Common St., is planning for the rebuilding of the portion of its plant destroyed by fire, April 26.

New Companies

THE FRASER CHEMICAL CO., Fraser (Macomb County), Mich., has been incorporated with a capital of $25,000, to manufacture washing powders, paint emulsifiers and other chemical products. The incorporators are Ernest Lorenz and Simon Palmateer, Mount Clemens, Mich.; and Charles J. Reindel, Fraser.

THE RILEY-FORD CO., Brooklyn, N. Y., has been incorporated with a capital of $200,000, to manufacture industrial alcohol, chemicals and chemical byproducts. The incorporators are C. Riley, J. E. Ford and W. E. J. Collins. The company is represented by W. E. J. Collins & M. Kamber, 135 Broadway, New York.

THE EAGLE REFINING CO., Houston, Tex., has been incorporated with a capital of $10,000, to manufacture refined petroleum products. The incorporators are O. M., W. E. and Clarence Kendall, all of Dallas.

THE SAVOEI RUBBER MFG. CO., 314 Pond St., Woonstocket, R. I., has been organized to manufacture rubber products. Philias J. Savoei heads the company.

THE PIERPONT PAINT & COLOR CO., Camden, N. J., has been incorporated with a capital of $50,000, to manufacture paints, varnishes, colors, etc. The incorporators are E. C. Young, M. A. Sudlow and W. J. Wix. The company is represented by the Corporation Co., 104 Market St., Camden.

THE TIDEWATER CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals, paints, dyestuffs, etc. The incorporators are F. H. Twyeffort, J. Moncrief and W. C. Dubois. The company is represented by Fletcher, Brown & Twyeffort, 342 Madison Ave., New York.

THE ARMOR OIL CO., Room 846, 29 South La Salle St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture petroleum products. The incorporators are Morton H. Eddy, Oliver C. Heywood and Bernice Gormley.

THE INDUSTRIAL PRODUCTS CORP., Trenton, N. J., has been incorporated with a capital of $125,000, to manufacture brick, tile and kindred products. The incorporators are John P. Fenner, William F. Garton and Fred P. Rearwin, 842 Greenwood Ave., Trenton.

THE UNIVERSAL PRODUCERS CORP., Kansas City, Mo., has been incorporated under Delaware laws with capital of $500,000, to manufacture petroleum products. The incorporators are C. W. Sheppard, Kansas City; F. J. Horton, Iola, Kan.; and L. L. Morgan, Chanute, Mo. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE D. C. CORP., 1317 Gratiot Ave., Detroit, Mich., has been chartered under state laws to manufacture soap products. The incorporators are Alexander Miller, Theodore M. Browne and Samuel Hoffenberg, 513 Kirby Ave., Detroit.

THE WINNER LABORATORIES, INC., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture chemical products. The incorporators are A. A. and E. F. Smith, and J. Baptiste. The company is represented by Frost, Watson & Sharp, Albany, N. Y.

THE CONVERSION PRODUCTS CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $100,000, to manufacture chemicals, dyes, etc. The incorporators are Lester C. Brulett, John J. Doeley and George W. Study, New York. The company is represented by the United States Corporoation Co., 65 Cedar St., New York.

THE CHARLES S. WILBUR CO., Columbia, S. C., has been chartered under state laws to manufacture paints, varnishes, etc. The incorporators are Charles S. Wilber, E. J. Duffy and George F. Von Kolnitz, all of Columbia.

THE DUNIGAN-PATTON OIL CO., Tulsa, Okla., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are W. A. Dunigan, Tulsa; Paul Patton and C. D. West, Kansas City, Mo.

THE FLORIDA FIBRE CONTAINERS, INC., Leesburg, Fla., has been incorporated with a capital of $150,000, to manufacture fiber products. Edward E. Lacy is president; Gilbert D. Leach, vice-president; and Charles E. Danniel, secretary, all of Leesburg.

THE CENTRAL RUBBER CO., 25 North Franklin St., Chicago, Ill., has been incorporated with a capital of $15,000, to manufacture rubber goods. The incorporators are Robert M. Pierson, Francis J. Loughran and E. E. Schobel.

THE ROY I. L. CARTER OIL CO., Wichita Falls, Tex., has been incorporated under Delaware laws, with a capital of $1,000,000, to manufacture petroleum products. The incorporators are Roy I. L. Carter, Wichita Falls; I. W. Keys and Richard F. Bailey, Mexia, Tex. The company is represented by M. M. Harbordt, Dover, Del.

THE LEON BLOCH BRASS CORP., New York, N. Y., has been incorporated with a capital of $15,000, to manufacture brass and bronze products. The incorporators are L. H. and W. Bloch, and E. C. Cohen, 110 William St.

THE FRANK M. KENNEDY PAINT & COLOR CO., Newark, N. J., has been incorporated with a capital of $50,000, to manufacture paints, varnishes, colors, etc. The incorporators are M. C. and Frank H. Reynolds, and Frank M. Kennedy, 277 Passaic St., Newark.

THE HARRINGTON PETROLEUM CORP., Cairo, Ill., has been incorporated under Delaware laws with a capital of $1,000,000, to manufacture petroleum products. The incorporators are Herbert Harrington, V. C. Clarke and Casper K. Usener. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington.

THE WAYNE BRICK CO., Wayne, W. Va., has been incorporated with a capital of $50,000, to manufacture brick and other burned clay products. The incorporators are C. D. Martin, L. F. Adkins and W. F. Toney, all of Wayne.

THE DUNN-GRENET OIL CO., Pittsburgh, Pa., has been incorporated with a capital of $25,000, to manufacture oil products. V. P. Keefe, Sharpsburg, Pa., is treasurer.

THE ACME POTTERY WORKS, INC., Trenton, N. J., has been incorporated with a capital of $100,000, to manufacture pottery products. The incorporators are Noah W. Boch, A. H. Kennedy and M. K. Hoffman. The company is represented by Frederic R. Brace, 137 East State St., Trenton.

THE PENNZOIL CO., Buffalo, N. Y., has been incorporated with a capital of $1,000,000, to manufacture petroleum products. The incorporators are A. S. Matthews, D. Hyland and R. R. Bearsley. The company is represented by Kent, Cummings & Means, Dun Bldg., Buffalo.

PHILLIP S. MALICKSON, INC., Philadelphia, Pa., has been incorporated with a capital of $100,000 under Delaware laws, to manufacture automobile tires and other rubber goods. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

THE TULSA-TENNESSEE OIL CO., Salpulpa, Tenn., has been incorporated with a capital of $75,000, to manufacture petroleum products. The incorporators are George L. Burk, Tulsa; John M. Jones and Grason A. Bailey, Sweetwater, Tenn.

THE BLACK SEAL CHEMICAL CO., Tampa, Fla., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. H. C. McMichael is president; J. L. Moon, vice-president; and H. P. Boyce, secretary, all of Tampa.

THE ATLAS PRODUCING CO., Kansas City, Mo., has been incorporated under Delaware laws, with a capital of $2,500,000, to manufacture petroleum products. The incorporators are Joseph Clover, M. England and R. H. Yates, all of Kansas City. The company is represented by the Corporation Service Co., Wilmington, Del.

FOOSHKILL & HIRSCH, INC., Woodhaven, L. I., has been incorporated with a capital of $25,000, to manufacture ceramic products. The incorporators are W. and S. Hirsch and L. Fooshkill. The company is represented by Slensby & Wolff, Richmond Hill, L. I.

THE DENNETT & PRINCE LEATHER CO., Boston, Mass., has been incorporated with a capital of $25,000, to manufacture leather products. The incorporators are Nathan W. Dennett, Auburndale, Mass.; Fred A. Prince, Sharon, Mass.; and Byron S. Kent, Melrose, Mass.

THE TANNER OIL CO., Lake Charles, La., has been incorporated with a capital of $100,000, to manufacture petroleum products. T. J. Tanner is president, and R. B. Sutherland, vice-president, both of Shreveport, La.; and W. C. Strange, Singer, La.

THE H. A. BLOESER CO., Buffalo, N. Y., has been incorporated with a capital of $5,000, to manufacture turpentine, industrial alcohol and chemical products. The incorporators are H. A. Bloeser, J. R. Hartley and G. E. Keller. The company is represented by Albert F. Geyer, Brisbane Bldg., Buffalo.

THE AMERICAN TEXTILE SOAP CO., Springfield, Mass., has been incorporated with a capital of $100,000, to manufacture soaps and affiliated products. The incorporators are Charles A. Stone, Robert F. Warren, both of Springfield; and Albert F. Alstrom, West Springfield, Mass.

THE WEATHERFORD-BRAZOS REFINING CO., Weatherford, Tex., has been incorporated with a capital of $200,000, to manufacture refined oil products. The incorporators are A. G. Fullerton, V. H. Williams and J. W. Wilson, all of Weatherford.

THE RICHARDS CHEMICAL CO., Glen Olden, Pa., has been incorporated under Delaware laws with capital of $50,000, to manufacture chemicals and chemical byproducts, drugs, etc. The incorporators are Arthur Richards, John H. Yates and J. Lamont Stewart, all of Glen Olden. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia, Pa.

THE HOLSTON FOUNDRY CO., Knoxville, Tenn., has been incorporated with a capital of $10,000, to manufacture iron, steel and other metal castings. The incorporators are H. G. Fowler, C. H. Johnson and C. E. Dawson, all of Knoxville.

THE FRAMINGHAM MFG. CO., Framingham, Mass., has been incorporated with a capital of $125,000, to manufacture iron and other metal castings. The incorporators are: Edward H. Talbot, Sharon, Mass., and Edward A. Hitze, Framingham.

THE TRI-STATES OIL CO., New Boston, Tex., has been incorporated with a capital of $150,000, to manufacture petroleum products. The incorporators are E. B. Guess, G. Roell and Walter Deemer, all of New Boston.

THE ROSENWASSER LEATHER PRODUCTS CO., Brooklyn, N. Y., has been incorporated with a capital of $10,000, to manufacture leather specialties. The incorporators are B. Merker, M. Jones and M. Kanin. The company is represented by C. E. Frankel, 19 West 44th St., New York.

THE STAR OIL CO., Harrisville, W. Va., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are B. F. Patten, A. C. Woodford and Edward Robinson, all of Harrisville.

THE CALIFORNIA-PACIFIC OIL CO., Wilmington, Del., has been incorporated under state laws with capital of $5,000,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

Manufacturers' Catalogs

PAUL MAEHLER CO., Chicago, Ill., has issued a new catalog which describes in detail its line of industrial ovens. The construction of Maehler ovens is given, as well as data on ventilation and circulation, assembling or setting up, fuels for industrial ovens, gas-heated ovens, electric heat and its adaptation to Maehler ovens, conveyor and special type ovens, core ovens, potash tanks and boiling cauldrons and oven accessory equipment. The booklet is well illustrated.

THE PAGE STEEL & WIRE CO., Monessen, Pa., has just issued a new handbook describing and illustrating interesting developments in the welding field.

THE AEROIL BURNER CO., INC., Union Hill, N. J., has just received from the press its new bulletin, No. 20, on "Oil-Burning Appliances."

CLEMENT K. QUINN & CO., Duluth, Minn., has issued its 1922 Analyses of Lake Superior Iron Ores.

THE GRINDLE FUEL EQUIPMENT CO., Harvey, Ill., has issued its first general catalog on Grindle powdered fuel equipment, which contains 40 pages of text and illustrations. The advantages of powdered fuel in general is given and the advantages and operation of the Grindle system in particular. Copies will be sent to interested parties on request.

Industrial Developments

RUBBER—The Mason Tire & Rubber Co., Akron, O., has increased its production schedule from 2,500 to 2,800 tires per day, and will soon advance this output to 3,500. The ultimate manufacture will be on a basis of 5,000 tires a day, and arrangements are being perfected for the installation of considerable new machinery for this purpose.

The Seiberling Tire & Rubber Co. is arranging for an immediate increase in production at its New Castle, Pa., and Barberton, O., plants, to a basis of 3,000 tires a day, as against a present schedule of slightly in excess of 2,000 tires.

The Kelly-Springfield Tire Co. is increasing production at its plant at Cumberland, Md.

The Firestone Tire & Rubber Co., Akron, O., is advancing production in its tube-manufacturing department, developing an output of about 3,400 tubes a day.

PAPER—The Parsons Pulp & Lumber Co., Horton, W. Va., has reopened its local pulp and paper mills, and will operate under a day and night shift until further notice.

Paper mills in the Montreal, Que., district are now operating on a basis of about 90 per cent of capacity.

The International Paper Co., New York, N. Y., has placed its new mill at Three Rivers, Que., on an increased operating basis for the manufacture of newsprint.

CERAMIC—The United States Refractories Corp. has resumed operations at its plant at Mount Union, Pa.

The Harbison-Walker Refractories Co., Pittsburgh, Pa., is advancing production at its plants at Mount Union, Pa., and is now operating at both the No. 1 and No. 2 factories.

The National Fireproofing Co., Pittsburgh, Pa., is increasing manufacture at its different plants to handle incoming orders. A number of large contracts have been obtained during the past month for hollow tile, vitrified clay conduit and other fireproofing specialties.

The General Refractories Co. has resumed operations at its plant at Mount Union, Pa., on a 6-day week basis.

CEMENT—The Giant Portland Cement Co. has resumed operations at its Central Mill, Egypt, Pa., following a shut-down since last summer. The company is running at capacity at its Reliance Mill.

Practically all mills in the Lehigh Valley cement district of Pennsylvania are now in operation, including reserve plant units. It is said that production within the next 2 or 3 weeks in this section will be the highest ever recorded.

The Coplay Cement Co. is arranging for the immediate resumption of operations at its Mill B, Coplay, Pa. The Mill C, of the company, with 10 kilns, is now running at capacity.

The Atlas Portland Cement Co., Northampton, Pa., is running full at its local mills, and has announced an increase in wages, effective May 1. The Lawrence Portland Cement Co., in this same section, has also increased the wage scale at its plant.

The International Cement Co., New York, N. Y., has increased production at its different mills, and is now making heavy shipments from the plants.

IRON AND STEEL—The Charcoal Iron Co., Manistique, Mich., is arranging for the resumption of operations at its plants at Boyne City and Newberry, Mich., not later than May 15.

The Brier Hill Steel Co., Youngstown, O., has blown in another blast furnace at its mills. The company is also planning for the early resumption of an additional sheet mill, now said to be impossible through labor shortage.

The Trumbull Steel Co., Warren, O., is now operating 34 hot mills at its plant. The Liberty Steel Co., in the same district, is running 10 hot mills at its works.

The Wheeling Steel Corp. has resumed operations at three mills, located at Yorkville, O.; Creek and Beech Bottom, W. Va., respectively. This brings production up to the highest point for the company within the past 18 months.

The Bethlehem Steel Co. has reopened another finishing mill at its Lebanon, Pa., works, giving employment to about 100 additional men. The unit has been idle for more than a year past.

The American Steel Foundries, Chicago, Ill., is arranging for an immediate increase of 15 per cent in production at its various plants. The company is now running at more than 50 per cent in advance of the output at this time a year ago.

The Rogers-Brown Iron Co., Buffalo, N. Y., has increased production to a capacity basis at its blast furnaces. The company is said to have orders on hand to insure this schedule for the remainder of the year.

The Worth Brothers Steel Co., Marcus Hook, Pa., is increasing production at its mills and adding to the working force. It is planned to adopt a double operating shift at an early date.

The Gulf States Steel Co., Birmingham, Ala., is running full at all of its finishing mills. Two open-hearth furnaces are in service.

The Steel & Tube Co. of America, Chicago, Ill., is running 7 of its 8 blast furnaces at capacity, with orders on hand to insure this basis of output for the remainder of 1922.

Capital Increases, Etc.

THE NEW YORK RUBBER CO., 84 Reade St., New York, N. Y., has filed notice of increase in capital from $500,000 to $800,000.

THE PEERLESS OIL CORP., Richmond, Va., has filed notice of increase in capital from $250,000 to $500,000. A. L. Hawse is secretary.

THE GRAND CORRUGATED PAPER CO., INC., 30 Crosby St., New York, N. Y., has filed notice of increase in capital from $150,000 to $300,000.

THE UNION BAG & PAPER CORP., Woolworth Bldg., New York, N. Y., manufacturer of paper products, with plant at Hudson Falls, N. Y., has disposed of a bond issue of $6,500,000, the proceeds to be used for general operations, financing, etc.

THE WESTON GLASS CO., Weston, W. Va., has filed notice of increase in capital from $50,000 to $75,000.

THE FORT ORANGE PAPER CO., Castleton, N. Y., has filed notice of increase in capital from $200,000 to $500,000.

THE H. C. FRY GLASS CO., Rochester, Pa., is disposing of a bond issue of $600,000, the proceeds to be used for additional working capital, expansion, etc.

THE DECATUR UNION CHEMICAL CO., Decatur, Ill., has filed notice of increase in capital from $150,000 to $180,000.

THE BULLION CHEMICAL CO., Memphis, Tenn., has filed notice of increase in capital from $50,000 to $150,000.

THE PRODUCERS & REFINERS CORP., California Bldg., Denver, Col., operating oil refineries at West Tulsa and Blackwell, Okla., has disposed of a bond issue of $2,000,000, the proceeds to be used for general operations, expansion, etc. F. E. Kistler is chairman of the board.

THE ROGERS-BROWN IRON CO., Buffalo, N. Y., producer of pig iron, coke, ferromanganese, fluorspar, etc., has disposed of a bond issue of $4,000,000, the proceeds to be used for general operations, financing, etc. William A. Rogers is president.

THE CHAPEL LEATHER CO., 308 Prudential Bldg., Newark, N. J., has filed notice of dissolution under state laws.

THE NEW YORK BRASS FOUNDRY CO., 405 Broome St., New York, N. Y., has filed notice of increase in capital from $10,000 to $50,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the association, on the occasion of the annual meeting of the latter, in Salt Lake City June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meeting at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., June 5 and 6.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS is holding its spring meeting at Atlanta, Ga., May 8-11.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS of the NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CANADIAN INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY will hold their annual meetings in Ottawa May 15-17.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its tenth annual meeting in Washington, D. C., May 15 to 18.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15-22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NINTH NATIONAL FOREIGN TRADE CONVENTION will be held at Philadelphia May 10 to 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: May 12—Société de Chimis Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A New Trade Association of Chemical Equipment Manufacturers

IN THE organization last week of a trade association by manufacturers of chemical equipment, the chemical industry has now rounded out its quota of such associations. For some time past the producers of heavy and fine chemicals have been organized in the Manufacturing Chemists Association and the Synthetic Organic Chemical Manufacturers Association, and the makers of apparatus have been banded together in the Apparatus Makers Association. The group of four is now completed by the makers of plant equipment, who have just formed the Chemical Equipment Manufacturers Association. With every interest of the chemical industry thus organized, it should be possible through concerted action to accomplish whatever is best for its welfare.

The new association has been launched under most favorable auspices. Trade associations are the order of the day in business. Government encouragement and leadership are offered through the friendly attitude of Mr. HOOVER and the Department of Commerce, which has been reorganized to afford the greatest measure of assistance to business. That there are numerous problems internal to the chemical equipment manufacturing industry is clearly evidenced by the purposes and aims of the new association set forth in its constitution, printed elsewhere in this issue. And if any doubt existed in the minds of the organizers as to probable activities for the association it was dispelled at the first meeting when the subject was thrown open for discussion. Thoughts that apparently had long been slumbering in the minds of those present suddenly found expression in the form of suggested activities for the new organization.

We offer our congratulations to those manufacturers whose foresight has led them to create and foster the Chemical Equipment Manufacturers Association and we urge upon all others the merit of joining and supporting a movement that, in our judgment, must inevitably prove helpful to the industry. There are many problems of common interest to be solved, and doubtless many more will develop as experience is gained. Success in early undertakings will beget confidence in the organization and suggest new lines of activity. The movement has had sound guidance thus far and we confidently predict success if attention is directed primarily to the avowed purposes of the association. The first requisite is a membership representing as nearly as possible 100 per cent of the manufacturers of chemical equipment. The second is the selection of able and energetic officers and committeemen through whom the association will function. To those ends CHEM. & MET. is glad to lend its aid and encouragement and pledge its support.

New Lamps For Old

COMING when naval disarmament did, many fears were expressed that the abandonment of warship construction would prove the last straw to break the back of the deeply depressed metallurgical industry. With steel mills operating at one-quarter capacity or less and important brass works running but one or two shifts a week, to some pessimists it seemed particularly inopportune to shut off one substantial outlet for highly wrought metal and add to the millions of men facing a jobless winter.

However, a little calculation indicated that our warship program consumed an extremely small percentage of the total output of steel and alloys. With the exception of four or five sizable plants engaged in making armor and guns, it makes comparatively little difference to the industry by and large whether we are building warships or not. The proportion of their product going directly to the navy is small indeed—even armor plants are usually single departments of highly integrated steel companies, making almost everything from huge forgings to railroad spikes.

Sober second thought and a wide vision indicated immediately (and events have proved) that the indirect effects of naval disarmament were to be far greater than the direct effects. It is a truism that business is based on credit—that is to say trust—and nothing cuts deeper into the volume of sound trading than suspicion, wars and rumors of war. If naval disarmament increased the sum total of peace on earth by 1 per cent, the direct loss to those industries most vitally concerned has been repaid to them indirectly through their other departments. Other lines of activity have multiplied their profit enormously.

Being of an optimistic turn of mind, we are sure that even the dislocation and scattering of the personnel from the armor and gun plants will quickly redound to the benefit of sound metallurgy. Perhaps this is small comfort to the worker who must hunt up a new job and probably move to a new town, all at considerable loss in money and contentment. But there are few American metallurgical plants whose operations would not eventually profit by adding to their staff even one man who has been exercising for years that meticulous care necessary in the making of fine steels. Granted that the most of the laborers from gun plants are men who merely do as they are told without knowing why they do it, and therefore are not capable of applying their experience to other kinds of product, there are many other men, some with the advantage of college education and some who have acquired their knowledge in the works, men who have studied steel closely for years and have always made a sincere effort to find the cause of failures

in whatever stage of manufacture they occur, so as to avoid them in the future rather than to establish an alibi.

A wise manager does not let such men get away if he can possibly take care of them in any other department. But some managers are not particularly astute, and others may be chained by circumstances. So if one of these technologists of parts, metallurgist, heat treater, melter, smith, whatever he may call himself, is available, and you can obtain his services, do not hesitate to give him a job, for he will prove to be a jewel of great price.

Beginnings of Chemistry in China

IN THE May number of the *Scientific Monthly*, Dr. WILLIAM HENRY ADOLPH gives some interesting notes on the history of chemistry in China. While the Chinese are responsible, he says, for many things long before the European world had developed them, "the tendency has been to consider the hoary annals of Chinese history a convenient dumping ground for disposing of clouded beginnings." We suggest as a secondary reason for the tendency that it is the safer guess. In the early sources of science there were three centers of almost independent development, of which India was the first, China the second and Egypt-Arabia-Europe the third and ours. The Hindus claim responsibility for being the teachers of China, but this is rather a claim than an established fact.

Like the development of chemistry in Europe, the Chinese began with an age of alchemy, which was followed by one of iatrochemistry, but the respective periods in China were much earlier than those of Europe. Alchemy was a Chinese art as early as 1100 B.C. Their iatrochemistry, or inorganic chemicomedical practice, which would more correctly describe it, began very early, but it lasted until the close of the nineteenth century. Two hundred years ago Chinese and Europeans were at about the same milestone of chemical science.

A number of interesting notes are given. For instance, mercuric chloride was used in surgery, although there is no evidence to indicate that the Chinese had any idea of the principle of sepsis. We understand that the people at large are still somewhat unfamiliar with the subject. Practice frequently outran theory, as with us, by many centuries. Gold, silver, copper, iron and tin constituted the "five metals," which were so known for a long time. Indeed the Chinese ideograph for a hardware store is literally translated "Five Metals Shop." Mercury was known as water-silver, and lead, being used only as an adulterant of tin, was not dignified as one of "the metals." This knowledge dates back to the early days of Chinese alchemy. The five metals were regarded as convertible into one another, a belief which grew from the fact that the galenites of China invariably contain all five, in varying proportions. There's a touch of philosophy in this conclusion which is especially interesting in the light of modern research. Discussion of "elements" and "original substance" date back to LOADZE, the great philosopher who flourished about 700 A.D.

Another theory with the odor of prophecy makes all compounds reducible to a single substance which is a gas. The gas may recombine with itself, and assume various forms and groupings. These are secondary elements and one philosopher likens them to vortex rings. They are of two kinds, being either positive or negative in principle. Combination between a negative and a positive may take place, and all the simple, material substances are formed in this way. This theory was put into its final shape in China about the tenth century of our era. With the substitution of hydrogen and H ions and OH ions for various Chinese words used in the text, it comes pretty near to telling what we think we think about matter today.

Alloys were considered as combinations, and much attention was given to the preparation of bronzes. Zinc was compounded with lead and bears the name "secondary lead" in current language. They had a phlogiston theory long before the days of STAHL, and they needed it more than our chemists, because they had scarcely any reagents. Heat was the universal agent used by them in their transformations. White lead is made by what we call the Old Dutch process, but the Dutch got it from the still older Chinese. Sulphates were prepared by oxidation of sulphides; they had no sulphuric acid.

Fevers and Chills In Steel

ABOUT 20 years ago a stock brokerage house got out a prospectus for some new steel venture, inviting the confidence of the public on the ground that the steel industry had lately got into a position of stability and was no longer an uncertain proposition. The steel trade poked some fun at the statement, holding that the industry had been rather a stable affair for years.

Now we can take a longer range view. Much more than 20 years ago the late JAMES M. SWANK had said in one of his annual reviews that the iron and steel industry appeared to be chronically subject to alternations of chill and fever. ANDREW CARNEGIE, who was a great admirer of SWANK, said "prince or pauper," but that expression rather grates on one's nerves these days. Developments of the past 20 months show that the demand upon the steel mills, which is a different thing from the actual ultimate consumption of steel and manufactures of steel, is more subject to chill and fever than was the case 20 years and more ago.

Demand upon the steel mills fluctuates more than does steel production. The steel mills do not stock steel to any extent, simply making it on order. When demand decreases production decreases, but sometimes demand increases more than production, because production reaches a physical limit. Even production, however, has shown unprecedented fluctuations in the past 20 months. In the first 9 months of 1920 the rate of steel ingot production averaged 42,000,000 tons a year. At the middle of the following July the rate was down to about 10,000,000 tons. Then the rate rose to 25,000,000 tons Nov. 1, dropping to less than 18,000,000 tons at the end of the year, while last month has now shown a rate of more than 36,000,000 tons.

The United States Steel Corporation's "unfilled tonnage," which is reported monthly, has shown wide fluctuations, and yet these fluctuations do not exhibit the full fluctuation in demand, for when demand is heavy the corporation is reserved about accepting obligations and does not enter all the tonnage it is offered. The corporation's unfilled tonnage (including unspecified contracts) stood at a high point of 11,118,-

468 tons July 31, 1920, and decreased to 4,141,069 tons at the end of last February, the low point for years. At the end of April it stood at 5,096,917 tons, making an increase of 956,848 tons in 2 months. The shipments during the 2 months were about 1,850,000 tons, so that the bookings were about 2,800,000 tons, a trifle more than the full capacity, which is now reckoned at 53,000 tons (in steel products for sale) per working day. The shipments were at about 65 per cent of capacity in March and 70 per cent in April. Production would have been heavier in the latter month but for the coal strike.

That actual requirements in steel have been increasing since last July is beyond question, but they have not increased either as buying or as production has increased. Last July the country was running largely on stocks of steel and stocks of manufactures of steel. Lately it has been replenishing stocks. Jobbers and manufacturing consumers seem to have but one settled policy, never to keep their stocks uniform, but always to be increasing or decreasing them.

The bituminous coal strike has undoubtedly had much influence in stimulating buyers of steel in the past few months, both when the strike was being talked about as a certainty and when it was an actuality. Strikes have played and still play an important part in steel market history.

Photography as a Tool of Industry

AMONG the familiar tools of science, there is probably none which finds more universal application than the art of photography. In the modern routine of business and industry, there is scarcely an individual who does not depend to some extent upon one of the myriad applications of photography. In fact, such an admirable tool has it become that we are apt to lose sight of the fact that photography is a science in itself, keeping pace with the development of industry through the efforts of its devotees, who are at once scientists and artists.

In order that photography may serve industry most efficiently and blaze the way for progress in the technology of the industries, technical photographers have felt the need of closer co-operation with one another and with the industries that they serve. This sentiment has crystallized in the formation of a new organization, the Technical Photographic and Microscopical Society, details of which are set forth on the news pages of this issue. It is with an appreciation of the importance of industrial photography that we welcome the new society and bespeak for it the co-operation of the chemical and metallurgical industries.

Within the past few years photography has been enlisted to an increased extent in the aid of technology. Industrial establishments are coming to consider the permanent photographic department an invaluable adjunct to the business instead of an added item of overhead, as was once the case. Industrial photography not only has come to stay, but its applications are bound to increase. Witness the field opened by the ultra-rapid cinematograph in motion study or in the study of detailed stresses in physical tests. Witness, too, the development of apparatus for photographing such minute but spectacular physical phenomena as the disintegration of an alpha particle or the pulsations of an alternating current. Metallography has long been indispensable to metallurgical research and photomicrography and macrography are becoming equally important in the pulp and paper and textile industries, in the study of powder, dynamite and other explosives, for the comparison of raw materials in the manufacture of drugs and chemicals, for studying gelatine and other emulsions, for investigations of yeast cultures, bacteria and molds, in studying leather tanning processes, in the technology of rubber, paint and pigments.

A step to correlate the experience and problems of photography in these and other fields should be of mutual benefit to all concerned and should open new uses for an already invaluable aid to industry.

An Innovation in the Teaching of Chemistry

BEGINNING next September, at the College of the City of New York, where Prof. HERBERT R. MOODY succeeds the late Prof. CHARLES BASKERVILLE as director of the department of chemistry, an interesting experiment will be made in presenting the general inorganic course in chemistry. This was formerly given by Dr. BASKERVILLE himself. The innovation will consist in bringing in various members of the staff and occasionally someone from outside the faculty to expound phases of chemistry with which each one is especially familiar and which he has taught successfully. The entire course will be supervised by Professor MOODY, who will address himself more particularly to industrial development within the science and such other features as may call for exposition by him.

This is the series in which the lecture hall is twice filled to capacity for each lecture. The purposes of the experiment are obvious. The students will receive instruction from men who have been tried and approved as teachers of their several subjects. To knit together what is said into a consecutive whole will present its own difficulties, but we have abundant faith in Dr. MOODY'S capacity to do so. It will also bring the leading members of the staff into contact with a large proportion of the student body, which is also desirable. And it will provide a certain stimulus—we may almost say a gentle competition—in the art of exposition, within the faculty.

City College, as it is popularly called, is *sui generis*. It is free to residents of New York. There are very few automobiles or other objects of luxury owned by its students. The courses are intensive, and the students themselves are a very live body of young men. Their attention is remarkably close; they fairly eat up what the lecturer says. It is indeed an unusual experience to appear before them. We shall follow with keen interest the results of the experiment, and, more particularly, its effect on the faculty.

Another innovation which is to be introduced in the fall term is a series of lectures on chemical economics, to be delivered at both the day and the night sessions by Prof. FREDERICK E. BREITHUT, who has returned to the faculty. With the exception of Dr. BERNHARD C. HESSE, it would be difficult to find any one so well equipped as Dr. BREITHUT to explain the sources, the wanderings and the utilization of materials. The advantage of this course to chemists, especially to those engaged in business or technological activities needs no comment, and we predict for Professor BREITHUT a lively attendance, especially at his evening lectures, from the enrollment of graduate chemists.

Readers' Views and Comments

Improved Technology on the Chilean Nitrate Pampa

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was disappointed to read that Paul F. Holstein, an interview with whom appeared in your April 12 issue, although emphasizing the need for improvement in the working of the average nitrate oficina in Chile, failed to indicate, directly or indirectly, the direction that such improvement should take. Many chemical engineers interested in the treatment of Chilean caliche feel that his experience there during many years would add weight to constructive criticism. They would appreciate something more than casual comment on the obvious need for "better recovery, more efficient fuel utilization and improved mining methods . . ."

I suggest that the high cost of extracting the raw material has been due primarily to the expense incurred by selective mining—(1) in hand picking the richer caliche to boost the grade and make possible profitable operations on a small scale, and (2) to avoid the inclusion of slime or borra. Recent developments on one of the most refractory deposits in Chile are tending to disprove the need for this. Large-scale operations are inevitable eventually.

Low recovery of nitrate during beneficiation has been due to the inefficiency of treatment by the Shanks system and a neglect to appreciate the fundamental principles of a logical method of dissolving the nitrate and displacing the nitrate liquor.

High expense in fuel consumption has been aggravated because of a neglect to realize the cheapness and efficiency of solar evaporation in a country where atmospheric conditions are ideal for the purpose.

San Francisco, Cal. A. W. ALLEN.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I think Mr. Allen is entirely correct in his comments on the causes of high cost of extraction of the caliche, low recovery in manufacture and poor fuel utilization. The industry, in my opinion, requires a complete reformation in methods from the extraction of the ore in the pampa to the shipping, every step being susceptible of improvement, some of them in a very great degree. The combined reductions in cost possibly would reduce the cost of nitrate at the plant in many instances by 40 per cent and the cost f.o.b. by several shillings. The past 10 years has seen much, on the whole, unprofitable experimentation with new processes, most of them attempts to apply bits of knowledge snatched from milling practice without any great understanding of the applicability of the methods. The use of filters of various types is an example of one of these unfortunate efforts. While the nitrate man has gained costly knowledge, his enthusiasm has become much dampened as each much-heralded "invention" went the way of its predecessors into the scrap pile. The only definite advance made in many years outside of a better application and control of the old system has been the Allen process, which gets down to fundamentals which, as very usual, means simplification. Filters, screenings, classification, etc., are, in this industry, but medicine for the symptoms instead of for the disease itself.

Specifically I would indicate the following points (among many others) as worthy of study:

1. Co-operation of plants not too widely separated for the centralization of manufacture. The production of a cold solution and its transportation by pipe line to a central plant is not only feasible but has many more or less obvious distinct advantages.

2. The Shanks system has outlived its usefulness mainly through lack of appreciation of the fact that decrease in the percentage of nitrate in the ore being handled is accompanied by an increase in the percentage of insoluble matter and a consequently much greater proportionate retention of liquid by the extracted masses. Indeed old tailing dumps of 15 to 20 per cent nitrate content often indicate a higher percentage recovery of nitrate in those days than a 5 per cent tailings dump does today. The only reason that recovery today is as good as in the early years of the industry must be because of slower operation in leaching. This thought can be carried to its logical conclusion. If it were practicable, a plant consisting of, say, one hundred leaching tanks (cachuchos) and treating ten tank charges (fondadas) per day would give a recovery well over 90 per cent. This has been proved by the writer by experiments on slow operation on full-sized tank charges. It appears therefore that the time factor is a good point for attack, there being several ways by which this factor may be applied in a practical manner. As for leaching in a shorter time with a high recovery, particularly from ores containing much borra, there has been no method tried which appreciates the fundamental principles with the exception of the Allen process.

3. Evaporation of water from leaching tanks is a crime against common sense. As high as 50 per cent of the fuel consumed in some plants is thus driving off water from open boiling tanks. The non-technical manager often appreciates this to the extent only of stopping boiling, and then talks much about saving fuel but very little about recovery. Without entering into the other aspects of the subject, a triple effect evaporator will save one-third of the total fuel.

4. Hand picking of the ore in the pampa is not the only, though the principal, cause of high cost of ore placed at the plant. Several other factors might be mentioned, for instance car-loading, track-shifting, transportation. A penny per quintal here and a penny there is part of the 40 per cent possible reduction in cost previously mentioned. Should the ore be transported, or only the solution transported, to a central plant?

5. Regarding solar evaporation, it may be of interest that experiments conducted by the writer show that a ton of water is evaporated from nitrate solutions from an open exposed area of 3,400 to 3,600 sq.ft. The applicability of this fact has not been sufficiently ap-

preciated, yet it must not be immediately assumed that here is a solution of this point for all conditions; there are other considerations.

I think the most serious need of the industry today is a reconsideration of every step from ore in pampa to sales, without regard to precedent as established by methods outlived, but rejecting, changing and retaining solely by the criterions of simplicity, practicability and accordance with the fundamental facts. Indeed, many changes suggested years ago never really got much beyond conversation, principally because of lack of appreciation of the changing conditions and perhaps, too, of a lack of incentive by competition. Is it not conceivable that, if private producers do not make improvements, it may some day become the business of the Chilean Government, in self-preservation, to step in?

At a later date the writer hopes to go more fully into the above-enumerated and many other points, and though perhaps far from unbiased because of his convictions as to the best means for producing cheaper nitrate, it is believed at least that discussion and criticism will bring out many ideas and eventually establish truths that will serve as a basis for progress.

PAUL FERGUSON HOLSTEIN.

Buffalo Foundry & Machine Co.,
Buffalo, N. Y.
(Sailed for Chile, May 17.)

Mr. Almqvist's Point of View Repudiated

To the Editor of Chemical & Metallurgical Engineering

SIR:—The viewpoint of Harold Almqvist, of Domnarfvet, Sweden, as represented in his letter to you published in your April 5 issue, certainly does not represent, fortunately, the prevailing viewpoint in Sweden.

The majority of the people of Sweden during the war were of the Liberal and Socialistic parties and at no time were pro-German and at no time did they take the point of view your contributor has taken in regard to the European war.

The tone of the letter is unfortunate and the few Swedes to whom I have shown this letter have all expressed themselves as highly regretting Mr. Almqvist's contribution of provincial venom.

San Francisco, Cal. J. W. BECKMAN.

Henry P. Davison—An Appreciation

To the Editor of Chemical & Metallurgical Engineering

SIR:—The name of the late Henry P. Davison, of J. P. Morgan & Co., who died on May 6, is doubtless familiar to most of your readers, although he was distinctly a banker, and as such he became eminent. He had the banking mind, with singular freedom from its faults. He did not think he knew what he did not know. He was, however, a person of such potentiality in affairs and of such remarkable strength that a note on his passing may not be amiss. He was one of the few financial leaders of this country. Our reserve banking system was largely of his making. Immense institutions of today are the children of his imagination and his great organizing ability. During the war his work to relieve suffering was probably unprecedented in the annals of history. And he was always constructive; he would not destroy for profit.

What manner of man was he? There was nothing unusual in his bringing up. His mother died while he was a young child, his father was of a roving disposition, and he grew up with a couple of elderly uncles who owned the village bank in Troy, Pa., where he was born. They sent him to boarding school, but would not send him to college, which was a sore disappointment to him. Later he received no fewer than ten doctorates of law from leading universities and the grade of Major-General from the U. S. War Department. He taught school, became a bank clerk in Bridgeport, Conn., then in the Astor Place Bank in New York, and within a few years he was president of the Liberty Bank at the age of 31.

But how did he do it? We can give only incidental facts about him. He had a very engaging quality of good fellowship. Few men are loved as he was by those who were close to him. He was the best kind of company, with a rich sense of humor, although serious things were not funny to him. He did not worry about his dignity; that took care of itself. He was just a little quicker on the trigger than most other men; a little keener to sense what was going on. When he was a bank teller and a lunatic presented a check for a thousand dollars drawn to the order of Almighty God together with the end of a loaded revolver, he engaged him in such pleasant conversation about the size of the bills he wanted and meeting his convenience in every respect that the lunatic forgot to shoot until he was pinioned from behind. He thought only a little harder, a little more intensely, than other men.

He was not a speculator, and yet, when he knew he was right, there seemed no limit to his courage or his nerve. He recognized talent when he saw it, and thus surrounded himself with men of signal ability. He paid a little above rather than a little less than the market rate for services rendered. But he had also the catalytic quality that develops ability in others which theretofore lay dormant. There was no trickery in this; it was merely a little extra gift of what we call intelligence. Had he been selected as president of Yale, for which post his name was earnestly considered, and had accepted the task and retained his health, he would have been a rare inspiration to the students.

There was no particular quality that stood out as explaining his success in everything except perhaps his likableness and his resolution. At the age of 19 he wanted a post in the First National Bank of New York, but was frightened away by the man at the door. Fourteen years later he entered it as first vice-president. While at Bridgeport a post as cashier of a suburban bank with better pay was offered him, but he refused because he did not want "to get lost in a hole." When he applied for the position of paying teller in the Astor Place Bank he was refused. Three times he visited the vice-president, urging his suit, and the third time he won it. Then the vice-president telegraphed him that strong pressure was brought to bear to give the place to another, and would he accept a junior position at less pay? He replied that he would gladly do so. Three months later he was paying teller. This shows a little longer vision and a little more clearly defined purpose than most young men possess. His other qualities all seemed just a shade or so more developed than those same qualities in other men who are good and competent without being national figures or even great.

What a grand thing it would be for chemistry to add minds and characters of that sort to the practice of the profession! I do not deny that we have them, but we need more of them.

ELLWOOD HENDRICK.

New York City.

Thermal Problems of Petroleum Refining

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your April 26, 1922, issue an article appeared by L. A. Mekler entitled "Thermal Problems of Petroleum Refining." On page 775 equations for coefficients of heat transfer *a* and *b* were given.

While probably Mr. Mekler did not intend to give the impression that the coefficients *a* and *b* respectively would hold for any cold or hot fluid flowing through a pipe, the casual reader might infer that the expressions given for *a* and *b* were *general* equations. The facts are that the value given for *a* represents certain data for *water* flowing inside pipes over a definite range of velocity and temperature, and similarly *b* represents certain data for *air*.

As a result of more recent investigations, equations more accurate than those quoted by Mr. Mekler are available for the flow of both gases and liquids in pipes.

As shown in recent articles, the *general* equations for the heat transfer coefficient between a fluid and the pipe through which it is flowing are quite complex because of their generality and must include corrections for the physical properties of the fluid being handled, such as viscosity, etc. In designing an oil to oil or a vapor to oil heat exchanger or preheater, the use of the coefficients quoted by Mr. Mekler may introduce enormous error; in the case of a direct-fired oil preheater or still, suitable allowance should be made for the transfer of heat by radiation, in addition to that transferred by conduction and convection.

W. H. MCADAMS.

Assistant Professor of Chemical Engineering,
Massachusetts Institute of Technology,
Cambridge, Mass.

Austrian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

VIENNA, March 22, 1922.

WITH the collapse of the Austro-Hungarian monarchy the new Austria has become a country with a rather weak and undeveloped chemical industry. Entire branches of its former industry have disappeared, not only because the works were located in the territory of some of the new succeeding states, such as Czechoslovakia, but also because raw material is not at all available or is present in insufficient quantities within the Austrian borders. Such, for instance, is the case with both the mineral-oil and the beet-sugar industries. Attempts have been made to increase the growth of beets in Austria, but so far only very modest progress can be reported. The harvest of 1921, because of unusually unfavorable climatic conditions, did not even reach the quantity produced in 1920.

CHINA AND GLASS INDUSTRY

A new deposit of kaolin has recently been discovered in upper Austria and there has resulted a considerable expansion of the ceramic industry. A new chinaware factory will soon be erected near Wels. A factory for the manufacture of plate glass, established in 1920, is working at Attnang (upper Austria), but up to the present time has been able to furnish only a small part of the plate glass needed in Austria. The purpose of these efforts is, of course, to render Austria as far as possible independent of Czechoslovakia, where nearly all of the glass factories of the former monarchy had been concentrated. It is also reported that another company, founded in 1921, has taken up the manufacture of glassware in Stockerau, near Vienna.

PHARMACEUTICAL CHEMICALS

Industrial activity along pharmaceutical lines has had an unusual development since the breakdown of the monarchy. Existing establishments have been enlarged and a goodly number of new plants have been erected, some of which, to be sure, are still in the early stages of production. A factory producing salicylic acid in Kufstein, belonging to the firm Suchy-Werke, has already taken up work and the same firm is also manufacturing ichthyol products from a fossilliferous oil obtained from a seam of oil shale lately discovered in Tirol.

INORGANIC CHEMICAL INDUSTRY

The production of sulphuric acid during the war had been increased to a considerable extent. The annual productive capacity at the end of the war is compared with that of 1913 in the following table:

	1913		End of War	
	Sulphuric Acid, 92 to 98 Per Cent, Tons	Oleum, 20 Per Cent, Tons	Sulphuric Acid 92 to 98 Per Cent, Tons	Oleum, 20 Per Cent, Tons
Austria	60,000	3,900	80,400	62,700
Hungary	16,800	800	61,200	27,700
Total	77,500	4,700	141,600	90,400

The actual consumption during 1921 amounted to 53,000 tons of domestic production and 22,000 tons of acid imported from Germany, making a total of 75,000 tons. The total productive capacity after the war calculated in terms of 92 per cent sulphuric acid amounted to 236,000 tons, or something like three times pre-war requirements. The breakdown of the monarchy, however, has left Austria with only two oleum factories and one other important establishment producing other strengths of sulphuric acid. The production of pyrites had also been increased to 25,000 tons a month during the war, principally by more intensive operations of existing works and the resumption of production at various abandoned mines. In the new Austria pyrites is now mined at only a few places and in relatively small quantities, so that there is practically no domestic raw material for manufacturing sulphuric acid. Recently, however, it has been announced that the newly organized Permanganat-Aktiengesellschaft of Linz, which since 1921 has been producing potassium permanganate by an electrochemical process, is going to erect a new factory for sulphuric acid production. The same company is also erecting some new plants for wood distillation, since there is an entire absence of such an industry at the present time in Austria proper.

The situation as far as the manufacture of caustic soda is concerned is much more favorable. Austria has, it is true, lost nearly all of the establishments for the manufacture of this article, but the raw material is available in abundance from the brine of the Salzkammergut. Consequently the industry is preparing to manufacture caustic soda on a large scale. The Bosnische Elektrizitats-Gesellschaft has enlarged its plant at Klagenfurt until it now has several times its former capacity. A new company, Elektro-chemische Werke of Aussee, is erecting a hydro-electric plant which will produce caustic soda electrolytically. The previously mentioned permanganate company at Linz also intends to produce caustic soda from brine in this manner. The utilization of considerable quantities of

chlorine, however, presents a very difficult problem. Only a small quantity can be used for manufacturing bleaching powder. It is hoped that there will be a commercial development for using chlorine in chlorinating methane, since natural gas is available at Wels, which is very near the salt mines. The opinion as to the quantity of gas to be obtained from these sources is, however, widely different.

The works of the former state gunpowder factory at Blumau, which during the war had been enlarged to enormous dimensions, have already been transformed and adapted for peace-time production. Their newly organized chemical company produces nitric acid, hydrochloric acid, sodium sulphate, and in addition a number of organic chemical products. Furthermore a fertilizer factory has been installed there and the melinite factory of Blumau has been altered and adapted for the manufacture of coal-tar products, such, for example, as aniline and certain basic colors. Only the oleum plant was not changed. A second large gunpowder factory had been built during the war by the Skodawerke-Wetzler Aktiengesellschaft near Tulln, but these works, with a power plant of 9,000 hp., and an estimated capacity for producing 400 tons of gunpowder per month, have not yet engaged in any extensive peace-time pursuits. An exception, however, is in the case of copper sulphate and chrome alum, now being made there.

Italian Chemical Industries

From Our Special Correspondent

Genoa, Italy, April 6, 1922.

During the past 5 weeks there has been some recovery in the status of the Italian chemical industries. One reason has been the larger supply of electric current available due to an increase in the utilization of water power; another has been a further reduction in the price of coal and of certain imported raw materials. A general strike in all of the Italian ports recently brought imports and exports practically down to zero, crowding the harbors with ships loaded with all kinds of merchandise. In the port of Genoa alone there were at the end of March as many as twenty-seven ships loaded with coal awaiting discharge, and many others have since arrived. The industries that suffered most through this situation were the fertilizer manufacturers, the sulphur-mining industry and the metallurgical industry.

Fertilizers

After a series of discussions between the owners of the principal Italian fertilizer plants and their workers, an agreement has finally been reached which will keep alive the wage contracts effected last November. There are other factors, however, which are seriously affecting this industry. The situation in the phosphate market has completely changed owing to the continued fluctuations in foreign exchange and the increase in the cost of transporting phosphate rock from the mines to the sea in the principal countries of origin. During 1921 conditions in the phosphate industry were practically normal. The output of superphosphate was 501,975 tons, as compared with 496,575 tons in 1920. The maximum productive capacity of Italian plants for producing superphosphate is probably in the neighborhood of 750,000 tons. Consumption in Italy during 1921 was about 850,000 tons, although in 1913 it had reached 1,070,000 tons.

During the war practically all of the supplies of nitrate of soda were used for the production of explosives. Sulphate of ammonia, produced as a byproduct in the manufacture of illuminating gas, was produced in a quantity corresponding to only about one-half of the pre-war output. Likewise the importation was enormously reduced. During 1913 there was a consumption of about 100,000 tons of nitrogenous fertilizer; in 1918 this had fallen to 50,000 tons and in 1919 it remained at approximately this amount. Some little increase was noted in 1920, and there was further betterment in 1921. During this latter year the consumption of nitrate of soda was 32,000 tons, against an average of 55,000 tons before the war; that of sulphate of ammonia was 20,000 tons (of which only about one-half is of domestic origin), against an average consumption of 35,000 tons in 1913. The consumption of ammonium nitrate was about 12,500 tons, that of cyanamide was 16,000 tons in 1921 and 24,000 tons in 1920. Italy consumed only about 8,000 tons of crude potash salts during 1920, as compared with 28,000 prior to the war. The average consumption of potash in Italy at that time was 0.8 of a kilo per hectare of cultivated ground, while in France the average was 3.2 kilos, in Belgium 20 kilos and in Germany 63 kilos.

Sulphur and Blue Vitriol

A meeting was held in Rome about the middle of last month for the purpose of demanding the immediate intervention of the government in settling the crisis existing in the Sicilian sulphur industry. It has since been reported that a large Italian bank would offer financial backing to one of the most important mines, and it is hoped that this will result in speedy recovery and consequent re-employment of the miners.

The sulphur refineries of Cesena, Bellisio and Pesaro have been working regularly with satisfactory results and continue to produce products of good quality which find sale in Italy and abroad. The refinery of Murano was closed and its work taken up by the refineries at Bagnoli, Borgo Panigale, Pozzolo, Reggio and Rifredi. The Societa Unione Raffinerie Siciliane, as a consequence of the high prices arranged by the sulphur consortium for its raw material, has had to reduce its activity considerably.

The consumption of copper sulphate was unusually good in 1921 and the establishments at Vicenza, Casale, Rifredi and Bagnoli were able to take care of a considerable part of the supply. A new plant is under construction at Reggio Emilia and it is believed that a plant in this locality will facilitate the distribution of the product and also reduce expenses of transportation. Blue vitriol will also be produced in the works at Piano d'Orte and in other chemical plants of that vicinity. The total production of copper sulphate at present is about 1,000,000 tons per year, whereas the national requirements are probably only about 750,000 tons.

Pharmaceutical Products

On March 4 the special committee which is assisting the Ministry of War in the sale of those pharmaceutical chemicals obtained from Germany on account of war reparations established a sales organization for these products with the Farmacia Centrale Militare of Turin. Certain limitations have been set on these sales with a view to protecting the interests of the Italian industry producing pharmaceutical products. It is reported that the German goods are in very good condition and nearly all are in the original package bearing the name of the original producer.

The Business Side of Chemical Manufacturing

In This Article, the Second in the Series, the Marketing Function Is Analyzed, the Necessary Steps Are Outlined and a Detailed Consideration of the Advertising Department Is Undertaken

By CHARLES WADSWORTH, 3d

THE marketing function in any organization includes a number of departments. The scope of these departments varies tremendously with the type of organization and with the men in it. If, for example, we were to describe accurately the functions of the sales department in a given organization today and if tomorrow a new sales manager were appointed, we would have to rewrite our description. The old description would not fit the new department. Let us take a mythical example. Old J. P. Smith, head of the sales department, had been with the company 30 years. He was a Tartar and people never intentionally aroused J. P.'s wrath. Fulton, head of advertising, was the only one who dared to argue with him, but "J. P." had the final say on all marketing policy. "J. P." died, and Sprague, metropolitan district sales manager, took over the work, but Fulton dominated sales policy from that time on. So you see we would first have said the advertising manager formulated all the plans for campaigns, but they were always revised and approved by the sales manager. After "J. P.'s" death we would have to say the advertising manager had entire charge of the planning of the marketing campaigns and the co-operation of the sales department was tacitly assumed. With the possibility of such variations in mind, let us examine the various component departments co-operating in the marketing function of an organization. The following steps are undertaken in the order named and the work is accomplished by the department or group listed on the same line.

1. Locate the market.	Sales research or engineering.
2. Interest it in the product.	Advertising.
3. Classify prospects.	Credit.
4. Consummate sales.	Sales.
5. Deliver the product.	Traffic.
6. Keep customer satisfied.	Trouble dept., or sales source.
7. Collect the bills.	Collection (or credit).

There are a great many more incidental steps necessary which will be taken up under the detailed consideration of the departments, but those steps just mentioned summarize the functions of the main departments engaged in this work.

Advertising

In the first article of this series I mentioned only two of these departments as being fundamental units of organization, sales and advertising. That was because the other departments are usually subsidiary functions of the sales department. Not infrequently sales and advertising will also be under one head, but they are more apt to keep their own identity, and therefore deserve to be considered fundamental units. In discussing this work we shall adhere to our original classification and take up advertising first and then all the rest of the functions under sales.

In this discussion of advertising we are forced to leave the chemical field for our models. The question, How shall advertising be done? cannot be answered by the chemical industry. With the exception of perhaps half a dozen large corporations chemical advertising is rather unintelligent. It is unintelligent because it is generally not well advised. Good advertising men are not used.

There is rather a valid excuse for this, however. It is this. Advertising technique seems at first glance to be simple. As a very able advertising man once remarked, "Every American business man believes that he is preeminently competent to criticize advertising copy and organize an advertising campaign, whereas nothing could be farther from the truth." The result is that at first business men are very apt to underestimate the value of an advertising department. The first industries to appreciate its value have been those selling to the general public. Their advertising departments have been able to show conclusive proof of more efficient expenditure and greater net results. The chemical industry does not sell to the general public and has been slower, therefore, to understand the value of advertising and of the advertising department.

Relation to Sales Department

If you will recall the definition given of the advertising function, it was "to interest the prospective customer in the product." It is the second step in marketing the product and must very obviously be closely co-ordinated with other marketing effort. Co-operation is really not a strong enough word to indicate the relationship which should exist between advertising and sales. United is more accurately descriptive if we remember that this should not mean a complete merger of identity. The advertising manager must be intimately familiar with all of the other steps of marketing. He is the only one who needs to be in this position. All of the other marketing units such as sales engineering, credit, traffic, etc., function fairly independently. Not so with advertising. The manager must study the sales engineering or research work, the demand for the goods, the distribution of the market, competition, merchandising methods, policy of price regulation. These things he must correlate with the details of advertising policy. He therefore acts as a consultant in the marketing field. By the very requirements of his work he is in a position to get a perspective of marketing which is unique.

The work of the advertising department falls naturally into three parts: 1. Planning. 2. Production. 3. Statistical.

For this discussion we shall devote most of our time

The first article in this series appeared in Chem. & Met., vol. 26, No. 15, p. 679, April 12, 1922.

to planning. The technique of producing advertisements is too complicated for treatment in an article of this kind. There are many excellent books which take up this subject, and none of them contains less than several hundred pages. It would be impossible even to list and balance the factors which must be considered in constructing advertisements. Men who have such work in charge correspond to high-grade technical men in other departments. They have artists, draughtsmen, copy writers, photographers to assist them. In a large department such men are called creative men. They must be capable of translating advertising policy into a message through one of the many methods of advertising. The production unit of the advertising department will vary in size as greatly as the production unit in a plant: from zero on the one hand where the department depends on the agency or the publishing house for practically everything, to units which in addition to large staff of specialists will have their own engraving done and send the finished plates to periodicals. The needs and temperament of the business will determine the kind of production unit.

Similarly the statistical work of the advertising department may be negligible, with scarcely an adequate record of the kind of advertising placed. Or it may be of the most elaborate kind, including tables of sales or other returns classified by the medium used, the time of year or month, the territory, the salesman and in combinations of these classifications. Then there can be costs per unit sold or per unit advertising depending on the judgment of the head of the department and the kind of results desired.

Planning

We are mainly interested, however, in the planning. It is here that the advertising manager displays his deftness in co-ordinating advertising effort and sales policy. It is the most important part of the advertising manager's work. Good drawing, good copy, good layouts, good choice of medium, all go for naught unless they are part of a plan harmonious with sales effort. Examples without number indicate the loss which results from a petty jealousy or lack of co-operation between sales and advertising.

Therefore before making any plans the advertising manager should absorb (and perhaps modify or create) marketing policy. With that as a foundation he can begin to build toward a definite result. Advertising should strive for a definite result almost quantitatively expressed.

Naturally the size of the appropriation is closely tied to the results desired. You can't buy a Rolls-Royce when you can only afford a bicycle. Neither can you reach the ten million people, nor ten industries, nor the automobile accessory men in ten states when you can afford only one of each. So we have two factors to determine first, the result desired and the appropriation. Usually the board of directors determines the appropriation and the advertising department does its best with what it can get. The department, however, should be able to supply the board with programs of what can be accomplished with various given amounts.

Distribution of Advertising

Given an aim and an appropriation, the most difficult problem is that of distribution.

Shall we use direct advertising, periodical advertising or poster advertising?

Those are the three classes of advertising which are usually differentiated. Direct advertising may not be an obvious term. It includes all forms of advertising which are specifically addressed to an individual. Usually this takes the form of mailing circulars, catalogs, letters or advertisements.

By far the largest annual expenditure for advertising is for periodical advertising, including newspapers, magazines, programs, etc. This does not mean that periodical advertising is the best kind of advertising. There is no "best kind" in general. Practically all of the Sears-Roebuck appropriation goes into direct advertising, whereas for years Campbell's soups appeared only on posters and car cards. Each advertiser has a different problem, a different group of prospective customers, a different appeal, and consequently would choose different media. It is obvious that the problem of distributing advertising is one which should command experience and knowledge of advertising technique. On what basis except experience can there be any preference for one method as against another? The only other basis is the royal game of guess, in which the ordinarily shrewd business man seems to like to indulge. It is incidentally a convenient way of accounting for poor advertising.

Chemical Advertising

It has seemed to me rather obvious that, in general, chemical advertising could be limited to direct advertising and advertising in technical and trade periodicals. With a definite and limited list of prospective consumers, manufacturers of chemicals and chemical equipment do not have the difficult problems of national advertising to face nor yet those of local advertising to the general public. (The few exceptions to this general rule, chemical manufacturers whose products go to the general public, are in a healthier condition in regard to advertising policy than the rest of the industry and will be neglected in this article.)

Evidence is at hand that there are advertisers who do not agree with the above thesis. A large manufacturer of equipment recently appeared in some full-page displays in the *Saturday Evening Post*. For the price of one page he could have covered his six biggest consuming industries for a year in the technical and trade magazines. That is one example of unintelligent advertising.

Again, a manufacturer of chemicals spent nearly a thousand dollars putting little $\frac{1}{16}$-page announcement cards in trade periodicals and did not back up the campaign with proper sales support. He received three inquiries—from dealers—in the course of a year. He was depending on his advertising to make sales, an ill-conceived policy, expensive no matter how few dollars and cents are involved.

These two advertisers represent the two extremes—the profligate spending of a large and poorly estimated appropriation on the one hand and the self-advised throwing away of a small amount of money on the other. Most chemical advertising resembles the second example. The attitude of the advertiser lies midway between that of a patron of art bountifully bestowing a largess and that of a skeptic who, though he does not believe in vaccination, nevertheless for his own peace of mind grudgingly pays a physician to be inoculated. The idea that advertising is an aid to marketing and is a study conducted by experts on scientific principles has not seemed to occur to the chemical advertiser.

The point I am anxious to make is this: Chemical

manufacturers must realize that their advertising problems should be solved with the aid of the advertising experts. Otherwise their money is apt to be wasted.

Indirect Advertising

There are other methods of advertising—indirect methods. They have value, although they are not usually included in advertising appropriations. Manufacturers of high-grade automobiles sometimes make it a practice to keep cars of their make looking well. When they see a dilapidated car they approach the owner with offers to trade it in or have it fixed up. An analogous procedure exists in the follow-up of some firms to make sure their customers are satisfied.

One enlightened firm sends some of its technical representatives to the various conventions at which consumers of its products are likely to be found. No soliciting is done, but the good appearance and friendliness of these men create a very favorable tone.

The trouble work, so called, or sales service, which will be discussed later, is a splendid advertising aid. One satisfied customer is worth a number of prospects; the exact number depends on the product and might vary from two or three with acids to say fifty with dyestuffs.

Every point of contact with other firms presents an opportunity to create favorable or unfavorable impressions and to build up assets and liabilities. The policy of collecting accounts may lose friends. The purchasing agent may leave a bad impression on salesmen. The company's salesmen in particular are ambassadors reflecting policy. All of these contacts are indirect advertisements and should come under the scrutiny of the advertising manager.

The Advertising Agency

If I had been made advertising manager of a company I should certainly not begin to talk about advertising agencies at once. It would be poor psychology. Presumably the board of directors would assume that I was trying to get someone to do my work for me. Few persons realize that the advertising department and the advertising agency are complementary and not interchangeable. The point at which the department stops and the agency begins varies with each company. One firm may have an advertising manager and two or three stenographers or clerks who simply keep records. In such a case the agency would co-operate in planning the campaign, produce all the drawings and literature necessary, take charge of accounting, etc. The same agency may have a client with a large staff of advertising men, artists, compositors, as well as routine clerks, etc. In such a case the agency acts in an advisory capacity only.

In any national advertising the advantages of dealing with an agency are very great. Its wealth of experience can be focussed on the problem of the individual firm to great advantage. It cannot displace the advertising department, however. Experience has shown that it is very wise to have the point of view of someone inside the organization turned on these problems. Several large companies have experimented with this plan and abandoned it.

There is less evidence of the value of the agency in technical advertising. There has been less of it for them to do and in addition many accounts were and are still unwisely undertaken by agencies—accounts about which they know very little. Their advice is therefore either superficial or obtained from technical publishers. So widespread has this been that a large number of technical publishers have instituted their own advertising service. Some have all the facilities of first-class agencies at their disposal and are able to plan for clients a campaign of advertising which will put their product before that part of the technical world which will be interested.

In general then the agency has yet to prove its value in technical advertising, but has won a deserved place in the counsels of national advertisers.

There have been no figures given here to show the value of advertising. That has not been the purpose of the discussion. Such figures are easily available, even in our backward industry. A firm which tries to market without obtaining the advice of an advertising expert and finding out whether and how he should advertise is like the man who lit a candle and put it under a bushel basket. It is a waste of light. Rather set it on a candlestick and use the lenses and reflectors of advertising so that the light will go where it will do most good.

A word of caution to technical men may be in order. Our confessed attitude in these articles has been how valuable technical training is in non-technical departments. In the case of advertising, however, technical men will find their training of least value. It would be difficult to justify a technical course as a preparation for advertising. Other things would be so much more worth while. Every position, technical or non-technical, should be approached with humility but with perhaps confidence. If you are drawn toward advertising, take it up with more humility and less confidence but with great optimism. The future is there for the department and for the man who creates and develops it.

Indications of a Finished Heat in Acid Electric Furnace*

By James L. Cawthon, Jr.

In the acid way, a percentage of silicon may be reduced from the slag. Under certain conditions, if the temperature is permitted to get high, the slag highly acid and the furnace condition highly reducing, a considerable amount of silicon will be reduced from the slag. The action which produces this takes place at a very rapid rate, conditions being propitious, and a closer analysis may be obtained if this condition be avoided, relying entirely upon a ferrosilicon addition.

All three of the conditions mentioned above are necessary to silicon reduction, and by modifying any one of them it can be stopped instantaneously. The simplest method is to introduce a small amount of fireclay or lime immediately under the electrodes. To the operator experienced in acid electric furnace operation, the condition is immediately apparent by several signs, among them being the almost total silence of the arcs, the extreme paucity of fumes around the electrodes and the general "tightness" of the furnace.

It may be added here that this condition which comes about in the acid electric furnace is indicative of a highly deoxidized condition of the bath. Tests taken from heats under this furnace condition show the metal to be in excellent condition. Its use, with proper judgment and understanding, may therefore well be adopted. Some steel foundries regularly permit a heat to come to this condition incipiently before tapping, the results being reflected in the soundness of the castings.

*Extract from a paper on "Synthetic Cast Iron," read before the Baltimore meeting of the American Electrochemical Society, April 27, 1922.

Studies in the Carbonization of Coal: Characteristics of Low-Temperature Coal Tar*

Outline of a Scheme of Examination for Tars Obtained in the Low-Temperature Carbonization of Coal—Composition of a Commercial Low-Temperature Tar and Comparison With Coke-Oven and Gas-Works Tars—Review of Results Obtained by Previous Investigators

BY JEROME J. MORGAN AND ROLAND P. SOULE
Department of Chemical Engineering, Columbia University

THE present report is the first of a projected series of studies in the carbonization of coal. It concerns itself primarily with an examination of a low-temperature coal tar, but its scope has not been confined to specific analytical data. In the absence of any standard analytical procedure in this little explored field, it has become necessary to develop a scheme of examination by which the component groups of low-temperature tars may be readily examined. An intensive investigation has been made of a commercial low-temperature tar, comparing the analytical results obtained with those of other tars. This scheme and the character of the tar determined by it are described in the present paper.

The composition of this tar indicates a stage in the decomposition of the primary liquid distillates of coal which hitherto has not been carefully studied. In a second installment it is intended to define more precisely several distillation reactions, and to present a new viewpoint on the much disputed mechanism of the carbonization of coal. Thus, a rational basis will be found for reconciling to a large extent the reported differences in the composition of low-temperature coal tars.

Until recently the commercial carbonization of coal has been performed at 1,000 to 1,300 deg. C. primarily for the production of city gas and metallurgical coke. Within the past decade, however, lower temperatures of distillation have been made to serve two purposes. The first of these is scientific in nature—the study of the products of distillation at various temperatures has shed light on the constitution of coal, and afforded evidence for theories of carbonization. The second object has been the production of new materials of commercial value. By distilling an ordinary bituminous coal at 500 to 600 deg. C. there are obtained a friable, free-burning coke which may be made to serve as a smokeless fuel, and a distillate which upon removal of the phenols resembles crude petroleum in properties and uses.

*Condensed from a thesis presented by Roland P. Soule in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Faculty of Pure Science of Columbia University in the City of New York.

OUTLINE OF INVESTIGATION

An outline of the type of methods used in the present investigation is given in Fig. 1. According to this pro-

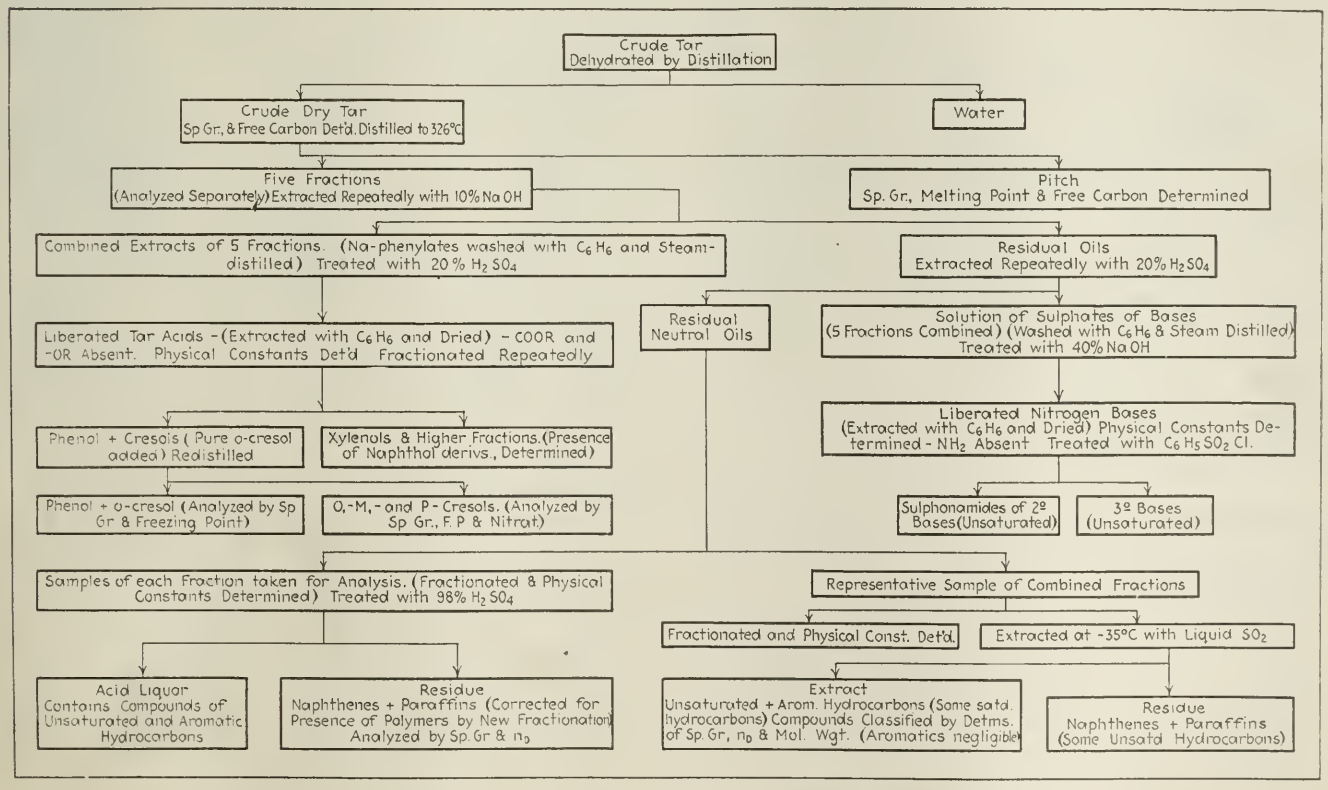
Crude Tar
Dehydrated by Distillation
Crude Dry Tar
Sp Gr, & Free Carbon Det'd. Distilled to 326°C
Water
Five Fractions
(Analyzed Separately) Extracted Repeatedly with 10% Na OH
Pitch
Sp. Gr., Melting Point & Free Carbon Determined
Combined Extracts of 5 Fractions. (Na-phenylates washed with C_6H_6 and Steam-distilled) Treated with 20% H_2SO_4
Residual Oils
Extracted Repeatedly with 20% H_2SO_4
Residual Neutral Oils
Solution of Sulphates of Bases
(5 Fractions Combined) (Washed with C_6H_6 & Steam Distilled) Treated with 40% Na OH
Liberated Tar Acids - (Extracted with C_6H_6 and Dried) - COOR and -OR Absent. Physical Constants Det'd Fractionated Repeatedly
Liberated Nitrogen Bases
(Extracted with C_6H_6 and Dried) Physical Constants Determined - NH_2 Absent Treated with $C_6H_5SO_2Cl$.
Phenol + Cresols (Pure o-cresol added) Redistilled
Xylenols & Higher Fractions. (Presence of Naphthol derivs., Determined)
Phenol + o-cresol (Analyzed by Sp Gr & Freezing Point)
O.-M.- and P.- Cresols. (Analyzed by Sp Gr., F.P & Nitrat)
Sulphonamides of 2° Bases (Unsaturated)
3° Bases (Unsaturated)
Samples of each Fraction taken for Analysis. (Fractionated & Physical Constants Determined) Treated with 98% H_2SO_4
Representative Sample of Combined Fractions
Fractionated and Physical Const. Det'd.
Extracted at -35°C with Liquid SO_2
Acid Liquor
Contains Compounds of Unsaturated and Aromatic Hydrocarbons
Residue
Naphthenes + Paraffins (Corrected for Presence of Polymers by New Fractionation) Analyzed by Sp. Gr & n_D
Extract
Unsaturated + Arom. Hydrocarbons (Some satd. hydrocarbons) Compounds Classified by Detms. of Sp. Gr, n_D & Mol. Wgt. (Aromatics negligible)
Residue
Naphthenes + Paraffins (Some Unsatd Hydrocarbons)

FIG. 1—SCHEME OF EXAMINATION OF A LOW-TEMPERATURE COAL TAR

TABLE I—SUMMARIZED COMPOSITION OF CARBOCOAL DISTILLATE

Component Classes	Basis	Percentages by Weight of Distillate		Basis Crude, Dry Tar	
Phenols	42.7		13.7		
Nitrogen bases	1.94		0.624		
Hydrocarbons *a*	55.4		17.8		
Cyclic unsaturated		41.5		13.4	
Saturated		13.9		4.4	
Naphthene			8.8		2.8
Paraffine			5.1		1.6
Totals	100.0	55.4	13.9	32.1	17.8	4.4

a May contain traces of aromatic hydrocarbons.

cedure the tar examined was found to have the composition indicated in general by Table I and Fig. 2.

Fig. 2 shows the change in the percentages by weight of the various classes of components in the condensate as the boiling point of the tar rises during distillation. The vertical axis of boiling temperatures is so graduated that the areas of the figure represent proportions by weight of the different groups. The horizontal dotted lines separate the five fractions of the distillate, and the curved lines are the boundaries between the component groups.

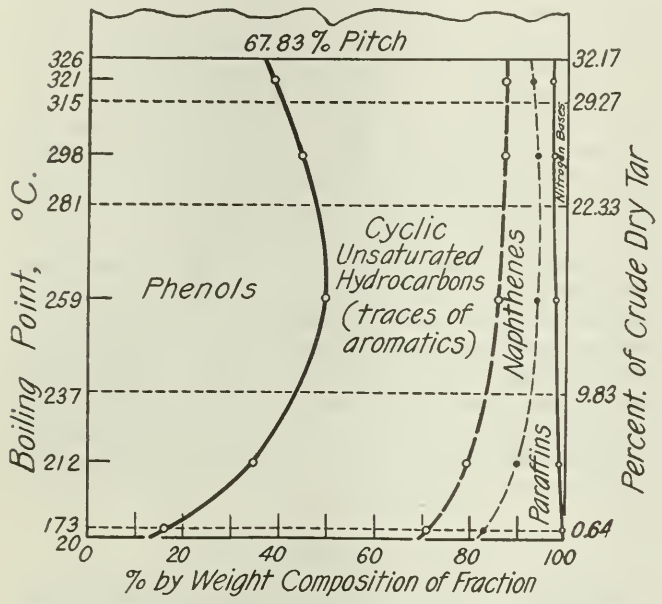

FIG. 2—COMPOSITION OF THE CARBOCOAL DISTILLATE

Résumé of Earlier Studies

Low-temperature coal tar may best be defined as the tar produced by the carbonization of coal at temperatures (500 to 750 deg. C.) not high enough to cause an appreciable decomposition of the primary liquid products of distillation.

Certain circumstances must be borne in mind in attempting a comparison of previous investigations of low-temperature tars. The low heat conductivity of coal makes the exact nature of tars distilled at approximately the same temperature dependent upon such factors as agitation, rate of distillation, the thickness of the fuel layer and the resulting temperature gradient. Moreover, the extent to which secondary reactions may also occur is determined by the pressure employed, the use of steam, the size of the gas space, the temperature of the crown of the retort and other conditions controlling the path of the gases.

Of the several investigations of one aspect or another of low-temperature tars, four studies are cited in Table II as the most important and representative efforts toward a through analysis. A. Pictet[1] and his co-workers in Switzerland and D. T. Jones and R. V. Wheeler[2] in England employed the tar as an agent in their re-

[1] A. Pictet et al., *Ann. Chim.* [9], vol. 10, p. 249 (1918); *cf.* A. Pictet and M. Bouvier, *Ber.*, vol. 46, p. 3342 (1913); vol. 48, p. 926 (1915); *Compt. rend.*, vol. 157, pp. 779, 1436 (1913); vol. 160, p. 629 (1915); A. Pictet, O. Kaiser and A. Labouchere, *Compt. rend.*, vol. 165, pp. 113, 358 (1917).

[2] D. T. Jones and R. V. Wheeler, *J. Chem. Soc.*, vol. 105, p. 140 (1914).

TABLE II—COMPARISON OF INVESTIGATIONS OF LOW-TEMPERATURE TARS

	Morgan and Soule	A. Pictet	Jones and Wheeler		S. W. Parr	F. Fischer
Name of investigators						
Date of investigations	1921—1922	1913—1918	1914—1915		1914—1915	1916—1919
Temp. of distn., deg. C.	500–600	450 max.	430		450–525	350–500
Distillation apparatus:						
Form	horizontal cylinder with rotating screws	2 horizontal D-shaped retorts, one above other	round-bottom flask		vertical cylinder	horizontal rotating cylinder
Material	Carborundum	Cast-iron	Jena glass		Cast-iron	Cast-iron
Dimensions	18 ft. x 7 ft.	.....	about 1 liter		44 in. x 6 in.	110 cm. x 30 cm.
Amount distilled	5,000 lb.	1,500 kg	1.25 kg		20 lb.	10 kg.
Method	Dry	Dry	Dry		Superheated Steam	Steam
Pressure	atm.	15-20 mm. of Hg	13-15 mm. of Hg		<8 in. water above atm.	atm.
Time	3 hours	5 hours	5 weeks		6-8 hours	1-2 hours
Coal	Pa. "Pittsburgh Terminal"	Montrambert (Loire)	Scotch	Durham	Illinois (Vermilion Co.)	Lohberg gas coal
Analysis (dry basis), in per cent:						
Vol. comb. matter	35.30	15–20	20.36	30.81	34.92	39
Fixed carbon	57.92	66–75	70.36	65.09	48.81	59
Ash	6.78	10–15	3.28	4.10	16.27	1.65
Carbon	.....	.....	86.92	86.88	.....	80.68
Hydrogen	.....	.....	4.98	5.41	.....	5.54
Oxygen	.....	.....	5.56	4.71	.....	7.67
Nitrogen	1.65	....	1.75	1.75	..	1.90
Sulphur	1.77	.....	0.79	1.25	2.01	0.67
Crude, dry tar						
Per cent by weight of coal	11.3	4.0	6.5		8.7	10
Specific gravity	1.0676 at 15.5 deg./15.5 deg. C.	<1 fresh, 1 in 3 hr. >1 later	0.999 at 15 deg./15 deg. C.		1.072 at 15 deg. C.	"about 1"
Free carbon, per cent	0.71	.....	.....		1.35	.....
Max. temp. distn. tar	326	steam distillation	300		400	superheated steam distn.
Pitch						
Per cent of tar	67.83	.....	50		30	.....
Melting point, deg. C.	53	.....	"soft"		110	.....
Specific gravity	1.134 at 15.5 deg./15.5 deg. C.	.....	1.128 at 15 deg./15 deg. C.		1.27	.....
Free carbon, per cent	2.17	..	0		12	.....
Composition of tar, in per cent	Distillate	Tar	Crude, dry tar basis (8*a*)	Distillate	Tar	Crude, dry tar	Crude Tar
Phenols	42.7	13.7	0 2	12–15	6– 8	28.0	Phenols 50
Bases	1.94	0.624	2	traces	traces	0.2	Non-viscous oils 15
Alcohols	0.0	0 0	.....	.....	....	....	Lubricating oils 10
Hydrocarbons							Paraffine 1
Paraffine	5.1	1.6	..				Resins 1
Naphthene	8.8	2 8	30	40	20	14.5	Pitch 6
Unsaturated	41.5	13.4	68	40–45	20–23		Loss and water 17
Aromatic	..	..	0	7	3.5	57.3	

a Eight per cent of phenols found by Pictet in a later analysis.

searches on the constitution of coal. S. W. Parr[3] and his associates in this country were primarily interested in the commercial aspects of low-temperature carbonization, as were F. Fischer[4] and his staff in the Kaiser-Wilhelm Institute of Coal Research in Mülheim-Ruhr, Germany. The details tabulated in the case of Fischer's work represent only one of a large number of related experiments, but serve to indicate his characteristic method of reporting tar investigations in technical rather than in scientific terms. For the purpose of comparison the results obtained in the present investigation are also included in this table.

Origin of the Tar Examined

The tar examined was produced by the "Carbocoal" process[5] (C. H. Smith patents) of the International Coal Products Corporation. It was a representative sample made in March, 1921, under commercial conditions at the experimental plant of the company at Irvington, N. J.

The low-temperature tar produced by the *primary* retorts is the subject of this investigation. These retorts are horizontal, about 18 ft. long, and of cardioid section. The walls are constructed of carborundum blocks, and the ends of cast iron lined with firebrick. The coal is continuously stirred and advanced through the retort by paddles of radius 2 ft. 3 in. mounted on two parallel 12-in. paddle shafts, which revolve at 1.8 r.p.m. Each retort is operated about one-third full, and has sufficient capacity to permit an output of 1 ton an hour. The products of distillation leave at the top of the discharge end of the retort. The temperature in the retort shell is about 730 deg. C., in the gas at the feed end of the retort 300 deg. C. and at the discharge end about 500 deg. C. The temperature of the discharged coke approximates 480 deg. C.

It is apparent from this description of retort conditions that the opportunities for secondary decomposition are not negligible. Thus the outgoing products of distillation come into contact with surfaces heated to 600 deg. C. and undergo decomposition to some extent.

A Pennsylvania bituminous coal known as "Pittsburgh Terminal" coal was used in the preparation of the sample of tar examined. Its analysis[6] on a dry basis is given in Table II. The moisture content of the coal as fed into the furnace amounted to 2 per cent. The calorific value was 13,925 B.t.u. per lb.

Properties of the Tar and Pitch

Dehydration and Distillation. Carbocoal tar, in common with other low-temperature tars, is a black oil of petroleum-like fluidity. It smells strongly of cresols and to a less extent of hydrogen sulphide. The viscosity is lower than that of ordinary coke-oven and gas-works tar, and no odor of ammonia or naphthalene can be detected in it.

The tar was dehydrated for subsequent examination by distilling to 200 deg., separating the light oil from the water in the condensate and returning it to the main body of tar remaining in the still. A specially constructed 3-gal. copper tar-still of the same proportions as the Barrett type[7] was used in the operation. About 8 kg. of tar was distilled at a time. The content of water in the sample of tar amounted to 2.12 per cent.

A sample of thoroughly mixed, crude, dry tar was taken for specific gravity (Hubbard bottle) and "free carbon" determinations according to standard procedures[7]. A dry distillation of the 8 kg. of crude tar thus dehydrated was made at atmospheric pressure in the same copper still. The rate was 15 c.c. per minute, or about 0.2 per cent of the total volume of tar per minute. For comparison samples of coke-oven tar[8] and gas-works tar[9] were fractionated in exactly the same manner and the results are recorded in Fig. 3 and Table III.

TABLE III—FRACTIONATIONS OF REPRESENTATIVE TARS[10]

Fraction B.P. Range Deg. C.	Percentages of Total Weight—Low-Temperature Tar	Coke-Oven Tar	Gas-Works Tar
20–173	0.64	0.70	1.19
173–237	9.19	8.27	9.22
237–281	12.50	12.44	10.12
281–315	6.94	6.21	3.78
315–326	2.90	2.53	1.93
Pitch (diff.)	67.83	69.85	73.76
M. P. of pitch, Deg. C.	53	69	89

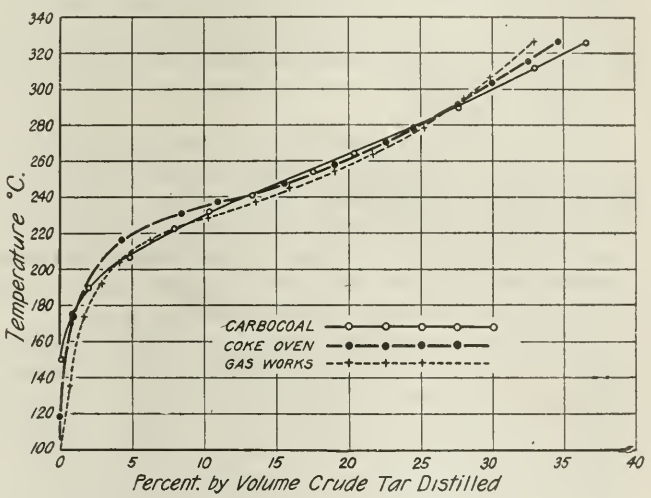

FIG. 3—DISTILLATION OF CRUDE, DRY TARS

In general there is a close resemblance between the three fractionation curves, disproving the many exaggerated statements that have been made of the larger quantity of low-volatile oils in low-temperature coal tars. The percentage of pitch is only slightly lower in this tar than in the high-temperature tars, although the difference would be greater with higher cutting temperatures, or if the distillates had been carried to a pitch of the same melting point in each case, as commercial conditions might demand. Thus, when Carbocoal tar is carried to a pitch melting at 80 deg. C. for use in briquetting, only 56 per cent remains in the still.

Pitch. The pitch obtained from the low-temperature tar was an amorphous, black residue, which lacked the brittleness and lustrous fracture of high-temperature pitches. Briquets made from it lost their sharp edges

[3]S. W. Parr and H. L. Olin, Univ. Illinois Eng. Exp. Sta. Bulls. 60 (1912) and 79 (1915); T. E. Layng, Dissertation, Univ. Illinois (1915).

[4]F. Fischer and W. Gluud, *Ges. Abhandl. zur Kenntnis der Kohle*, vol. 1, p. 114 (1916); *Ber.*, vol. 52, p. 1035 (1919): *cf.* also *Ges. Abhandl.*, vol. 3, pp. 1, 248, 270 (1918).

[5]H. A. Curtis, CHEM. & MET. ENG., vol. 23, p. 499 (1920); *J. Ind. Eng. Chem.*, vol. 13, p. 23 (1921); G. H. Thurston, *J. Soc. Chem. Ind.*, vol. 40, p. 51T (1921); Wallace Savage, CHEM. & MET. ENG., vol. 19, p. 579 (1918); C. T. Malcolmson, *Bull. Am. Inst. Min. Eng.*, vol. 137, pp. 971, 1686 (1918).

[6]Analysis by Research Laboratory of the International Coal Products Corporation.

[7]J. M. Weiss, *J. Ind. Eng. Chem.*, vol. 10, pp. 732, 817 (1918).

[8]Obtained through the courtesy of the Seaboard By-Products Coke Co., Kearny, N. J. (Koppers retorts); distilled at 850-900 deg. from a mixed coal, avg, 30 per cent V.C.M.

[9]Obtained through the courtesy of the Consolidated Gas Co., New York City; consists of approximately equal proportions of horizontal and inclined retort tars; coal distilled at about 1,000 deg.

[10]All temperatures reported in this investigation are corrected for the emergent stems of the thermometers.

TABLE IV—COMPARISON OF TARS AND PITCHES

	Low-Temperature	Coke-Oven	Gas-Works
Crude, dry tar			
Sp.gr. 15.5 deg./15.5 deg.	1.0676	1.1845	1.2172
"Free carbon," per cent	0.71	6.93	20.1
Pitch, cut at 326 deg.			
Sp.gr. 15.5 deg./15.5 deg.	1.134	1.263	1.312
"Free carbon," per cent	2.17	16.8	31.1
Air melting point, deg. C.	53	69	89

within an hour at room temperature. The specific gravity (Hubbard bottle), "free carbon" and air melting points of the Carbocoal, coke-oven and gas-works tars and pitches were determined by standard procedures, and are recorded in Table IV.

The Phenols

The high content of phenols in low-temperature tars has been remarked by nearly all investigators (*cf.* Table II), and within certain limits may be accepted as an important characteristic distinguishing them from high-temperature tars.

Removal From the Tar. The percentages of phenols were determined separately in each of the five fractions (*cf.* Table III). In the method used, 100 g. of a fraction was weighed into a 200-c.c. glass-stoppered separatory funnel, and extracted four times each with 50 c.c. of 10 per cent sodium hydroxide solution. The loss in weight of each sample checked against the gain in weight of the alkali used was taken as the percentage of tar-acids present.

Fig. 4 was obtained by plotting percentages of tar-acids against the average boiling points during distillation of the corresponding tar fractions, taken as the mean ordinates of the respective sections of the distillation curve of Fig. 3. It shows a well-defined maximum between 240 and 280 deg., and indicates that a large quantity of tar acids is contained in the pitch.

Purification of the Tar-Acids. The fractions of low-temperature tar were washed completely free of phenols with 10 per cent sodium hydroxide solution. The alkaline solution, after purification by benzene extraction and steam distillation, was acidified with 20 per cent sulphuric acid to liberate the phenols, as indicated by Fig. 1. The tar-acids thus recovered formed a dark brown, slightly viscous liquid, which had a strong odor of cresols.

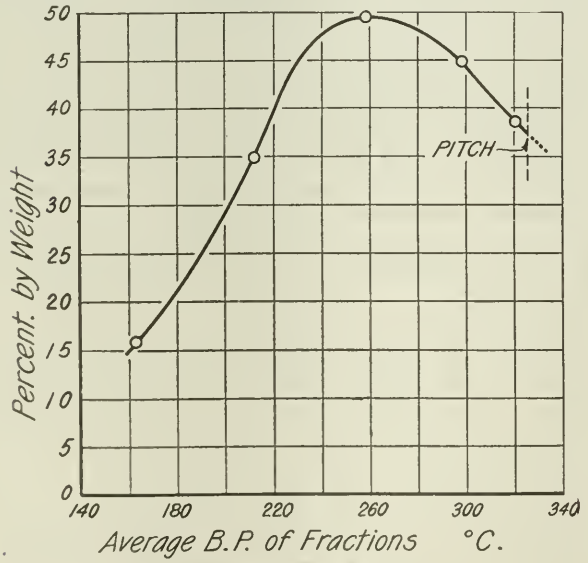

FIG. 4—RELATION OF THE BOILING POINTS OF TAR FRACTIONS TO PHENOL CONTENT OF EACH

Carboxylic Acids. No solubility of this mixture in a saturated sodium carbonate solution could be detected, and a sample after solution in sodium hydroxide was completely recovered by precipitation with carbon dioxide. Carboxylic acids, therefore, could be admixed with the phenols only to a negligible extent.

None of the four investigators quoted above has reported such compounds, but recently Marcusson and Picard[11] found in a low-temperature tar from upper Silesian coal a solid mixture of 13 per cent phenols and 12 per cent aromatic carboxylic acids. Tropsch[12] distilled under similar conditions a coal from the same region, however, and found viscous, not solid phenols, with only traces of solid carboxylic acids. He stated that the tar described by Marcusson and Picard was probably exceptional.

Phenol Ethers.—The occurrence of guaiacol in wood-tar[13] and in peat-tar,[14] both of which are formed by carbonization below 500 deg. and resemble low-temperature coal tars in their high content of phenols, suggests the possible presence in the latter of phenol ethers. A negative Zeisel test, however, showed that methoxyl and ethoxyl groups are absent from the phenol mixture obtained from the low-temperature tar.

A similar result has been reported[15] for the phenols from Lohberg coal tar (*cf.* Table II).

Polyhydroxy Phenols. The water obtained simultaneously with the tar in the distillation of the coal in the low-temperature process was not available for the present investigation. Since this liquor contained the largest proportion of polyhydroxy phenols distilled from the coal, their estimation in the tar was not attempted.

Catechol has been identified[16] among the products of low-temperature distillation of Lohberg coal, and was estimated to be present to the extent of 0.02 per cent of the weight of the coal.

Fractionation and Density Determinations

The phenol mixture from the low-temperature tar had a specific gravity[17] of 1.036 at 25 deg./4 deg. as compared with 1.044 of the mixed coke-oven and gas-works phenols extracted with 10 per cent sodium hydroxide at 60 deg., and purified in the same manner as the low-temperature phenols. Fractionation curves of the two types are seen in Fig. 5.

It is evident that in the first-named mixture there are no phenols of boiling point higher than may be found among the high-temperature phenols. The proportions of the components, however, differ quite markedly, 52 per cent by volume of the low-temperature phenols boiling below 220 deg., as opposed to 77 per cent of the phenols from coke-oven and gas-works tar. In both cases these percentages may be increased considerably by continued fractionation.

[11]J. Marcusson and M. Picard. *Z. angew. Chem.*, vol. 341, p. 201 (1921).

[12]Hans Tropsch, *Brennstoff Chem.*, vol. 2, p. 251 (1921); *cf. ibid.*, vol. 2, p. 312 (1921), where he reports 0.49 per cent of carboxylic acids in a vacuum tar from Lohberg coal.

[13]Ossian Aschan, *Brennstoff Chem.*, vol. 2, p. 273 (1921) reports 4.9 per cent of phenol ethers in wood tar.

[14]E. Börnstein and F. Bernstein, *Z. angew. Chem.*, vol. 271, p. 71 (1914); F. M. Perkin, *J. Soc. Chem. Ind.*, vol. 33, p. 395 (1914); *J. Inst. Pet. Tech.*, vol. 1, p. 76 (1914).

[15]W. Gluud and P. K. Breuer, *Ges. Abhandl.*, vol. 2, p. 236 (1917).

[16]W. Gluud, *Ges. Abhandl.*, vol. 3, p. 66 (1918); *cf.* W. Gluud and P. K. Breuer, *loc cit.* (ref. 15), and E. Börnstein, *Ber.*, vol. 35, p. 4324 (1902).

[17]Unless otherwise specified, all densities cited in this investigation were determined by use of a Becker analytical balance and a 7 g. glass plummet immersed in the liquid, which was jacketed with water at the desired temperature.

To obtain a more informative comparison of the low- and high-temperature phenols, each series was slowly distilled four times with a Young four-pear head, dividing the distillate into eight fractions. The specific gravity at 25 deg./4 deg. of each was determined, and plotted in Fig. 6 against the average boiling point of that fraction, taken as the mean ordinate of the boiling-point curve of the final fractionation in each case.

The decrease in the specific gravity of the phenols as the boiling point increases indicates the presence of

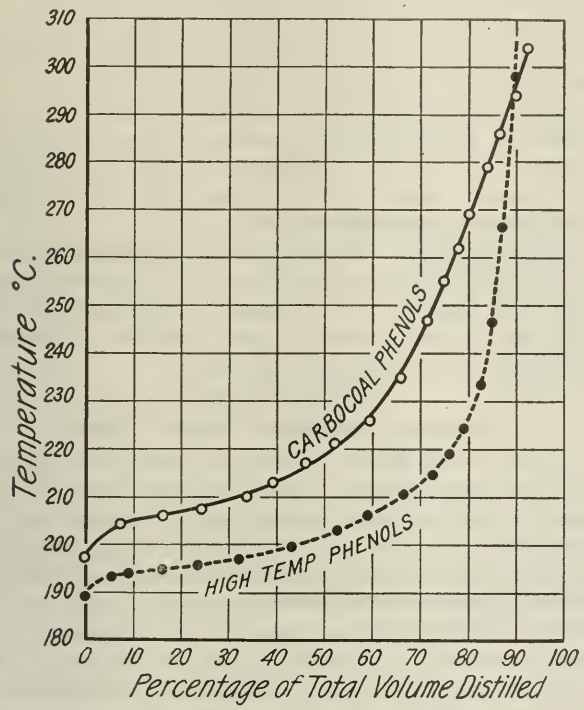

FIG. 5—DISTILLATION OF PHENOLS

aliphatic sidechains of lower density attached to the phenol nucleus—e.g., cresols and xylenols. In the higher homologs a sharp rise in density and a notable increase in the viscosity of the fractions mark the appearance of α- and β-naphthols[18] in the high-temperature phenols, and bicyclic compounds at least in the low-temperature phenols.

These higher homologs have been investigated,[19] and found to contain naphthol derivatives, as the wide divergence of the two curves suggests, but neither α- nor β-naphthol. However, the coincidence of the first section of the curves indicates that the Carbocoal mixture contains the same low-boiling components as the high-temperature phenols, although the proportion is much smaller.

TABLE V—FRACTIONATION OF PHENOLS FROM LOW-TEMPERATURE TAR

No.	Fraction, Deg. C.	Weight in G., Fraction	Per Cent of Total Phenols	No.	Fraction, Deg. C.	Weight in G., Fraction	Per Cent of Total Phenols
1	182–189	41	7.3	6	214–220	44	7.9
2	189–195	38	6.8	7	220–227	14	2.5
3	195–202	60	10.8	8	227–260	102	18.3
4	202–207	71	12.7	9	260–300	92	16.5
5	207–214	48	8.6	10	Pitch	48	8.6
					Total	558	100.0

Another sample of the mixed phenols was fractionated once each with a Young four-pear and a 10-in. Vigreux column, and then five additional times below 230 deg. with the Vigreux head. The average rate of distillation was 1 c.c. per minute, or 0.2 per cent by volume per minute. The results, corrected for the slight distillation losses, are recorded in Table V.

The specific gravity and bromine tests of Fraction 1 indicated the presence of phenol. Fraction 2 showed with ferric chloride the characteristic color reaction of *o*-cresol. In classifying these fractions it is customary to assume that if the cut is made midway between the boiling points of two components, the quantity of the higher-boiling compound appearing in the lower fraction will be approximately balanced by an equal amount of the lower-boiling compound in the higher fraction. Subsequent experiments have shown this assumption to be justified. On this basis Fractions 1 through 4 contain phenol and the cresols (210 g.; 37.6 per cent); Fractions 5 through 7 contain the xylenols (106 g.; 19.0 per cent); and Fractions 8 through 10 contain the higher homologs (194 g.; 34.8 per cent).

Estimation of Phenol and the Cresols

The general scheme employed is that indicated in Fig. 1. The phenol and cresols, separated from the higher homologs by 15 fractionations, amounted to 35.0 per cent (uncorrected for distillation losses; *cf.* 37.6 per cent above) of the total phenols. Since *m*- and *p*-cresols preponderated in the mixture thus obtained, pure *o*-cresol was added to accomplish a sharper separation by distillation into two fractions, one comprising essentially phenol and *o*-cresol, and the other a mixture of the three cresols.

These fractions were analyzed separately by methods

TABLE VI—COMPOSITION OF THE LOW-TEMPERATURE PHENOLS

Component	Percentages by Weight, Phenols	Basis of Distillate	Crude Tar
Phenol	4.2	1.9	0.6
Cresols *a*	33.4	15.2	4.9
Xylenol fraction	19.0	8.7	2.8
Higher homologs	34.8	15.9	5.1
Pitch (acid resins)	8.6	3.9	1.3
Totals	100.0	45.6	14.7

a Ratio: 27 per cent ortho-, 19 per cent meta-, and 54 per cent para-cresols.

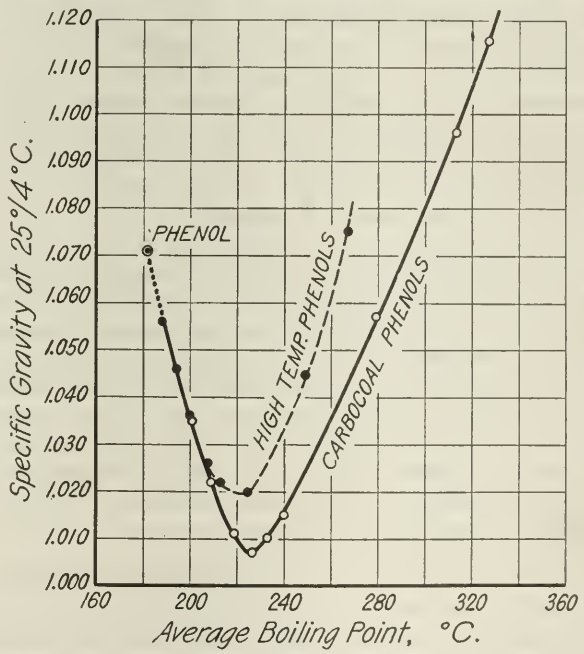

FIG. 6—BOILING POINT VS. SPECIFIC GRAVITY OF PHENOLS

[18] K. E. Schulze, *Lieb. Ann.*, vol. 227, p. 143 (1885).

[19] Unpublished investigation of M. T. Bogert and S. Caplan, to whom are due the data in Fig. 6 on the three highest-boiling fractions.

involving nitration[20] and the determination of density and freezing points.[21] Table VI shows the composition of these phenols.

Comparison With Previous Investigations

The yield of tar in the Carbocoal process from the particular coal in question is 225 lb. per ton, or 11.3 per cent. This is higher than any other yield reported in Table II. The reason for this lies to a large extent in differences in the composition of the coal used by various investigators, as indicated by Table VII.

TABLE VII—COMPARATIVE YIELDS OBTAINED IN VARIOUS INVESTIGATIONS

Investigation	Temp. of Distillation, Deg. C.	Time of Distillation	Tar Yield Per Cent V.C.M. in Coal	Tar Yield Per Cent Wgt., Coal	Per Cent Tar-Acid Dist.	Per Cent Tar-Acid Tar
Pictet	450 max.	5 hr.	15–20	4.0	....	8
Jones & Wheeler	430	5 wks.	26–31	6.5	12–15	6–8
Parr	450–525	6-8 hr.	35	8.7	40	28
Morgan & Soule	500–600	3 hr.	35	11.3	43	13
Fischer	350–500	1-2 hr.	39	10.0	..	50

For the purpose of comparison it may be noted in connection with this table that the distillation of a 30-55 per cent volatile coal in a coke oven at 900-1,000 deg. C. yields from 4 to 6 per cent of tar. The phenols recovered from the coke-oven and gas-works tar mentioned above averaged about 9 per cent by weight of the distillate, or 2.5 per cent of the total tar.

It must be borne in mind in studying these results that Pictet and Fischer alone actually removed the phenols from the entire tar, and that the percentages of tar-acids in the total tars reported by the others are consequently somewhat too low. As an added complication, Parr[3] reports a decrease in the yield of tar-acids with a decrease in the amount of steam used in the distillation of the coal. In general, however, it will be observed that the content of phenols increases with a rise in the volatile content of the coal from which it was distilled, and hence with the actual yield of tar. It seems apparent, therefore, that this increase in bulk of the tar is due largely to phenols.

The comparison of Table VII is superficial, however, and the underlying cause of this relationship is probably not so simple a matter as the mere volatile content. It has been shown[22] that the phenols owe their origin to the fraction of coal insoluble in pyridine and chloroform (the so-called "cellulosic" constituent), which is not a direct function of the volatile content. A low content of phenols in a tar, therefore, cannot be taken as direct evidence of a high temperature of coal carbonization unless the constitution of the coal distilled is also taken into consideration.

Previous Analyses of Low-Temperature Phenols

Jones and Wheeler[2] collected the fraction of phenols distilling between 100 and 145 deg. C. at 30 mm. (d. 1.037 at 15 deg./15 deg.), and from its ultimate analysis concluded it to consist essentially of a mixture of cresols and xylenols. Pictet[1] stated that the phenols obtained in fresh Montrambert "vacuum tar" have a very high boiling point, crystallize easily and contain no phenol, cresols or xylenols. Among the phenols which appeared on standing in a sample of tar prepared 5 years before, he was able to identify phenol itself, the three cresols and 1:2:4 xylenol by qualitative tests.

Fischer[23] reported the 45 per cent of phenols from Lohberg gas coal to contain 0.25 per cent catechol, 0.06 per cent phenol, 1 to 2 per cent cresols, 1 to 2 per cent xylenols, 30 to 32 per cent higher-boiling than xylenols, and 10 per cent acid resins. Phenol was determined by a freezing-point method[24] in a mixture obtained by fractional neutralization of the tar-acids. The cresols were studied by a development of Lederer's chloracetic-acid method[25] using Raschig's nitration method[20] as an alternative procedure for *m*-cresol. The amount of *m*-cresol was about one-quarter of the total cresols, which checks roughly the 19 per cent found in the cresols from low-temperature tar.

EDITOR'S NOTE: This study of the characteristics of low-temperature tar is to be concluded in a second paper which will appear in a subsequent issue and will describe the nitrogen bases, alcohols, sulphur compounds and hydrocarbons present in the tar.

Census of Industrial Power Plants

When the 1919 census was taken, there were 290,105 industrial establishments being operated in the United States. They employed $44,688,093,771 capital and an aggregate horsepower of 29,575,242. These establishments employed 10,160,107 wage earners in addition to 1,447,227 officers, superintendents and other salaried employees. The figures are those of the Bureau of the Census, grouped in a special form for the use of the Senate, in connection with its study of the tariff.

The amount of fuel used by these industrial plants is as follows: Bituminous coal, 203,452,724 short tons; anthracite coal, 14,545,300 long tons; coke, 42,764,287 short tons; oil, 92,608,186 bbl.; gasoline, 2,344,469 bbl.; natural gas, 305,768,321,000 cu.ft.; manufactured gas, 38,522,330,000 cu.ft.

At 237,855 of these plants 116,158 steam engines furnished 13,839,744 hp.; 6,472 steam turbines furnished 3,258,235 hp.; 33,407 internal combustion engines furnished 1,259,394 hp.; 13,244 waterwheels furnished 1,753,548 hp.; 817 water motors furnished 22,165 hp. In addition to the foregoing equipment which is owned by the establisment, 9,442,156 hp. is furnished by rented equipment. Of that amount 9,347,556 hp. is furnished by 996,000 electric motors. The remaining horsepower generated with rented equipment amounts to 94,600.

Explosives Production in 1921

A decrease in the quantity of explosives used in the United States in 1921 as compared with 1920 is shown by a falling off of 37.2 per cent in sales of black powder, 25.4 per cent in high explosives, and 23.8 per cent in permissibles. The total sales amounted to 372,107,503 lb., as compared with 537,954,750 lb. the year before. Of this total, 160,021,250 lb. was black blasting powder, 170,952,402 lb. high explosives other than permissible explosives, and 41,133,851 lb. permissible explosives.

[20]F. Raschig, *Z. angew. Chem.*, vol. 14, p. 759 (1900).
[21]J. J. Fox and M. F. Barker, *J. Soc. Chem. Ind.*, vol. 36, p. 842 (1917); vol. 37, 265T, 268T (1918); vol. 39, p. 169T (1920); H. M. Dawson and C. A. Mountford, *J. Chem. Soc.*, vol. 113, pp. 923, 935 (1918). J. M. Weiss and C. R. Downs, *J. Ind. Eng. Chem.*, vol. 9, p. 569 (1917); G. W. Knight, C. T. Lincoln, G. Formanek and H. L. Follett, *ibid.*, vol. 10, p. 9 (1918).
[22]D. T. Jones and R. V. Wheeler, *J. Chem. Soc.*, vol. 107, p. 1318 (1915); vol. 109, p. 707 (1916); *cf.* S. R. Illingworth, *J. Soc. Chem. Ind.*, vol. 39, p. 111T (1920).
[23]F. Fischer, *Brennstoff Chem.*, vol. 1, pp. 31, 47 (1920).
[24]Franz Fischer and P. K. Breuer, *Ges. Abhandl.*, vol. 3, p. 82 (1916); *cf. ibid.*, vol. 2, p. 236 (1917); F. Fischer and H. Gröppel, *Z. angew. Chem.*, vol. 301, p. 76 (1917); *Ges. Abhandl.*, vol. 2, p. 178 (1917).
[25]L. Lederer, *Frdl.*, vol. 4, p. 91 (1894/1897); D.R.P. 79,514.

Fine Steels From the Acid Open Hearth*

Discussion of the Underlying Principles and Necessary Furnace Practice for the Production of High-Grade Nickel Steel for Gun Tubes and Shafting—Comparison of the Pig, Scrap and Ore Process Used in America With the All-Scrap Practice Used in Europe

STEEL for gun tubes and heavy shafting is usually tested tangentially, and should develop the following physical properties, depending upon its use:

Ultimate tensile strength..86,000 to 95,000 lb. per sq.in.
Elastic limit .....46,000 to 65,000 lb. per sq.in.
Elongation in 2 in. .....18 per cent
Contraction of area .....30 per cent

To comply with these specifications, especially the maximum, acid open-hearth nickel steels within the following limits of composition are usually supplied by American makers:

	Per Cent		Per Cent
Carbon	0.35 to 0.50	Manganese	0.50 to 0.75
Phosphorus	below 0.05	Silicon	0.15 to 0.30
Sulphur	below 0.05	Nickel	2.50 to 3.75

Charging and Melting

Forty parts of pig iron are usually charged to 60 parts of scrap, not more than 20 per cent of which may be turnings (which oxidize badly in melting). Half the pig iron is put into the furnace, then the scrap, and finally the remainder of the pig. Thus the top layer protects the scrap from undue burning caused by direct impact of the flame, and the lower layer reduces the oxidized drops of molten metal before they reach and corrode the hearth beneath. Composition of the mixture is as follows:

	Per Cent		Per Cent
C	2.0	Mn	1.0 to 1.25
P	less than 0.05	Ni	less than specification
S	less than 0.05	Cr	less than 0.05

Melting should be done with expedition, since the hearth is attacked more or less severely during the early hours.

Sulphur and phosphorus, being substantially unchanged during the heat, should be low. Both of these elements segregate toward the axis of the ingot, and also at the surface of primary austenite crystals, and on forging result in black ghost lines. A surprising amount of manganese remains in the metal, and is throughout a very powerful deoxidizer and desulphurizer. Chromium intensifies the tendency toward laminated fractures in the finished forging, and should be kept to the extreme minimum.

Oring

When the charge is well melted it contains 0.90 to 1.20 per cent C, which must now be removed. A preliminary step is to add 10 lb. $CaCO_3$ per ton of charge and stir it in. It gives off CO_2 gas, which bubbles up through the metal. Boiling or chemical stirring aids the mechanical stirring in heating the cold metal at the bottom of the bath. Cold metal mixes with the hotter upper layers, which in turn have received radiation from flame and roof. The CaO remaining also forms a fusible slag with the oxides formed during melting.

As shown in Fig. 1, in about 45 minutes the temperature of the bath is hot enough so that small amounts of cold ore thrown in from time to time will not chill the adjacent metal and slow down the reactions. For each ton of metal is added 28 to 33 lb. of rich, pure low-phosphorus hematite. Reactions of the type

$$Fe_2O_3 + 3C = 2Fe + 3CO$$

take place; the liquid boils violently. In about 2 hours oring should be complete, the carbon then being some 0.30 per cent above the desired figure, a margin which is needed in the subsequent operations.

Deoxidizing

A rather thin line exists between the oring and the deoxidizing period. In the former, iron oxide was added to rid the bath of excess carbon. Now comes a time when the object is reversed; the reaction is the same, but the residual carbon is used to rid the bath of excess oxide.

Carbon is a good deoxidizer to use, since the product is a gas which easily escapes. In order to proceed with reasonable speed the reaction requires a very high temperature, as high as the roof can stand. Progress is judged by the appearance of the slag crust adhering to furnace tools—as the slag contains less and less FeO, the freshly broken sample becomes more vitreous or waxy, and the color changes from dark brown or black to pale lemon and then to light gray.[1] Toward the end of the carbon reaction, decreasing oxide in the metal may also be recognized by a decreasing number of gas cavities in test ingots, taken periodically.

The principles of physical chemistry indicate that a soluble oxide will distribute itself between two liquids in contact in a definite ratio (which is constant as long as such conditions as temperature and nature of slag remain fixed). Therefore, as the slag loses FeO, it is a sign the metal is also losing oxygen. A light gray slag contains about 15 per cent FeO, and when the heat has progressed this far, the reaction between carbon and FeO has been nearly halted. In fact during the later portion of this stage carbon has been attacking the slag and hearth, reducing SiO_2 and adding up to 0.12 per cent silicon to the metal.

It is of utmost importance, in the manufacture of fine steel, that this high-temperature refining of the metal by carbon be carefully attended and pushed to completion.

When the carbon has fallen to approximately that percentage required for the finished product, as judged by the fracture of a test ingot, a rapid carbon analysis is made, and the word passed to "go ahead" with prepa-

*A digest of a paper entitled "Acid Open-Hearth Process for Manufacture of Gun Steels and Fine Steels," presented by W. P. Barba and Henry M. Howe before the February meeting of the American Institute of Mining and Metallurgical Engineers.

[1]The outer surface of slag samples is always brown, like glazed tile, doubtless on account of oxidation of the cooling ferrous oxide. Use of high-manganese pig has a considerable influence on these slag samples, giving them a strong greenish cast and at times a dark green core. Appearance is also affected by the rapidity of melting, and the kind of hearth, and excessive drippings from the roof.

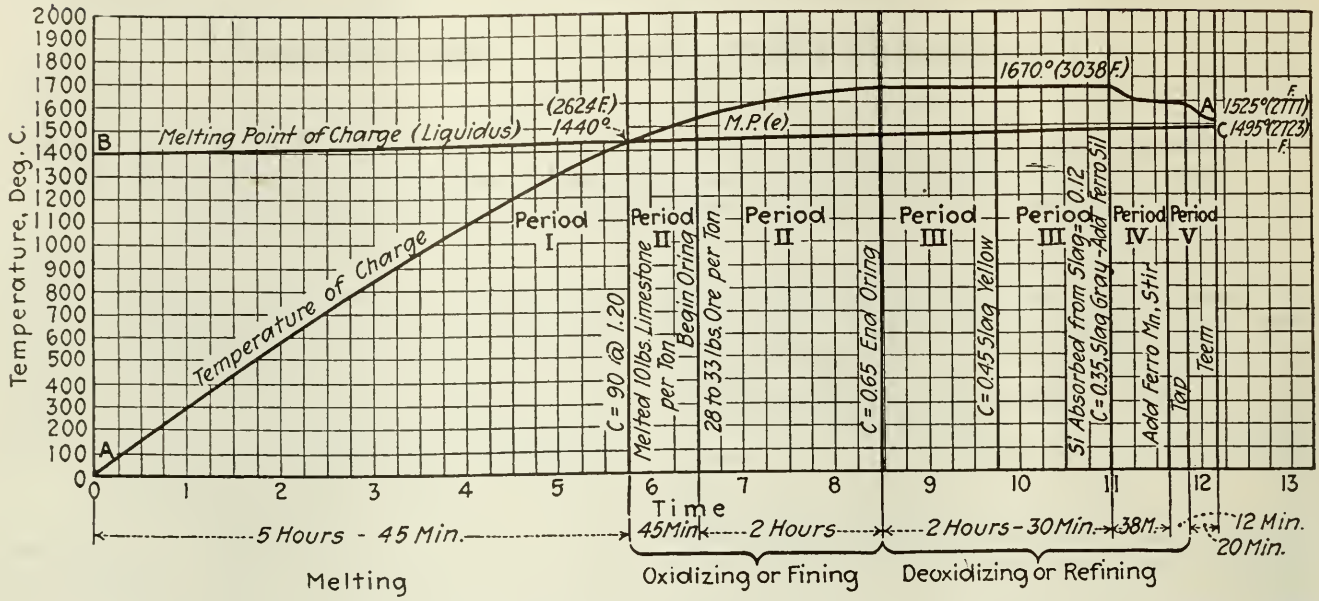

FIG. 1—APPROXIMATION TO A TIME-TEMPERATURE DIAGRAM OF THE ACID OPEN-HEARTH PROCESS ON GUN STEEL

rations for tapping. Further decarburization is halted and deoxidation continued by adding ferrosilicon to the intensely hot bath. This melts quickly, alloys with the metal, and the silicon is rapidly oxidized to silica, which in turn joins with additional basic oxides to form fusible silicates. In a hot bath the resulting silicate particles coalesce, rapidly rise and enter the slag. (It is evident that nearly but not quite enough ferrosilicon should be added to complete the oxidation. If an excess were used, infusible silica inclusions would remain in the finished steel.) Activity of the carbon is further reduced by lowering the temperature by shutting off gas and air and closing the stack damper. Cool areas will quickly show darkly on the quiet slag surface. At this time—the close of period IV of Fig. 1—equilibrium has apparently been reached, and very little change will be noted in the chemical composition of the metal if held in the furnace for many minutes.

Within 40 minutes after the silicon is added ferromanganese is added and stirred in. The bath may possibly contain 0.10 per cent manganese; if 0.73 per cent is added, the resulting ingot will contain about 0.65 per cent Mn, conforming to specification. An apparent loss of not more than one-tenth the addition is an excellent indication that deoxidation has previously been well done. Larger losses in heats which are apparently normal are associated with uncertain metal which should be watched with great care. (Segregates of manganese silicate would doubtless be found in the axial region of the ingot; owing to its fusibility it would remain liquid to the last, and would have a correspondingly enhanced opportunity to coalesce into sizable particles.)

After 12 minutes the diffusion of manganese should be complete. Slag is gray or greenish gray, and the metal is tapped from the furnace to the ladle, held about 20 minutes, when the temperature will be close to the liquidus and proper to pour into very large ingots. Use of aluminum, titanium or vanadium, not as alloying elements but as final deoxidizers or scavengers, should be avoided, since their efficacy will be a direct measure of the temptation to use them to cover up careless furnace practice. They form infusible oxides which remain included in the steel.

It should be apparent that in acid bottoms silicon should be used before manganese. If the latter were added first, it would form basic oxides with the oxygen in the metal, and these would take silica from the hearth to form a fusible slag. Much more alloy would be used, much more damage done to the furnace and much more slag would have to be eliminated from the metal. The arguments and procedure are evidently reversed for basic practice.

Summary[2]

(1) "The steel should be brought at the moment of teeming to the desired composition in every respect.

"The manganese and silicon must be brought to the desired proportion. In order to do this, the bath should be freed from oxygen as nearly as possible and certainly to a constant degree. This freedom from oxygen is important also for lessening or preventing segregation, blow-holes and structural metallurgical weakness.

"Phosphorus and sulphur must be below the prescribed limit, and to this end the stock must be sufficiently free from them.

"The chromium and nickel must be within the prescribed limits.

(2) "The temperature must be accurately regulated.

(3) "Retention of inclusions must be restrained by deoxidizing the molten steel as fully as possible by means of the carbon of the pig iron, because the product of its oxidation is gaseous and escapes, whereas those of all other deoxidizing agents are solid or molten and tend to remain as inclusions. In order that as much as possible of the deoxidation should be done by carbon, the working temperature during refining must be held as high as the safety of the roof will permit.

(4) "The nearly complete deoxidation by carbon should be followed by further deoxidation by silicon. The manganese should not be added till after this silicon has done its work of deoxidation, in order that as little as possible of it may oxidize. This is both so that the manganese content of the product may be as nearly constant as possible, and that as little manganese oxide as possible may form to corrode the siliceous hearth of the furnace and form inclusions of manganese silicate with the silica so eaten away. This postponement clearly tends to lessen the oxidation of manganese;

[2] In the words of the authors.

first, by shortening its stay in the furnace and, second, by pre-deoxidizing the bath with the silicon.

(5) "The steel should be held in the ladle a moderate length of time to allow the inclusions to rise to the surface, and also for the much more important purpose of permitting the finished steel to fall to the proper temperature for casting into a successful ingot.

(6) "The furnace itself must be protected. To that end its hearth should be protected from iron oxide by covering it, before charging the scrap, with about half of the pig iron used.

"The working temperature of the furnace must be maintained during the melting and refining periods at the highest point consistent with safety to the furnace: First, so as to shorten the melting period, during which the hearth is exposed to the attack of the iron oxide, because it is not fully covered by the molten charge; second, so as to stimulate the deoxidizing action of the carbon of the bath during the refining period.

(7) "In all respects the working conditions should be brought as nearly as possible to a fixed standard, because it is difficult to compensate for the results of even minor variations in procedure."

Comparison With European Practice

Typical French and Italian practice uses much less pig iron in the original charge, so that when melted the metal has but 0.10 to 0.20 more carbon than desired in the finished steel. Oring is therefore unnecessary, and period II of Fig. 1 is omitted; refining the bath of oxygen acquired during melting proceeds immediately by reaction with the surplus carbon. If carbon reaches specification before the bath is deoxidized, more carbon is added by periodically adding pig iron, coke or both until the desired condition is arrived at. In some works coke is made to float on a deoxidizing slag, specially made up by additions of lime, clay, sand and fluorspar, until the slag test is green and reactions in the bath cease. Even after this the charge is held for 1 hour at a very high temperature to permit the inclusions to rise and deoxidation to be completed.

Oring allows the use of a larger amount of pig iron, which may be not only more readily accessible than high-quality scrap, but also cheaper. However, it increases the time and correspondingly the fuel bill per ton of product.

Boiling or chemical stirring is a valuable aid in keeping the metal hot enough without destroying the furnace. It is fortunate that the boil is present in a metallurgical practice which produces a heavy blanket or slag, when a maximum of stirring is necessary.

Oring also furnishes some iron and thus increases the yield, but this is not a valid consideration in the manufacture of fine steel.

On the other hand, high pig charges cause thick slag blankets and a correspondingly large amount of material to deoxidize before the metal is quiet. Furthermore pig iron can be refined only by oring, which introduces oxide into the metal, the very thing we are later at such pains to eliminate completely.

It should be remembered, however, that even the act of melting heavy scrap in an open-hearth furnace will oxidize the metal so that refining is necessary; furthermore, that it is the last stage of purification which requires the highest skill—a stage which cannot be avoided in either practice. Even though Americans judge the progress of deoxidation in the metal by the slag appearance, deoxidation is actually done by reaction of carbon and iron oxide *in the metal*, and this is later reflected by a diminished content of iron oxide in the slag. Slag, therefore, is always a step behind the metal, and a satisfactory slag test is proof that the metal has been in good shape for some time. This is an advantage much stressed by American metallurgists. They point out that when the slag is also being deoxidized by coke, its condition is not indicative of the reactions which are going on underneath, even though these reactions may proceed to completion more rapidly.

Physical properties of steels from comparative heats, where the only variable was the presence or absence of the oring stage, are not available for use as an indication of the relative weight which should be given the above considerations.

U. S. Production of Refined Primary Lead in 1921 Compared With Preceding Years

An estimate of the production of lead in the United States during 1921 made by the U. S. Geological Survey is given below, in comparison with figures for preceding years:

	1919 (Short Tons)	1920 (Short Tons)	1921 (Short Tons)
Domestic desilverized lead	208,751	220,327	187,962
Domestic soft lead	147,744	189,854	157,513
Domestic desilverized soft lead	67,938	66,668	52,747
	424,433	476,849	398,222
Foreign desilverized lead	57,787	52,808	50,367
Total refined primary lead	482,220	529,657	448,589
Antimonial lead	13,874	12,535	10,064
APPARENT CONSUMPTION OF REFINED PRIMARY LEAD IN THE UNITED STATES — (REFINERY STOCKS DISREGARDED)			
Supply:			
Stock in bonded warehouse Jan 1	472	234	1,322
Imports of pigs, bars, and old	5,107	35,719	31,301
Production	482,220	529,657	448,589
	487,799	565,610	481,212
Withdrawals:			
Exports of foreign lead—			
From warehouse	40,976	17,363	25,000
In manufactures, with benefit of drawback	1,936	6,175	9,369
Exports of domestic lead	10,510	2,730	1,624
Stock in bonded warehouse Dec. 31	234	1,322	347
	53,656	27,590	36,340
Apparent consumption	434,143	538,020	444,872
Lead content of ore and bullion in bonded warehouse Dec. 31*	45,476	51,220	19,186
Average selling price in cents per pound	5.3	8.0	4.5

*Some part of this may have been smelted and refined and thus be included in the quantities given above as "Foreign desilverized lead."

Tanning Sole Leather With Sulphite Liquor Investigated by Bureau of Standards

The investigation of the durability of sole leather filled with sulphite cellulose extract as compared with sole leather filled with ordinary vegetable tanning materials has been completed and will appear shortly as a technologic paper of the Bureau of Standards.

The results show that sulphite cellulose extract is as firmly fixed in the leather as the ordinary vegetable tanning material and that leather filled with it is as durable as leather filled with such materials as chestnut and quebracho.

Occupational Figures for Chemical Industries

Chemical industries employed 74,289 persons as laborers when the 1920 census was taken. This compares with 41,741, the figure shown in the 1910 census. Semi-skilled operatives totaled 50,341 in 1920 and 30,705 in 1910.

Chemists, assayers and metallurgists, engaged in the practice of their profession, in 1920 numbered 32,941. This compares with 16,273 in 1910.

Metallic Sodium—II

A Critical Review of the Processes Which Have Been Developed for the Preparation of Metallic Sodium by Chemical Reduction—Difficulties Encountered — Chronologically Arranged Bibliography Covering the Metallic Sodium Industry*

By HOWARD E. BATSFORD

FROM the earliest times there have been attempts made to get metallic sodium from its salts by chemical reduction. The basic principle in all these experiments was that of reduction by some form of carbon at a temperature high enough for fusion of the salt and volatilization of the metallic sodium. The sodium was then condensed in a suitable manner.

In 1879 W. P. Thompson mentioned a process in which molten iron alone or in combination with hydrogen or coke was the reducing agent. Iron, mixed with a great deal of coke, was heated in a sort of bessemer converter with caustic soda; and the sodium formed was distilled off.

In 1883 C. A. Faure patented a process for making sodium by reduction of Na_2CO_3. He used a furnace composed of a refractory material, such as compressed magnesia. Electrical conductors were imbedded in the bottom for heating the contents, and holes were left in the top for supply of material and escape of gas and the vapor of sodium.

In 1884 S. G. Thomas used wrought- or cast-iron retorts or tubes with thick lining of refractory material unacted on by sodium. The mixture of Na_2CO_3 and carbon was fed continuously in the current of hot reducing gas. The sodium vapor was condensed from the gases.

In 1886 Dr. E. C. Kleiner-Fiertz reduced the sodium salts by fusing in an arc between two electrodes in a carbon-lined retort.

C. S. Bradley and F. B. Crocker reduced sodium by heating a charge of Na_2CO_3, charcoal and chalk in a hollow cylinder of wrought iron heated by passing a current through it.

St. Clair Deville made a mixture of the following proportions for the reduction: Na_2CO_3, 30 kg.; coal, 13 kg.; chalk, 5 kg.

The chalk has no chemical effect on the reaction, but it is added only to make the mass tacky and not fluid.

All materials were pulverized and screened, then mixed and again passed through a screen, after which they were heated to a red heat in an iron crucible, sintered strongly together and finally converted to a pasty consistency. They were removed from the crucible and transformed into a coarse powder on cooling, the last-named being put into the reduction vessel.

He used as pure soda ash as possible, since the ordinary calcined soda of commerce always gave poor results, containing foreign salts which raised the melting point.

In 1887 J. B. Thompson and W. White invented a process for intimately mixing dry Na_2CO_3 with a liquid carbonaceous material, preferably tar; it was then heated to a dull red heat in iron pots by the waste heat of flue gases. When all volatile matter was consumed, the charge was distilled in a fireclay tubular retort, connected with a tightly closed receiver, containing paraffine oil to insure a non-oxidizing atmosphere and also provided with an escape pipe for CO_2.

O. M. Thowless improved previous methods of sodium production by introducing the NaOH or other compound preheated into the previously heated carbonaceous matter.

In 1888 several patents were issued, as the metal sodium was beginning to be studied very seriously.

H. S. Blackmore heated the following mixture to dull redness for 20 minutes and then to a white heat:

27.5 parts of $Ca(OH)_2$	30.9 parts of dry Na_2CO_3
31.1 parts of Fe_2O_3	10.5 parts of charcoal

Caustic soda was first produced, and the organic matter reduced the ferric oxide to metallic iron, which in turn reduced the soda; the metallic sodium distilled off and was suitably condensed. After slaking, the residue of ferric oxide and quicklime was used again.

A. B. Cunningham fused caustic soda in an open vessel and mixed pulverized carbon with it. He introduced the charge while still liquid into a red-hot retort. The fumes of sodium were condensed.

C. A. Jarvis proposed the use of fireclay apparatus in order to prevent the large amount of corrosion which takes place when iron crucibles or tubes are used.

Netto Process

C. Netto heated a column of coke or charcoal in a retort or receiver to a high temperature. The NaOH was fused and run in, falling as a spray on the red-hot charcoal. It was decomposed very rapidly and the vapors of sodium were able to escape freely between the lumps of charcoal into the receiver.

He further improved his process by continuously feeding fused NaOH into the top of a furnace with a condenser at the top and with a hydraulic trap at the base. The retort was filled about one-half with incandescent charcoal. The sodium distilled over and the Na_2CO_3 produced ran down to the bottom of the retort where it could be siphoned off continuously or intermittently, and thus be prevented from interfering with the continuous action of the process. Sodium by this means could be produced at a much lower temperature and more regularly than when the carbonate was not removed.

H. W. Wallis powdered "hydrated alkali" and mixed it with 10 or 15 per cent of carbonaceous material, which was also pulverized. This mixture he fed at intervals into a heated retort.

In 1889 W. G. Forster introduced coal gas or carbonaceous vapor or other reducing gas or vapors

*For Part I see Chem. & Met. Eng., vol. 26, No. 19, p. 888, May 10, 1922.

Note: Complete references to all the work discussed will be found in the chronologically arranged bibliography at the end of the article.

through a perforated pipe immersed in the fused alkali, distilled the sodium over and condensed it.

T. Parker and A. E. Robinson mixed carbonates, hydrates or oxides of sodium with a quantity of finely divided carbon sufficient to reduce them to the metallic state and heated them by means of "an electric arc or electrical resistance," the metal volatilizing and being condensed. The electrodes used could be of iron, and a liquid bath of iron or other metal might be maintained at the base of the furnace for heat diffusion. The charge was heated before entrance to economize current.

In 1890 the work on the electrolytic production of sodium was given an impetus by Grabau, and during the next ten years little was apparently done on chemical reduction.

In 1899 C. Wolfram introduced a process for reacting calcium carbide with molten caustic soda. He obtained Na_2CO_3 and sodium. By melting salt and introducing carbide he was able to get particles of sodium to come up and float on the bath.

In 1903 T. Parker mixed aluminate of soda with carbon in suitable proportions and calcined them in an electric furnace. Sodium distilled off and alumina was left. In his proposals he also mentioned the use of silicates, from which carborundum was recovered as a secondary product.

During the same year H. Specketer and C. H. Weber invented a process for making sodium by subjecting sodium fluoride to the action of metallic aluminum, having the salt just above the melting point.

Mehner Process

The electrolytic processes of Castner, Darling, Ashcroft, Carrier and others dominated the field and there was little mentioned in literature about chemical reduction till 1912, when H. Mehner proposed to react soda with molten cast iron in such a manner that the sodium metal was set free in vapor form and carbon monoxide was formed. The carbon was returned to the iron by known methods, or the old iron was removed and replaced by new. The reaction was highly endothermic, and the highly heated mass of cast iron was efficacious in furnishing both carbon and extra heat.

In 1913 Swann and Kendall distilled Na_2CO_3 and carbon and conducted the sodium vapor through fused NaOH to condense it from its admixture with CO.

In 1919 H. Freeman proposed to make sodium by treating salt with calcium carbide in a manner slightly different than Wolfram. The present process consisted in mixing the finely powdered substances and heating them to a bright red temperature, not higher than 1,400 deg. C.

The great troubles with the early processes seemed to lie in the difficulty of getting apparatus which would stand the action of the sodium at the high operating temperatures, and also the difficulty in getting the sodium vapor removed from the reduction vessel and condensed. From the author's experience with sodium distillation it seems highly probable that quantities of salt and other impurities were entrained with the sodium vapor and remained to contaminate the finished product.

With the gradually increasing cost of electrical power and labor it seems possible that some chemical reduction method may be able to compete successfully with the electrolytic ones. Men are now working on this problem, as is evidenced by the patents coming out from time to time, and also by the fact that sodium may be used for several of the intermediate manufacturing processes, as well as for making peroxide bleach and sodium cyanide.

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The Technical Man as a Citizen*

By Acheson Smith

NEVER in the history of our country has there been such a pressing need for an intelligent citizenry. The post-war problems are of such a nature that it is difficult to understand them and consequently almost impossible correctly to solve them. Various solutions are offered for the same problem, and to the great mass of people, unfamiliar with the technical side of a question, a man with an unsound penacea will appear to be just as safe to follow as the man who is a real authority on the subject.

The tendency is to look to our government for aid, and as governmental aid is usually legislative, all kinds of legislation are proposed or enacted. In the opinion of many our revenue laws can be made to contribute to the prosperity of the country, but their provisions always provoke controversy and the final enactment is usually a geographical and personal compromise. Our financial system is constantly subject to attack and there is an effort being made at present to alter it so as to make money more plentiful. Laws relating to our agricultural, mineral, water-power and other natural resources should be drawn with the greatest care, for upon their wise development will depend much of the future wealth of the nation. Regulatory legislation is being urged more and more, and while its purpose may be very laudable, the carrying out of such laws requires so many enforcement officers that we are adding a burden to ourselves which has a doubly bad effect. First, it requires the expenditure of a great deal of money to enforce such regulation, and secondly, it takes a large number of people who might be producers and places them squarely in the unproductive, official class.

Country Confronted by Serious Problems

Many other serious problems are before the country and the world today. For instance, the supremacy of the white race is being challenged by those whose color is black or yellow, and the white race can maintain its position only by raising the intelligence of its leadership.

It is perhaps natural, under our form of government, for the proletariat to put great faith in political laws and to be blissfully ignorant of the fact that where such laws are not based upon sound economic principles they will sooner or later prove futile. The futility of political laws when they are contrary to the economic needs is well illustrated by the conditions now prevalent throughout eastern Europe. Much more could be said on this subject, but it will probably suffice to add that the future success and safety of our country will depend upon the intelligence of its leaders.

When Lord Macaulay wrote his famous letter in which he expressed doubt about the ultimate success of Jeffersonian democracy, he said that "such democracy would sooner or later destroy liberty." We are now evidently in the process of being tried to see if this republic can endure. It is comparatively safe from external enemies, but if we do not act wisely and in conformity to sound economic law we may be destroyed by our own acts, in spite of our good intentions. The times, therefore, call for strong men; men who have knowledge, men who have been taught to reason and to be guided by fact. This type of man being demanded, none are better able to qualify than chemists, engineers and other technical men.

"The Age of the Engineer"

We often hear the statement that this is the age of the engineer, but it is possible that we do not understand the full significance of that phrase. The present advanced state of civilization is mainly due to the technical men. That we have more comforts and luxuries today than we could have had a hundred years ago, and at the same time have more leisure for study and recreation, is due to the greater productivity per man, due to labor-saving devices, improved processes and administrative methods. If production per capita had not increased, we would have little time for the fine arts, and no means with which to sustain those who would devote their lives to such pursuits. If we desire to visualize what the world owes to the technical man, all we have to do is to consider what would happen if our steam and electric power and all machinery and modern chemistry were taken away from us. We would have to reorganize society, and each one would be so occupied in producing the necessities of life he would have no time to produce non-essentials, and very little if any time to enjoy them.

The present standard of living among our laboring people is solely due to the engineer. For example: If a farmer is able to produce only enough to feed and clothe his family, he has no time for the finer things of life and cannot afford any luxuries. If, however, he can produce twice as much as is necessary to feed and clothe his family, he will have a surplus with which he can purchase luxuries. The number of luxuries he can buy will depend upon their cost, and therefore the cheaper they can be produced the more he can purchase. We thus see that the greater productiveness of the farmer enables him to acquire luxuries, and the greater the productiveness of those who manufacture them the cheaper these will be, and therefore the more the farmer can purchase. As the ability of the farmer and manufacturer to produce is largely dependent upon the implements and methods supplied by the engineer, we can see that upon him rests the responsibility for future progress and the credit for what has already been accomplished.

Increased Production Raises Living Standard

Putting it another way: The greater our productiveness the fewer people it will require to produce the necessities of life, and therefore the greater number that can be spared to work in art, medicine and other pursuits that contribute so definitely to our pleasures and comforts. In fact, our present standard of living can be maintained only if we keep up our production, and it is certain that the standard of living cannot be raised unless we increase our production per capita. As our increased production is due to the technical men, we see that the whole material progress of the country depends upon progress in pure and applied science.

If the things that make life worth while are ours because of greater productivity, it follows that we should honor the producers and do everything we can to educate all to the necessity for producing beyond their needs. The greatest incentive so far discovered to induce people to produce beyond their immediate

*Presidential address delivered before the American Electrochemical Society, at the forty-first general meeting, Baltimore, April 27-29, 1922.

Note: The terms engineer, chemist, technical men, etc., are used synonymously, and are meant to include all men working in pure and applied science.

requirements is the principle of property rights. When a man knows he can enjoy the products of his labor he will produce beyond the needs of the day, but if he is in doubt about being protected in such a right he will be without the incentive to produce a surplus. Therefore, we, as men who understand the tremendously serious effect of withdrawing or endangering such right to the enjoyment of property, should guard it zealously as the bedrock of civilization. While it sounds rather utilitarian to preach the gospel of production and property rights, it should be remembered that culture and the finer things of life presuppose leisure, and the amount of leisure we possess is in direct relation to the surplus of life's necessities which are produced per man.

The Engineer Seeking Recognition

In view of what has been accomplished by the engineer it may sound strange to say that he is seeking recognition, but such is the case. Nearly every technical society has had meetings and papers on such subjects as the status of the engineer. Practically all of the technical publications have had articles lamenting that the technical man does not take his proper place as a citizen and is not found in our legislative bodies. Comparatively recently a Federation of Engineering Societies was formed for the purpose of increasing their influence at Washington. Many articles could be cited wherein it is pointed out that the engineer should have greater recognition, and suggesting ways by which that very desirable end could be attained. It is evident that among the technical men of the country there is a feeling that they do not occupy as influential a position as they should.

If technical men are the leaders in science and industry, and no one will dispute that they are, and if they seek recognition, it must be in civic and political fields. The question, therefore, arises, What can the engineer do to procure such recognition? The matter has been discussed at considerable length, and the engineer should now take definite action toward attaining the position he seeks.

If we distinguish between the effort to force recognition through strength of numbers and the recognition gained by the profession through its individual members becoming influential, we shall see that recognition of a group or class is difficult to procure and more difficult to maintain, while recognition of individuals is a natural force which extends throughout our whole political system. It is not desirable that engineers exercise influence as a class, but that they as individuals gain a position of influence. The first would be artificial and uneconomic, while the latter would be very desirable and perfectly sound, because the struggle for success as individuals builds character, while the success of a class does not.

If we examine the political organization of our country, we shall find that overlapping spheres of influence exist, reaching from the humblest community to the highest official circles in Washington. An individual becomes active in the political and civic affairs of his own locality and is brought into contact with other similar individuals, who together form the dominating group in the city. A few from each city make the controlling group throughout the state, and a group from the various states are the influential men in the nation. These men are the real leaders and those who would take an active part in our body politic must be willing to work as these men are working. We must realize that the political machinery which controls our government is an actual fact, and if we are to become influential in the nation's affairs we must recognize the rules of the game and play accordingly. We, therefore, see that the leaders in the country are those who do a citizen's duty and a little more, over a term of years, and as a result find themselves the influential men in their community. Here is an opportunity for the engineer to do his locality a substantial service and at the same time put himself in a position of real influence in the state and nation.

Under a system of government where the illiterate and men of low ideals have an equal voice with the educated and men of high ideals, the only thing that can prevent liberty from destroying itself is intelligent leadership. The technical men of the country should, therefore, start to work, each in his own community, and see if we cannot in a generation or two raise the standard of leadership so that sound thinking shall become the dominating influence in our legislative bodies.

The engineer is justified in striving for a high degree of technical attainment, but he should not lose sight of the fact that if he does not have the ability to lead he will probably not get very far in his chosen profession nor in the civic field. The qualities of leadership must be developed, and there is probably no better way to begin than by taking a minor part in political affairs, working in civic bodies and taking an active part in at least one technical society. A man who is not willing to give a portion of his time and talents to his technical society has lost sight of the fact that by doing so he will develop himself as well as advance the interests of the profession. It is not what he takes in but what he gives out that constitutes his contribution to the world's work, and unless a man can become constructive he cannot hope for success. By taking an active part in civic affairs he will benefit his home community and at the same time be training himself to be a leader.

Need for Educated Men in Civic Life

While it is quite necessary that a man make himself proficient in his chosen line of work and avoid such things as would seriously interfere with such development, he should remember that this is a government of and by the people, and if he does not do his share someone is doing it for him and probably doing it less ably than he could do it. He might well heed the words of Herbert Spencer: "The man expending his energy wholly on private affairs, refusing to take part in public affairs, pluming himself on his wisdom in minding his own business, is blind to the fact that his own business is made possible only by the prosperity of all."

There is a great need for educated men in all strata of civic and political endeavor, and the university-trained men can render wonderful service if each one will do his part. If a technical man does not gain the position of influence he seeks he either does not have sufficient ability or he is unwilling to do the necessary work. If, however, the engineer will remember that he is a citizen as well as a technical man and develop himself by serving his own locality, he will some day be surprised and pleased to find that his influence extends beyond his community and is perhaps felt throughout the nation. Thus by his personal attainment he will help in procuring deserved recognition for the technical profession.

Recovery and Utilization of Cyanide From Byproduct Coke Ovens

Cyanogen Compounds Available in American Coke-Oven Gas Are Adequate to Supply Our Entire Demands—Description of a Process for the Direct Recovery of Hydrocyanic Acid and Sodium Cyanide—Possible Replacement of NaCN by HCN

By EDWARD V. ESPENHAHN

THE LARGE coke-oven installations in the United States and Europe present a source of supply of cyanide, which so far has not yet been exploited to any appreciable extent. Although the ferrocyanides are obtained by indirect methods from coal-gas works, the simple cyanide salts of the alkali metals are usually produced synthetically. The desirability of removing the hydrocyanic acid from coal gas at such works is generally recognized, but usually the conditions are not favorable for this recovery primarily because of the relatively high installation and operating costs. These disadvantages, however, do not exist at coke-oven plants, or at least to such an important extent, since much larger quantities of coal are carbonized at these plants and overhead expenses are correspondingly low.

The failure to recover cyanide at coke ovens at the present time may be attributed to the indirect methods hitherto adopted, and it is the opinion of the author that should these sources be exploited economically direct recovery methods must be resorted to. When coal began to be coked on a large scale in byproduct ovens, it was early recognized by coking technologists that the indirect methods of ammonium-sulphate recovery, whereby the ammonia of the gases is first absorbed by scrubbing with water, from which it is distilled by steam before being reabsorbed in sulphuric acid, were no longer suited for large-scale operation. The direct processes were then devised and have been almost universally adopted for the recovery of ammonium sulphate. The gas is passed directly through a bath of a saturated ammonium sulphate solution, which is kept slightly acid, between 50 and 80 deg. C., from which the precipitated salt is removed and washed by mechanical means. About the only instances where indirect processes are still employed is where a good market is obtainable for liquid ammonia, such as in the ammonia-soda process. Should cyanide recovery eventually be adopted at coke-oven plants, it might be expected to follow this history of ammonia recovery, wherein indirect methods hitherto used were discarded and superseded by direct and economical processes.

It is the purpose of the present article to describe such a process for the direct recovery of cyanogen compounds from coke-oven gas, but before such a description is attempted, it is believed that a brief review of the consumption and uses of cyanides will be of interest.

Consumption of Cyanides

The cyanide and ferrocyanide or prussiate salts of the alkali metals are among the most important inorganic chemicals used in the industrial arts. The consumption of the former in this country amounts to tonnages represented by five figures and the consumption of the ferrocyanides is somewhat less than half that of the simple cyanides. Statistics compiled prior to 1914 do not permit a survey of the separate sources of the cyanide salts, but in that year the imports and domestic manufacture amounted to 12,000 tons; in addition 3,250 tons of potassium ferrocyanide was consumed.[1] These tonnages from foreign and domestic sources were about evenly distributed. In 1919 about 11,000 tons NaCN was consumed, 25 per cent of which was imported. The consumption of sodium ferrocyanide was over 4,000 tons, of which 15 per cent was obtained from foreign countries.

Mexico is also one of the largest consumers of cyanide, where it is used mostly in treating silver ores. Practically all of the salt is imported from Europe, and the total Mexican consumption may be estimated to be at least 3,500 tons and perhaps may amount to 5,000 tons. Furthermore, at least 1,200 tons is used in Canada yearly.

Owing to abnormal business conditions, there was a decrease in the consumption of cyanide during 1920 and 1921, so that the year 1919 probably represents the best index of future requirements. It is rather remarkable, however, that the consumption has been maintained to such an extent while gold mining was at such a low ebb, although silver mining remained fairly steady. These indications point to the fact that other important and equally extensive uses have been found for this chemical. With prospects of the price being reduced to the pre-war level, a further impetus will be given for its consumption, especially along new avenues, which will be discussed in the following paragraphs.

Uses of Cyanide

Sodium cyanide and potassium cyanide, or mixtures of the two salts, are used principally for (1) extraction of gold and silver from ores; (2) generation of HCN for fumigation of fruit trees and eradication of rats and other vermin; (3) case-hardening of steel; (4) electroplating; and (5) miscellaneous uses, such as in the synthesis of dyes and other organic chemicals.

Comparing the first two uses, it does not seem improbable but that the importance of the chemical in gold mining has been relegated to an inferior position by the increased demand of cyanide by horticulture. The use of HCN for fumigating citrus trees is now firmly established in California, and although only one-third of the 20,000,000 trees in bearing are treated, it is claimed that from this third the bulk of the crop is obtained. The treatment provides the only effective means of

[1]For detailed information see official publications: U. S. Dept. of Commerce Bulletin 82, "Imports of Chemicals in 1914"; U. S. Tariff Commission, Tariff Information Surveys on "Sodium Compounds"; and U. S. Geological Survey Bulletins "Sodium and Sodium Salts."

overcoming pests harmful to the crop, so that it is to be expected that the benefits arising from fumigation will also become recognized by the citrus-growing areas of the South American states, especially since a moist climate is more conducive to the growth of pests and fungi.

About 500 tons of NaCN is consumed annually by the Department of Agriculture in fumigating freight cars at the Mexican border to keep out the pink boll weevil.

Case-hardening and electroplating annually require considerable quantities of cyanides. In the latter industry it is not unlikely that the electroplating of sheet iron will to a great extent displace galvanizing by hot dipping. The developments of the electrolytic zinc industry permit the use of the commercial article in new ways, and considerable investigation is now being conducted on the electrodeposition of zinc from sodium-zinc cyanide solutions. The coating thus obtained has a greater protective action against rusting than one from sulphate solutions.[2]

Under favorable conditions regarding cost of production, sodium cyanide might be considered as one means for conducting the synthesis of indigo. As it is, however, only relatively small quantities are used in the manufacture of dyes and synthetic organic chemicals.

Replacement of Sodium Cyanide by Hydrocyanic Acid

Hydrocyanic acid gas has already displaced the solid salt used in the old "pot method" of fumigation. This method was both dangerous and inefficient, and recently Harker[3] has shown that only about one-third of the HCN of the salt is liberated when sodium cyanide and sulphuric acid react on each other under ordinary conditions. The other two-thirds is therefore lost for fumigating purposes.

The use of hydrocyanic acid gas is now firmly established in California. The gas is generated in stations close to the fruit-growing areas, so that should the gas from coke ovens be used it would have to be transported over longer distances. Although certain restrictions are placed on the transportation of this gas, they are not sufficient to offset the advantages of having the cyanide in the most concentrated form possible, as 1 lb. of the gas is equal to at least 2 lb. or as much as 4 lb. of the less pure commercial salt. It cannot be denied that in the handling of hydrocyanic acid there is a certain amount of danger, but the few accidents resulting from the handling of such large quantities of the gas in California attest its comparative safety when due precautions are taken. Compressed in cylinders, it is probably as safe as any other toxic gas.

Apparently there is no reason why the use of hydrocyanide acid gas should not be extended, and made to replace sodium cyanide in other uses; provided it is possible to produce the cyanide more economically in the form of the gas. Thus in ore treating, calcium cyanide might be prepared easily and cheaply at the mines by passing a weighed amount of HCN gas from cylinders into a tank of water containing a slight excess of lime in solution. Calcium cyanide is readily formed and is quite stable in the dilutions employed for extracting gold and silver from ores. In some instances it might be necessary to add a corresponding amount of soda ash to form the sodium compound. This then would be produced without first obtaining the solid salt, thus saving the evaporation and other costs in preparing the ordinary commercial product.

In a like manner the preparation and purification of cyanide electrolytic solutions by means of a zinc salt and hydrocyanic acid gas, lime and soda ash instead of sodium cyanide is also suggested. The preparation of zinc cyanide could proceed from calcium cyanide as favorably as from sodium cyanide. When the latter salt only is desired, the double reaction between HCN, lime and soda ash would be resorted to. It could also be applied for rejuvenating cyanide solutions which have become impoverished in cyanide by the absorption of CO_2. In this instance, of course, no soda ash would be required; the calcium cyanide would be added direct, and the purified solution returned to the cells after filtering off the calcium carbonate, which is easily washed.

Description of Espenhahn Process

The process previously referred to for the direct recovery of cyanogen compounds from coke-oven gas has been described in the British patent 109,254 (1916), in U. S. patent 15,090 (1921 reissue) and in a number of foreign patents. It is designed to operate in conjunction with direct and semi-direct methods of ammonia recovery. Briefly, the washing solution consists of a strong solution of an alkali, such as soda ash, in which is suspended an iron compound, such as ferrous sulphide or sodium ferrous-ferrocyanide, which is capable with combining with the HCN of the gas. The iron compound is not withdrawn from the cycle of operations, the only chemicals added being soda ash, sulphuric acid and lime. The solution with the iron precipitate in suspension is circulated from tanks over vertical centrifugal washers, through which the gases pass, preferably after having been previously freed of their ammonia. These washers are very efficient in operation, as they bring the gas into intimate contact with the solution without offering large back pressure, require little power and take up only a small space. The hydrocyanic acid present in the gas is absorbed practically quantitatively as sodium ferrocyanide; and no side reactions occur, such as the formation of sulphocyanides. When the solution in the first washing tank has become charged with sodium ferrocyanide—about 75 per cent conversion—it is filtered through leaf filters suspended in the tank. The solubilities of the two salts in solution, sodium carbonate and ferrocyanide, are such that on being cooled after its withdrawal only the latter salt is precipitated. The crystals of ferrocyanide are then centrifuged before being transferred to a still, in which they are heated with the theoretical amount of sulphuric acid to drive off half the hydrocyanic acid and according to the reaction:

$$2Na_4Fe(CN)_6 + 3H_2SO_4 = Na_2FeFe(CN)_6 + 3Na_2SO_4 + 6HCN$$

The precipitate of sodium ferrous-ferrocyanide is washed free from sodium sulphate and transferred to the last washing tank containing the highest percentage of soda ash, from which it is circulated in countercurrent system, meeting the gas in the vertical washers. Here the precipitate is first converted into soluble ferrocyanide and ferrous sulphide by the hydrogen sulphide of the gas, according to the equation:

$$Na_2FeFe(CN)_6 + Na_2CO_3 + H_2S = Na_4Fe(CN)_6 + FeS + H_2O + CO_2$$

The solution of ferrocyanide with the excess soda ash

[2] C. J. Wernlund, *Trans.*, Am. Electrochem. Soc., 1921, pp. 346-366.

[3] *J. Soc. Chem. Ind.*, 1921, pp. 182-185.

finds its way to the last tank, and by being pumped over the first washer becomes enriched in soluble ferrocyanide until it is withdrawn. The solution containing the most soda ash and FeS absorbs the last of the HCN from the gases in the last washer. This washer is divided into two sections, in the upper one of which the FeS precipitate is prepared by circulating a solution of iron sulphate to which ammonia has been added. The section is used for this purpose only when a fresh supply of FeS is required, as for instance when ferrocyanide is withdrawn from the system. At other times the whole washer is devoted to the extraction of cyanide. The description is made clearer by the accompanying flow sheet shown in Fig. 1.

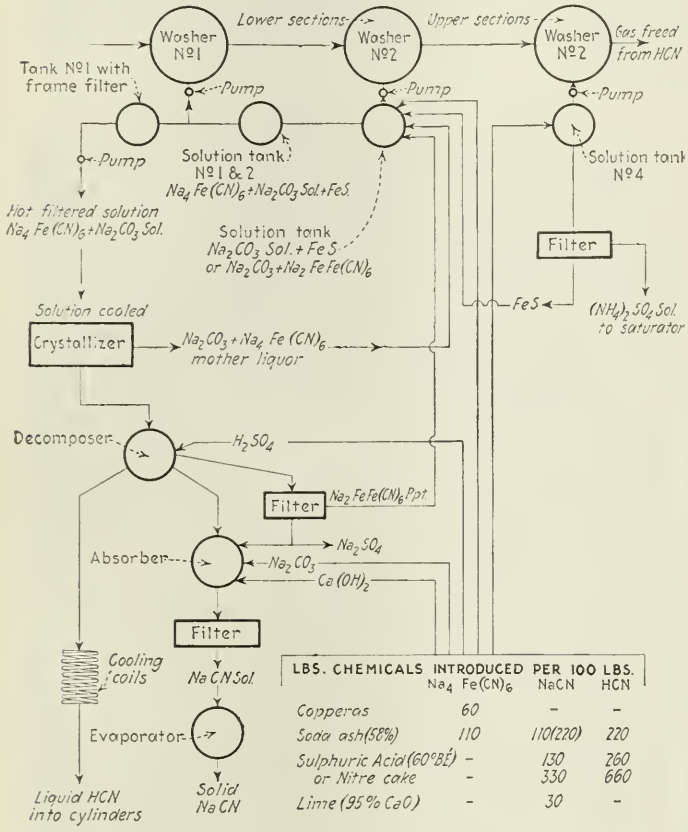


FIG. 1—FLOW SHEET OF PROCESS FOR THE DIRECT RECOVERY OF CYANOGEN PRODUCTS FROM COKE-OVEN GAS

As will be discussed later, the process promises to render the recovery of HCN possible in a very economical manner. If sodium cyanide is desired, it is preferable, owing to the high cost of caustic soda, to proceed with its preparation by absorbing the HCN in a solution of sodium sulphate or carbonate containing an equivalent of slaked lime in suspension. Double decomposition occurs with the formation of sodium cyanide and the precipitation of the lime in the form of the sodium salt employed. If sodium sulphate is used for this purpose, the process is rendered still more cyclic, since less soda ash and sulphuric acid are introduced into the scrubbing process, although in this instance the sodium cyanide recovered will not be as pure as when soda ash is used.

Cyanide Available From Coke Ovens

From several determinations made by the writer at different coke-oven plants in this country, it has been found that the gases contain on an average—the fluctuations are very slight—70 to 75 grains of HCN per 100 cu.ft., so that there is available from a ton of average coking coal at least 1 lb. of hydrocyanic acid or 1.75 lb. of sodium cyanide. Compared with the original quantity of coal charged into the ovens, or even with the yield of tar or ammonium sulphate, this amount at first sight may not appear considerable; but in the aggregate the quantities are more impressive. Thus at a coke-oven installation of moderate capacity carbonizing 2,000 tons of coal a day, there may be recovered 600 tons of sodium cyanide a year. Reviewing the byproducts statistics of this country, it will be seen that the quantity of cyanide now going to waste is considerable, and annually amounts to a tonnage represented by five figures.

Assuming a normal recovery of 1.75 lb. of sodium cyanide per ton of good coking coal, the estimated yield if direct recovery plants were introduced at all works in the near future may be considered to be between 25,000 and 27,000 tons of NaCN. The economical production by a direct process is, however, lower than appears from these figures. It will not be profitable in many instances for units of smaller sizes to install such a process, unless they are favorably situated near points of consumption, such as gold and silver mining centers. Hence the economical capacity of all ovens may be considered to be at most about 20,000 tons per annum,

It might be economical for such plants, however, to introduce recovery of ferrocyanide, as installation and operating costs are considerably lower when producing this compound only. It is also possible to centralize half of the cyclic process, whereby the ferrocyanide from one or more units is converted into hydrocyanic acid or sodium cyanide at a single plant centrally situated. By this means a considerable saving is obtained in operating and installation costs. This method of operation would appear advantageous in Great Britain, where byproduct plants are grouped in different localities, in any one of which the plants are relatively close together. The transportation of ferrocyanide to the central plant would thus not be attended with high freight costs, such as might be the case in the United States.

It is true that some plants have already introduced cyanide recovery, but with these few sodium ferrocyanide is generally the finished product. This is produced in a manner similar to European practice, by first forming a complex ammonium ferrocyanide, which is converted into sodium ferrocyanide at a separate stage after the washing process. The quantity thus produced, however, is very small and in value is negligible compared with any of the other byproducts. At such plants the ammonia of the gas is recovered by indirect methods. Few of the operators using direct recovery, certainly none at the larger units, have attached any importance to the cyanide in their gas, or at least they have not looked upon its recovery as economical.

Cost of Recovery

It is not intended in this paper to present an analysis of the costs of production. With rapid changes in prices of chemicals and materials as well as in labor and construction costs, such a presentation would require too frequent revision to be of much service. It is considered more suitable to make only general comparisons between the pre-war price of sodium cyanide (96 to 98 per cent), which was 15c. a lb., and the estimated cost of production under high post-war conditions, such as existed at

the beginning of 1921. The cost of manufacturing sodium cyanide and hydrocyanic acid from coke-oven gases by the process described in this paper is compared with the cost of producing hydrocyanic acid from synthetic cyanide in the following table:

	Price Per Lb. NaCN	Estimated Cost Per Lb HCN
By synthetic process (in 1913) . .	15c.	30-33c.
By synthetic process (in 1921) . .	20-24c.	37-52c.
By Espenhahn process (in 1921)	4.5-9.0c.	9-13.5c.
HCN as NaCN, per lb. (in 1921)	4.0-5.0c.	. . . . .

From such figures the production of sodium cyanide from coke-oven gases appears decidedly advantageous, but they are still crude estimates, based on a process which has not yet reached a semi-commercial scale.

When coke ovens are considered as a source of HCN instead of NaCN, the comparison is still more favorable to the direct process, especially since, as has already been pointed out, the gas is able to replace the solid salt with advantage in many instances. With synthetic processes it is first necesary to produce sodium salt before being able to proceed with the preparation of the gas; while with a direct recovery process from coke-oven gases the reverse holds true. This means that in the latter process considerably less labor and plant expenditure is required for the recovery of HCN than for NaCN; indeed it is approximately two-thirds. In other words, conditions are more favorable for the production of HCN as a byproduct direct than from an alkali salt, from which it must be liberated, such as is necessary in all synthetic processes now in operation.

Recent Researches on Static Notched Bar Testing

By Herman A. Holz

THE notched bar test is not necessarily an impact test. In fact, the static method of investigating notch brittleness as carried out on the Humfrey machine[1] possesses a number of important advantages:

In the single blow impact test one single figure only is obtained, representing the total energy expended in breaking the specimen plus an unknown and variable amount in friction, vibrations and noise, but no information is available as to the values of the various factors of which this figure is the integral. On the other hand in a static test the forces applied are under perfect control and can be measured with great precision. In breaking a notched specimen in a static testing machine, the angle to which the test piece is bent and the resistance which it offers to the external bending moment are known at each stage of the test. A complete and continuous autographic diagram of the bending-angle bending-moment may be therefore obtained, while the total force expended in fracture may be indicated by an automatic integrator.

Researches on the influence of variations in temperature, depth of notch or radius of notch can be conveniently carried out on the static machine, and a number of check tests can be made on adjoining sections of each specimen.

The curves shown herewith are results of recent experiments undertaken by J. C. W. Humfrey, the British metallurgist who designed the static notched bar testing machine carrying his name.

Fig. 1 shows a number of typical Humfrey curves, the standard specimens being 10 mm. square, with a V-notch 2 mm. deep, angle 45 degrees, radius at bottom $\frac{1}{4}$ mm. (the standard Izod specimen). As will be seen, tough Ni:Cr steel gave the highest value, both in the maximum strength of the specimen—i.e., the resistance to slow bending until the metal back of the notch gave way, and also in the resistance of the material to propagate the crack after initial fracture had once set in. The curve for "temper brittle Ni:Cr steel" runs parallel to that of the same material in tough state, showing a similar resistance to static bend, but shortly before the maximum bending was obtained in the correctly heat-treated material, the temper brittle steel fractures, the fracture running at once across the entire cross-section of the specimen, no resistance whatever being offered to the propagation of the crack after it was once started. The curve for "nickel steel forging" also shows strength and toughness. The next three curves (0.35 carbon steel forging; 0.42 carbon steel normalized, and dead mild steel) are of considerable interest. While the two first-named steels run fairly parallel through a considerable portion of the bending operation, the forged material being slightly stronger in that regard, the normalized steel (0.42 C) is more ductile, the forged specimen breaking clear off at its maximum bend. The "dead mild steel" shows, of course, lower strength but high ductility. The "soft brass" showed the highest ductility, reaching the maximum bending angle at more than twice that of tough Ni:Cr steel (0.425 radians against 0.2 radians). It is very interesting to notice in these typical curves that the plain carbon steels show irregularities in the initial portions of the curves, while

[1] Chem. & Met. Eng., vol. 23, p. 1180, Dec. 15, 1920.

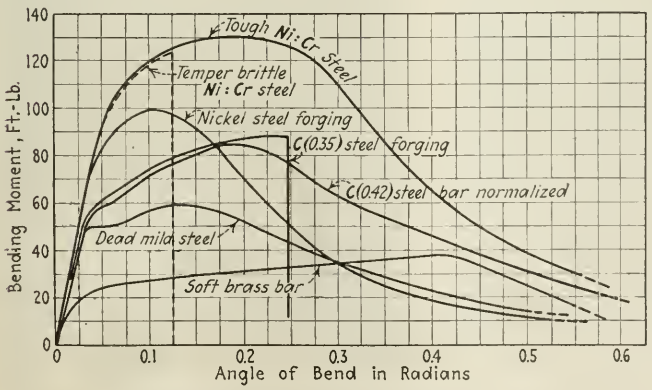


FIG. 1—TYPICAL DIAGRAMS OF VARIOUS ALLOYS, USING THE STANDARD IZOD SPECIMEN

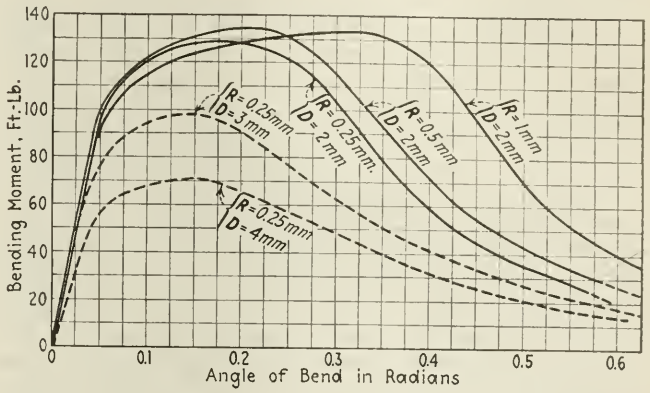


FIG. 2—EFFECT OF VARIATIONS OF RADIUS AT BOTTOM OF NOTCH AND DEPTH OF NOTCH IN TOUGH Ni:Cr STEEL

these do not appear in any of the other alloys investigated. It seems that these irregularities are due to the identical molecular disturbances in these steels which produce the "drop of the beam" in the tensile test.

Fig. 2 shows the effect of variations of radius at bottom of notch in tough Ni:Cr steel. Radii of 0.25 mm., 0.5 mm. and 1 mm. were investigated and the well-known law was confirmed that notched material breaks easier with a sharper notch, on account of the increased concentration of force. In the latter case the curves are almost identical, fracture with $\frac{1}{4}$ mm. radius occurring as shown in Fig. 1; $\frac{1}{2}$ mm. increasing the bending moment at sudden fracture to 125 ft.-lb. and deflection of 0.225 radians. Radius of 1 mm. slightly increases the bending moment, but fracture is resisted until the specimen bends through an angle equal to 0.335 radians (19 deg.). Much the same variations were observed in temper-brittle Ni:Cr steel.

Fig. 2 also demonstrates the effect of variations in the depth of notch; notches of 2 mm., 3 mm. and 4 mm. depth were investigated, the specimen cross-section remaining 10 mm. square, with no variations in the angle or bottom radius of the standard notch.

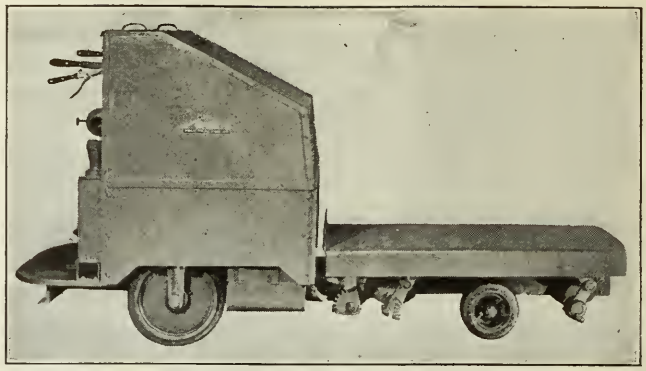
Looking over these curves, it will be readily appreciated that they yield much more valuable information than the single figures obtained in the notched bar impact test. In Fig. 1 the area covered by the curve for brass is more than twice as large as that for temper-brittle Ni:Cr steel. In a single blow impact test the "impact figure" of the brass would, therefore, be more than twice as high than that of the temper-brittle steel, but the interesting story connected with each fracture, demonstrating clearly the values of the factors of which the impact figure is the integral, would be missing. Furthermore, the area covered by the 0.42 carbon steel curve is considerably larger than that covered by the forged nickel steel curve; in this case, the impact figure would have been higher for the 0.42 carbon steel. On the other hand, the forged nickel steel is undoubtedly the stronger of the two materials, possessing a higher resistance against initial fracture at the notch. This point would not be brought out in the impact test, but is clearly shown in the Humfrey diagram. In the construction of machinery it may be preferable in some cases to utilize material of high resistance to initial notch fracture, while in other cases a steel will be found safer which offers a higher resistance to propagation of a crack.

Research work along similar lines will be of great practical value in the metallurgy and heat-treatment of ferrous and non-ferrous alloys. One subject still to be investigated is the reason for the very large increase in notch brittleness of steel at the lower range of atmospheric temperatures (from 0 deg. C. down to —30 deg. C.), resulting in failures of railroad material in winter and of aviation material in high altitudes. Such research work on low temperatures can be conveniently carried out by means of the Humfrey apparatus.

New Gasoline-Powered Lift Truck

The Clark Tructractor Co., of Buchanan, Mich., has placed on the market a gasoline-powered elevating platform truck. This truck is shown in the accompanying illustration. It will be noticed that it conforms in appearance to the electric lift trucks which have been in use for some years past.

The truck has a loading platform 26 x 54 in. which will elevate a load of 4,000 lb. from a minimum of 11 in. to a maximum of 16 in. above the floor in 8 seconds. This lift can be stopped by a hand control lever at any point. There are automatic stops for both upper and lower limits. The lifting mechanism is operated by hydraulic pressure.



GASOLINE-POWERED ELEVATING PLATFORM TRUCK

The power plant consists of a 15-hp. four-cylinder tractor engine of $3\frac{1}{8}$-in. bore and $4\frac{1}{2}$-in. stroke. Engine, transmission, governor, fuel tank and radiator are mounted together in a closed compartment. The drive is through a bevel geared axle. The design of all the parts is such that any good automobile mechanic can do all necessary maintenance.

The advantage of this machine lies in the use of a gasoline power plant. This permits continuous operation without the stops for changing battery necessary where storage batteries are used. Full power is available at all times. For plants located so that a charging station cannot be conveniently installed, the application of this truck should solve many difficulties.

Synopsis of Recent Chemical & Metallurgical Literature

Comparison of Expelled and Extracted Corn Oils.*— Comparison is made of the general characters and quality of three types of corn oil which have been prepared from the same general lot of material so as to make their source comparable. The three types are as follows: (1) Oil produced by expellers at the plant, (2) oil extracted with benzene from germs from the same source, and (3) oil extracted with benzene from the oil cake obtained from

TABLE I—COLOR AND APPEARANCE OF CRUDE CORN OIL IN STANDARD 5½-INCH BOTTLES AFTER STANDING IN THE DARK FOR ONE MONTH

Oils (*a*)	Color	Clarity, Deposit of Solids, etc
Sample D, dry-process germ by expeller	Bright golden	Very slight whitish deposit
Sample E, dry-process germ by solvent	Bright golden	About ¼-in. whitish deposit
Sample A, wet-process germ by expeller	Bright golden, with reddish tinge	Very slight whitish deposit
Sample B, wet-process germ by solvent	Slightly more reddish than oil A	About ⅛-in. whitish deposit
Sample F, dry-process oil cake by solvent	Reddish yellow	¾-in. dark brown deposit
Sample C, wet-process oil cake by solvent	Reddish brown	½-in. light brown deposit

(*a*) The samples of oil are arranged according to their depth of color, lightest to darkest.

*Abstract of Bulletin 1054, by A. F. Sievers, issued by the Department of Agriculture, Bureau of Plant Industry, March 11, 1922.

TABLE II—COMPARISON OF SOME PHYSICAL AND CHEMICAL CONSTANTS OF THE FINISHED CORN OILS

Oils	Sp. Gr. At 25 Deg.C.	Index of Refraction At 25 Deg.C.	Iodine Number (Hanus)	Acids: Acid Number	Saponification Number	Acetyl Number	Insoluble Hehner Number	Liquid Per Cent	Solid Per Cent	Reichert-Meisel Number	Soldifying Point of the Mixed Acids, Deg. C.
Sample A....	0.9181	1.4723	122.8	0.078	191.7	9.26	95.07	91.27	9.73	0.352	16.6
Sample B....	.9186	1.4726	121.6	.10	189.6	9.81	95.04	91.10	9.90	.312	16.8
Sample C....	.9185	1.4733	123.0	.116	183.0	10.93	92.60	89.96	10.04	.378	16.5
Sample D....	.9177	1.4726	124.8	.066	187.2	7.26	95.06	89.82	10.18	.115	16.0
Sample E....	.9165	1.4732	121.2	.106	194.2	9.99	93.00	89.88	10.12	.190	16.3
Sample F....	.9179	1.4731	125.5	.123	197.5	10.58	92.40	89.61	10.39	.135	16.5

the first-mentioned process. These oils were neutralized, bleached and deodorized, their physical and chemical constants determined, and their color, odor and taste compared. Such a comparison should show whether there is a possibility of preparing corn oil by benzene extraction that will be equal to that produced by the expeller method.

Samples of the two expeller oils and the four benzene-extracted oils were placed in standard 5¼-in. bottles for the purpose of comparing the color and other characteristics. Some of the oils, especially the benzene-extracted oils from the oil cake, appeared to be somewhat turbid when cold, although they were filtered clear while warm. For this reason the samples were permitted to stand in a dark place for a month and their condition then noted. Table I summarizes the appearance of the oils.

Of the crude oils those extracted from the cake were the darkest and deposited the greatest amount of sediment on standing. The benzene-extracted oils from the wet-process germs contained more free acids than the oils obtained by that method from the dry-process germs, this being especially true of the oils from the cake. All the oils were refined in the same manner, with the exception of the benzene-extracted oil from the dry-process germ cake. Owing to the sediment present, this oil required a greater quantity of caustic. The oils were all deodorized by blowing them with a current of steam at 225 deg. C. (437 deg. F.) for 2 hours under a vacuum of 25 in. This treatment removes odorous volatile constituents and in the case of solvent-extracted oils tends to remove the final traces of the solvent.

The expeller oils showed the lowest loss on treatment with caustic; in the oils obtained by benzene extraction from the germs the loss was somewhat greater, and the benzene-extracted oils from the oil cakes showed by far the greatest loss.

In order to show whether the six oils under discussion differed to any extent as regards the usual physical and chemical constants, these constants were determined and the results summarized in Table II.

In so far as is indicated by the physical and chemical constants, these six oils do not appear to differ to any great extent. Such differences as exist are not any greater than would be expected in several samples of normal oil. Neither do the constants of these oils on the whole show any considerable divergence from those reported by other observers.

No material difference could be noted in the finished oils from the germs immediately after their preparation, but upon standing, some deterioration took place, and this was somewhat more noticeable in the benzene-extracted oils than in the expeller oils.

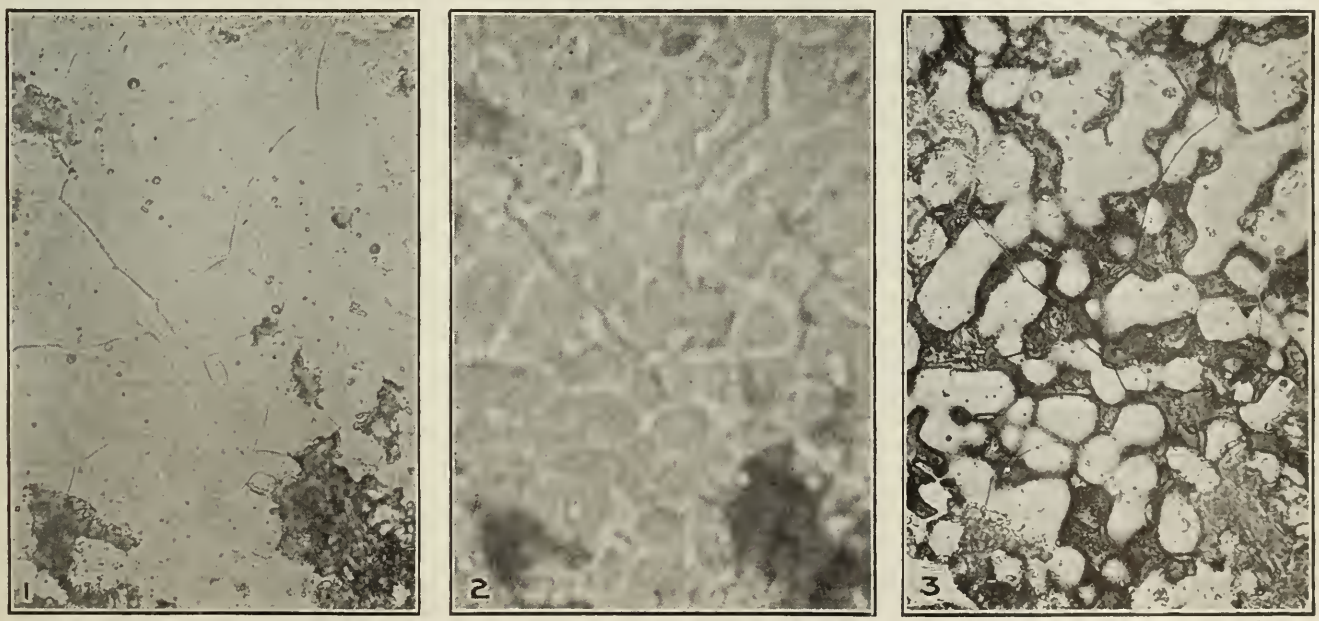
All the oils except perhaps that obtained by benzene extraction of the cake from wet-process germs were sufficiently light in color to make them suitable for salad and cooking purposes.

The oils obtained by benzene extraction from the two types of oil cake were inferior in all respects to the oils from the germs, that from the cake from wet-process germs being the poorer of the two.

A more thorough deodorization than that to which the oils could be subjected in these experiments might eliminate the remaining traces of either benzene or other odorous constituents, which no doubt account for the slight inferiority noticed in the benzene-extracted oils from the germs.

Phosphorus in Open-Hearth Steels.—Several years ago Dr. J. S. Unger, of the Carnegie Steel Co., prepared a series of 0.12 C basic and acid open-hearth steels, to which P was added while being cast, thus giving a series of ingots containing phosphorus in varying amounts from 0.008 to 0.115 per cent.[1] E. C. Groesbeck, of the Bureau of Standards, made some studies on small samples of these steels.[2] Samples of each were heated to 900 deg. C., held for about

[1] *Proceedings*, American Iron and Steel Institute, 1918, p. 172.
[2] Technologic Paper 203.



FIGS. 1 TO 3—CELLULAR STRUCTURE IN MEDIUM STEEL WITH 0.42 PER CENT P. × 500

Fig. 1—Etched with 5 per cent picric acid in alcohol.

Fig. 2—Same as Fig. 2, slightly out of focus.

Fig. 3—Same area etched with Stead's reagent.

15 minutes and cooled at a rate which carried them from 750 to 600 deg. C. in 4 hours, 2 hours, 1 hour, 30 minutes, 15 minutes, and 5 minutes respectively. There resulted a marked irregularity in the distribution and size of ferrite grains and pearlite kernels which cannot be ascribed to P content or method of manufacture. The grain size is roughly proportional to the time the sample remained above A_3, which represented the time available for growth of austenite grains. As the cooling rate increased, the relative number of pearlite kernels as compared to ferrite grains also increased, in conformity to the decreased opportunity for coalesence. No relation between P and amount of spheroidized cementite could be discovered. Brinell hardness (500 kg. load) appeared to increase consistently from 64 (P = 0.03) to 70 (P = 0.11), with a variation of $\pm$ 3, depending upon the rate of cooling.

In general the distribution of pearlite was very irregular; many times a large ferrite streak, shown to be high in phosphorus, contained along its rib a series of non-metallic inclusions. Groesbeck thinks this indicates that P segregates at the edges of the ingot crystals (dendrites), expelling therefrom the excess carbon which would also be expected to remain there. Normal picric or nitric acid etching often shows a shadowy cellular structure in the ferrite (Fig. 1) which is intensified if the field is a little out of focus (Fig. 2), a characteristic of very slight irregularities in a plane surface. Etching with Stead's reagent (Fig. 3) shows this cellular structure to be made up of regions high in P (light) and low in P (dark), a structure independent of the lines marking abutting ferrite grains. Such structures were developed in basic steels containing 0.05 P and more, and in the acid steels containing 0.03 P and more. Whiteley[3] has already studied the mutual distribution of C and P at various temperatures, and the present paper supports Whiteley's findings.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Pigments.—In processes for the preparation of oil pigment pastes from water pastes by grinding in the presence of a small quantity of a third substance or "activator," the following compounds are used as "activators": the oxides, hydroxide, acetate or basic acetate of lead, the borate, carbonate or basic carbonate of lead, cobalt, aluminum, magnesium, calcium, barium or strontium, or the carbonate or basic carbonate of manganese. The activator may be produced by reacting solutions in presence of the pigment. The pigment may be precipitated from colloidal suspension by the addition of an electrolytic or other coagulant. (Br. Pat. 173,350. Cookson & Co., Ltd., Newcastle-on-Tyne, and H. E. Clarke, Gateshead. Feb. 15, 1922.)

Dialkyl Sulphates.—Dialkyl sulphates are obtained by distilling alkyl hydrogen sulphates, or mixtures containing them, in vacuo so that only the small portion of liquid actually undergoing distillation is heated and so that the vapors and residue are rapidly removed from the point at which distillation occurs. For example, the liquid containing alkyl hydrogen sulphate may flow in a thin film over a heated surface, or down a heated coil or tube, or may be sprayed into the still or carried into the heated zone by a revolving drum or moving band. In an example a mixture of ethyl alcohol and fuming sulphuric acid is caused to flow by means of a revolving orifice down the inside of a vertical heated tube connected to a vacuum and condensing system; diethyl sulphate separates from the distillate, the remainder, consisting of alcohol, sulphuric acid, etc., being utilized in the next operation. Dimethyl, dipropyl and dibutyl sulphates may be similarly prepared. (Br. Pat. 175,077. British Cellulose Chemical Manufacturing Co., London, April 5, 1922.)

Phosphate Fertilizer.—Soluble phosphates are obtained by acting on a mixture of crude phosphate and alkaline sulphate with hydrochloric acid gas in presence of water. The addition of water may be effected by incorporating with the mixture loosening substances such as infusorial earth which can absorb moisture and still remain powdery. The required moisture may be added either before or after admixture with the crude phosphate and alkaline sulphate. The reaction is preferably carried out in stationary cylinders having stirring shafts, the mixture advancing slowly in the cylinder against a current of hydrochloric acid gas. (Br. Pat. 174,370. Not yet accepted. Rhenania Verein Chemischer Fabriken Akt. Ges. Zweigniederlassung Mannheim, Mannheim. March 22, 1922.)

Barium Hydrate.—In the production of barium hydrate from barium carbonate by forming barium silicate and decomposing this with water as described in specification 110,537, the proportion of silica to barium carbonate is such as to give a silicate of the formula $SiO_2.3BaO$ or a silicate intermediate between this and $SiO_2 2BaO$. The formation of the silicate from silica and barium carbonate or monobarium silicate and barium carbonate is effected in a rotary or tunnel furnace at 1,300 to 1,500 deg. C. The tribarium silicate or the intermediate silicate is treated with water to obtain barium hydrate and monobarium silicate, which is used for the next charge to be heated, and so on continuously. (Br. Pat. 174,052. Not yet accepted. C. Deguide, Enghien, France. March 8, 1922.)

Alkali Silicates.—Alkali silicates are obtained by treating barium silicates of the composition $SiO_2.1\text{-}3BaO$ with water and alkali carbonate or sulphate. Barium carbonate or sulphate is separated and may be converted into silicate by heating to 1,300 to 1,500 deg. C. with silica or silica and carbon. If the barium silicate is too basic, it may be treated with water to remove some barium as barium hydrate, leaving monobarium silicate. The sodium silicate obtained, containing some hydrate if basic barium silicates were used, may be caustified by lime. (Br. Pat. 174,581. Not yet accepted. C. Deguide, Enghien, France, March 22, 1922.)

Fatty Acids.—For the production of fatty acids, liquid hydrocarbons, such as the distillation products of rock oil or petroleum, are first treated with liquid sulphur dioxide for a sufficient length of time to remove all unsaturated impurities and an oxygen-containing gas is then blown through the unattacked residue, preferably in the presence of a base such as lime. (Br. Pat. 174,611. Not yet accepted. E. Zerner, Vienna. March 29, 1922.)

Metals and Alloys.—In an electric furnace method of making metals and alloys low in carbon and silicon from materials which are high in silicon and contain also oxides of one or more metals such as chromium, vanadium, manganese, tungsten, iron and nickel, the electric furnace is so worked that the voltage drop between a movable electrode and the charge is not less than 70. The constituents of the charge are finely powdered and intimately mixed and are preferably briquetted, the binder used being one not containing carbon, such as water glass or clay, and the briquets being dried by heating them to over 500 deg. C. For example a manganese-silicon alloy obtained by smelting a mixture of manganese ore, quartz and carbon may be powdered and mixed with manganese and dolomite, and the mixture briquetted with water glass, and the briquets, after being dried, may be reduced in an electric furnace operated as described above. The slag obtained may be used as raw material for the manufacture of silicomanganese. (Br. Pat. 174,618. Not yet accepted. Aktiebolaget Ferrolegeringar, Stockholm. March 29, 1922.)

Hydroxy-Quinones.—A chlorine-substituted anthraquinone is treated with a base in presence of an oxidizing agent, whereby a hydroxy group additional to those replacing the chlorine atoms is introduced. Alizarin, for instance, may be obtained from 2-chloranthraquinone by heating under pressure with caustic soda, sodium nitrate or chlorate, and water, the mixture being stirred. (Br. Pat. 174,101. A. H. Davies and Scottish Dyes, Ltd., Carlisle. March 8, 1922.)

[3]British Iron and Steel Inst., vol. 101, p. 363 (1920 I), and CHEM. & MET. ENG., vol. 23, p. 986, Nov. 17, 1920.

Book Reviews

ANALYSIS OF FUEL, GAS, WATER AND LUBRICANTS. By *S. W. Parr*, University of Illinois. International Chemical Series. Third Edition. New York: McGraw-Hill Book Co., Inc. 250 pp. Price $2.50.

This book in its third edition has been expanded somewhat to make it quite a comprehensive text book for students in chemical engineering and mechanical engineering. It is an admirable admixture of text for study and outline of laboratory procedure to guide the experimental work of the student. It is also very suggestive of lecture demonstrations which would be effective in presenting before classes the important points of fuel problems. However, it has not been in any way laid out as a lecture guide and it is only indirectly that it serves this latter purpose.

In many particulars the book has been brought well up to date, including in some cases data and references for 1920 and 1921. However, in other sections, notably the one on petroleum, the data are still those of 1918. This is unfortunate for any volume appearing in 1922, since data for 1921 are already available.

In general the work has not been prepared for chemists, but rather for engineers. Moreover, it is clearly intended as a text and not a reference work. Bearing these two points in mind, one need have no hesitation in looking upon the revised work as a valuable addition to our technologic literature.

R. S. McBride.

* * *

METRIC SYSTEM FOR ENGINEERS. By *Charles B. Clapham*, lecturer in the engineering department, University of London. 182 pp. New York: E. P. Dutton & Co. Price, $6.

The author states that "actual use of the metric system in the engineering industry in Great Britain has been steadily increasing, receiving much impulse during the recent war." There is a similar increase in this country, therefore a book of this sort will be very helpful to all who use the metric system in engineering calculation or measurement. The author is probably correct in stating that in the teaching of the metric system in the schools it is regarded as an alien subject to which a minimum of time need be given.

The author gives complete metric and English tables with the *exact* equivalents, but he also gives in each case the practical units and the *practical* equivalents, with rules and conversion charts for converting one into the other. There are many practical rules like the following which one would look far to find: "A weight in pounds is converted into kilograms by subtracting from it one-tenth of its own value and dividing the remainder by 2," error 0.3 per cent; and "a length in meters may be converted into yards by adding to it one-tenth of its own value," error 0.3 per cent.

Special attention is given to the use of measuring tools of the drafting room and workshop which may be graduated in metric units—e.g., verniers, micrometers and planimeters. Examples in connection with screw cutting and gear wheels are dealt with at length. The author points out a fact which will be a surprise to the uninitiated, that "all metric screws likely to be required can be cut on the usual English and American lathes, well within the accuracy required for manufacturing purposes, if one additional change wheel be provided" (p. 33). This arises from the fact that 1 in. equals very exactly 2.54 cm., hence it is necessary to have a wheel with 127 teeth, in addition to the wheels already in use.

Factors are given for the conversion of compound measures, such as British thermal units, horsepower, etc., also comparative tables of common engineering data, such as tensile strength and elastic moduli. A discussion of the C.G.S. system is also given, so that while the book is helpful to readers whose knowledge of mensuration is rudimentary, it is not without interest to the advanced student.

The author tries to take an unbiased position in regard to the compulsory adoption of the metric system in Great Britain and the United States, stating that this subject "is one upon which an isolated individual opinion would be of little value." He has, however, approached the subject from a constructive point of view and has done a piece of work which is essential to the transition to the metric system. His "brief survey of the controversy" is invaluable, since it throws much light (without heat) on the problem of the introduction of the metric system into industry from the standpont of the engineer. He repudiates the idea fostered by the opponents of the metric system that the adoption of metric units in metric countries is far from complete. He says "the use of such units [as the *sou* in France] is confined almost entirely to speech, and all written measurements and data appear in the official units." "At the present time the metric system is the only legal system of measurement in all the foremost countries of the world with the exception of the British Empire and the United States" (p. 143). In the newer and lighter branches of industrial work the metric system is met with to a considerable and ever increasing extent as regards lengths for manufacturing purposes. With some firms and some particular sections it is the only system employed (p. 143), and he gives a list of such types of firms. "In purely scientific work the metric system is alone used" (p. 144). "The English-speaking nations are the only non-metric ones of importance, and other nations cannot be expected to revert from metric to the Imperial system" (p. 146). "The real importance of the non-compliance of Britain and America with the international system is that rapidly developing countries using the metric units may be better catered for by the metric nations of Europe" (p. 146). In regard to the cost of the change, which is the great argument of the opponents of the metric system, he says, "It is to be feared that many false objections have been put forward" (p. 148). An authoritative statement of this character from an engineer who has made an unbiased study of the calculations, etc., involved in the change is very gratifying to the chemist who longs for the day when our cumbersome system can be entirely abandoned without hardship.

Eugene C. Bingham.

* * *

STUDY QUESTIONS IN ORGANIC CHEMISTRY. By *Alexander Lowry* and *Thomas B. Downey*. 92 pp. New York: D. Van Nostrand Co. Price $1.

The authors have put in pamphlet form a series of classified questions which are to serve as a guide and outline in the study of elementary organic chemistry. In addition they have appended a rather complete list of the more common reference books on the various phases of the subject.

This method of focusing attention on the subject has always proved valuable, in the experience of the reviewer, in teaching organic chemistry. The idea of using the same set of questions repeatedly, however, is open to criticism.

First, experience shows that when no changes are made in questions from time to time, completely answered sets are generally passed down from one class to the succeeding class. This practice, of course, defeats the very purpose of the questions. Second, due to wide variations in classes from year to year and to differences in presentation, the emphasis on the various topics has to be shifted. To meet this situation, it becomes necessary to frame new or at least different types of questions.

The material covered by the questions is fairly wide in scope. There are, however, certain omissions from the subject of optical activity—particularly optical resolution, symmetric synthesis, muta-rotation and the Walden inversion. It would seem that a separate section devoted to this subject would be better than the isolated questions scattered throughout the pamphlet. Except for the omissions just noted, the questions can be recommended as complete and satisfactory.

The pamphlet should prove particularly useful to those outside regularly organized courses in organic chemistry who are studying the subject or to those who, although they have had a complete course, have been out of contact with the subject and wish guidance in reviewing it.

T. C. Taylor.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Chemical Equipment Manufacturers Organize Trade Association

The Chemical Equipment Manufacturers Association was organized at a meeting of representatives of the industry held in the Chemists' Club, New York, on May 11. The association is the outgrowth of a movement begun last fall by twenty-five manufacturers of chemical equipment who were exhibitors at the Seventh National Exposition of Chemical Industries. They were brought together at that time to consider some matters relating to the Exposition, but realizing that there were other and perhaps more substantial reasons for organizing a permanent trade association, they have been active since last fall investigating the possibilities of an association to consider problems common to manufacturers of chemical equipment. All development work has been under the direction of an executive committee consisting of J. George Lehman, chairman; A. A. Holmes, secretary; Paul O. Abbe, P. C. Kingsbury and C. H. Kimberly.

The meeting on the 11th inst. was directed by Dr. C. H. Kimberly, who has been in active charge for some months past owing to the absence of Mr. Lehman, chairman. The following manufacturers were represented at the meeting:

Company	Representatives
United Filters Corp.	R. C. Campbell
Read Machinery Co.	A. N. Bowes
The Dorr Co.	G. E. Walker
Paul O. Abbe	Paul O. Abbe
Maurice A. Knight	Samuel J. Baril, M. Sultzer
Quigley Furnace Specialties Co.	H. T. Matthew
Vallez Rotary Filter Press, Chemical Equipment Co.,	C. L. Bryden
Duriron Co.	M. W. Smith
Nash Engineering Co.	C. B. Wright
Walter E. Lummus Co.	W. E. Lummus
Bethlehem Foundry and Machine Co.	A. H. Stevens
Precision Instrument Co.	L. D. Vorce
E. B. Badger & Sons Co.	A. A. Holmes
Schutte & Koerting	C. H. Kimberly
Aterite Co.	D. L. Dowling
General Ceramics Co.	R. S. Beecher
Oil, Paint and Drug Reporter	E. P. Specht
Drug and Chemical Markets	D. H. Killeffer
Journal of Industrial and Engineering Chemistry	H. E. Howe
Chemical Catalog Co.	F. W. Robinson, E. G. Nellis, F. M. Turner, Jr.
Chemical Age	R. H. McCready, Lloyd Lamborn
Chemical & Metallurgical Engineering	H. C. Parmelee, Irving Fellner

Addresses on Trade Associations

At the morning session there were two addresses on the general subject of trade associations: One by E. W. McCullough, chairman of the committee on fabricated production of the Chamber of Commerce of the United States, and the other by William A. Durgin, in charge of the Division of Simplified Practice in the Department of Commerce.

Mr. McCullough spoke from a broad experience with trade associations, particularly as a former secretary of an association of agricultural implement manufacturers. He emphasized the necessity of having a definite goal in starting an association of this kind. A prime necessity is a good secretary who will function as an executive and not merely as a clerk. He must not be handicapped by lack of funds, and preferably he should hold office continuously. Mr. McCullough pointed out the necessity of co-operation between a trade association and such government agencies as the Department of Commerce and the Federal Trade Commission in order that the government can be fully advised of the problems and needs of the industry.

Mr. Durgin outlined the reorganization of the Department of Commerce by Mr. Hoover and emphasized the fact that business is better represented today in the administration at Washington than it ever has been before. The Department of Commerce is functioning as the servant of business, but it can continue so to function only if business will co-operate with it and form close contacts through trade associations. By this means business will be in a position to obtain sympathetic attention from the government. Mr. Durgin dwelt on the subject of simplification in manufacture as one of the possible activities of the Chemical Equipment Manufacturers Association.

In the discussion which followed these two addresses representatives of the industry made tentative suggestions as to possible activities for the association. Among these were questions of standardization, guarantees of equipment, trade practices and activities of second-hand dealers.

At the afternoon session those present adopted the constitution and bylaws, which is printed below. By vote of those present, the executive committee appointed last fall will continue to direct the affairs of the association until permanent officers are elected. It will act as a nominating committee to prepare for an election to be held in September and it will also serve as a membership committee.

At the evening session the association was addressed by three representatives of trade expositions, Alfred Reeves, manager of the Automobile Chamber of Commerce; Robert Everett, secretary-manager of the Association of Ice Cream Supply Men; and F. W. Payne, of the National Exposition of Chemical Industries. The remarks of the latter were of particular interest on account of the light thrown on some matters in connection with the Chemical Exposition which had not been thoroughly understood or appreciated by exhibitors.

Constitution and Bylaws

Section 1—Name and Objects

The name of this association shall be Chemical Equipment Manufacturers' Association. The purpose of this association shall be to foster trade in chemical process equipment. In order to do this it shall be the aim of the association to:

Encourage high standards in the industry.

Promote a better knowledge of conditions controlling the industry's development.

Take steps to bring about definite understanding as to professional services rendered to purchasers in connection with sale of equipment.

Investigate conditions surrounding the resale of equipment originally produced for specific purposes.

Disseminate information as to methods of arriving at correct costs.

Standardize trade phrases.

Collect and disseminate information as to design, raw material and construction.

Take suitable and timely notice of, and action upon, matters of legislation, both national and state, which affect the members of this association.

Collect and disseminate market statistics both domestic and foreign.

Collect and disseminate information as to labor conditions and relations.

And enter into such other legitimate trade association activities as may be deemed in the interest and welfare of the industry.

It is distinctly understood that this association will not

undertake any activity which will restrain trade, limit production or competition, regulate prices, or otherwise be in violation of the law.

Section 2—Membership

Membership shall be divided into three classes: active, associate, and honorary.

Active membership shall be composed of manufacturers and their agents and others engaged in the manufacture and sale of equipment and accessories used in the chemical industries and industries using chemical processes. Only active members shall vote and hold office.

The associate membership shall be composed of such individuals, firms or corporations as are interested in the activities of the association. For example, consulting engineers and technical publications.

Any individual, firm or corporation qualifying for either of the above classes of membership, upon recommendation of the membership committee and the majority vote of the board of directors, and upon subscribing to the constitution and bylaws of the association, shall be declared elected to membership of this association. Payment of the annual dues shall be required within 30 days after election.

When a member has ceased from active participation in the work of the association, either because of retirement from business or change of position and has rendered distinguished service, either to the association or the industry, he may be accorded the rank of honorary member.

During term of office the presiding officer of affiliated technical societies such as A.C.S., A.I.C.E., A.O.C.S., etc. may also be accorded the rank of honorary member.

The proven participation of any member in any agreement to restrain trade, limit production or competition, regulate prices, or of other conduct prejudicial to the interests of the association, shall be reason for immediate expulsion by a majority vote of the board of directors.

Section 3—Board of Directors

There shall be a board of directors of seven members consisting of the president, ex-officio, and six others elected by the association. Of the original board, two members shall serve for 3 years, two members for 2 years and two members for 1 year from date of election. Thereafter, members of the board shall be elected annually to serve for 3 years. They shall have general supervision over the affairs of the association.

Section 4—Officers

The officers of the association shall be: president, vice-president and a secretary-treasurer.

Officers shall be elected at the annual meeting of the association. Ninety days prior to the annual meeting the president shall appoint a nominating committee of three who shall select at least two candidates for each office to be filled. Any other candidates can be nominated in writing by five or more active members of the association. All nominations shall be placed in alphabetical order on the ballot, which shall be mailed 30 days before the annual meeting. The ballots may be mailed to the secretary or brought to the annual meeting in envelopes unmarked, these envelopes being inclosed in others having the signature of the member voting. The nominee for each office receiving the highest number of votes shall be declared elected. In case of a tie the board of directors shall elect one of the two.

No member of the association shall be elected to the office of president more than twice in succession and there shall be a lapse of at least 3 years before he shall again be eligible for such position. The president and vice-president will hold office 1 year or until their successors are elected and qualified.

Section 5—Duties of Officers

The duties of the officers shall be as follows:

The president shall preside at all meetings of the association and act as an ex-officio member of board of directors. In his absence, the vice-president shall preside. In the absence of both the president and the vice-president, the members present at any meeting may by a majority vote, elect a chairman pro tem. to preside over such a meeting.

The following standing committees shall be appointed annually by the president, each to consist of at least three members: Membership, Standardization, Business Ethics, Industrial Relations, Statistics, Legislative and Publicity.

The secretary-treasurer shall be appointed by the board of directors and be directly responsible to them. The secretary-treasurer shall keep proper records of the meetings and all formal actions of the association and its committees. He shall have the custody of all its records and papers in general. Statistics and other confidential information received from members shall not be communicated to other members without specific permission of the member giving same, but nothing in this section shall be construed to prohibit the compiling of records and statistics *en bloc* or in totals and the furnishing of such compilations to all the members. He shall on request give to the president the names of members reporting and not reporting. He shall on order of the president issue written notices of all meetings of the association to members. He shall have the custody of and receive and disburse all funds of the association. He shall give bond in such sum and with such surety as the board of directors shall determine and such bond shall be held in custody of the president.

The books and accounts of the secretary-treasurer shall be audited at least once a year by a suitable disinterested accountant to be selected by the board of directors. Such accountant shall not be connected with the chemical process equipment industry.

The secretary-treasurer shall hold office during the pleasure of the board of directors.

Section 6—Dues

The annual dues of the active members shall be $100.

The annual dues of the associate members shall be $50.

Honorary members shall not be subject to either dues or assessments.

There shall be an initiation fee, the amount to be determined by the board of directors and it shall become effective when so determined.

The first annual dues are payable within 30 days of election; thereafter dues are payable quarterly at the option of the member. Membership shall be dated from the first of the quarter during which the member is elected.

Any member who shall become 90 days in arrears for dues and assessments shall cease to enjoy any benefits of the association. If he shall become 6 months in arrears he shall be subject to expulsion at the discretion of the board of directors.

Funds required in excess of revenue from dues are to be secured by assessment upon active members upon a basis to be determined by the board of directors and accepted by the members of the association. The association may also accept gifts, subscriptions and other funds for specific and general purposes.

Section 7—Meetings

The annual meeting shall be during the month of September and at the main office of the association.

The president shall call all other meetings of the association. In his inability, the vice-president shall have power to do so. A meeting shall be called at the written request of any seven members of the association.

At any business meeting the association members may be represented and vote as follows: Representation at the meetings of the association shall be only by designated representatives of the members, each member to have one vote.

Section 8—Publicity

The records of the association, its files and its correspondence and its meetings shall be open at all times to any public official who in the performance of his duties is legally authorized to investigate the workings of the association; the fundamental object of the association being perfect frankness and openness in all of its activities.

Section 9—Amendments

This constitution may be amended by a vote of three-quarters of the members present at any annual meeting,

provided a notice of such amendment has been sent to all members by the secretary 60 days in advance of such meeting.

SECTION 10—ORDER OF BUSINESS

The order of the business shall be as follows:

1. Calling the roll.
2. Reading minutes.
3. Election of officers.
4. Reports of officers.
5. Reports of committees.
6. Receiving communications.
7. Unfinished business.
8. New business.

SECTION 11

On points not specifically covered, Robert's Manual shall be considered as basis for rules of order.

Browne and Dow Address Joint Meeting of New York Chemical Societies

New York chemists who missed the joint meeting of the local chemical societies held under the direction of the American Section of the Société de Chimie Industrielle in Rumford Hall on May 12 have much to regret. The evening's program, featured by two intensely interesting addresses dealing with different phases of chemical history, proved to be one of the rarest treats of the season. Dr. C. A. Browne, chief chemist, New York Sugar Trade Laboratory, who is one of our few outstanding recorders of the history of American chemistry, spoke on "Early Chemical Industry in America—A Few Comparisons of Past With Present Conditions." Dr. Herbert H. Dow, president, Dow Chemical Co., followed with a very vivid and engaging account of some of his own experiences "in extracting dividends from chemical processes."

Dr. Browne's diligent searches into the archives of the Congressional Library have recently revealed records of the first chemical operations in the United States. In 1535 a party of Spaniards on their way into Mexico found certain pigments and bright minerals among the members of an Indian tribe and after tracing these to their sources, they discovered crude metallurgical operations in which the natives were smelting and refining precious metals. From this beginning we can follow the progress of the Spaniards, and later on the French, in exploiting the gold and silver of the new continent. In the New York colony the first of the chemical industries was the refining of sugar by the Dutch. As early as 1689 a large sugar refinery had been built in Liberty St. and continued its operations almost up to Revolutionary times. John Winthrop, early Governor of Connecticut, however, may be said to be the first American industrial chemist. Over 250 years ago he was manufacturing salt, recovering saltpeter and sulphur and making gunpowder. Dr. Browne, in his searches through the files of the Massachusetts Historical Society, has unearthed a number of interesting documents showing the alchemistic experiments and researches of this early American investigator.

The most startling of Dr. Browne's revelations, however, was the comparison of economic conditions in the chemical industry in the period 1806-1826 with those which have existed since 1914. Developments in the early days were almost identical with those we have just experienced. The expansion to meet the demands of the Napoleonic wars, followed by those of our own war of 1812, was repeated in 1914 and in 1917-18. Following the war of 1812 our chemical ancestors made every effort to hold onto their industrial gains and petitions for embargoes, tariff protection and patent legislation were as evident then as they have been in recent years.

A Bromine Industry Developed Under Difficulties

As is often the case in the commercialization of a chemical process, the early development of the American bromine industry was beset with almost insurmountable difficulties. But Mr. Dow early demonstrated that he was as much a business man as a chemist and the great industry at Midland which bears his name is evidence of his success in solving financial as well as technical difficulties. Beginning with his early and unsuccessful attempt to recover lithium from a salt brine near Cleveland in 1888, the speaker recounted his personal experiences which gradually culminated into a profitable method for extracting bromine. After his first bromine adventure had failed, Mr. Dow went to Midland, Mich., and purchased a brine-well property for $100. This was in 1890 and the next 5 years was spent in costly development and experimentation with plant processes. The first plant troubles were with the brine pumps and final success of the operation may be said to date from the development of an improvised check valve used on this particular pump.

Mr. Dow concluded his talk with a review of the sidelines developed in connection with the industry and as example showed how Dow metal, the new magnesium alloy, had its origin. This alloy has certain interesting properties which indicate that it may be destined greatly to affect the construction of the internal combustion engine.

Resolutions in Memory of Dr. Baskerville

This was the first meeting of the American Section of the Société since the death of its vice-president, Dr. Charles Baskerville, and President J. Enrique Zanetti read the following resolution which was unanimously adopted as a respectful recognition of the memory of this illustrious investigator:

> The Société de Chimie Industrielle has suffered a great loss in the passing of Dr. Charles Baskerville. He was able in counsel, sound in scholarship, kind and generous in disposition and prolific in invention. As a man of science, as professor and as head of the department of chemistry of the College of the City of New York, he was at once competent, clear of vision and keen of understanding; a constant friend to those serving with him and under his direction and an enduring source of inspiration to his students. He was both a gifted teacher and an administrator of rare ability.
>
> Besides his endowment of far vision and his diligence in research along with the fulfillment of his many duties, he was a joyous companion and bountiful in the benefactions of his friendship. In this he was always guided by magnanimous generosity toward others while holding close to high ideals of thought and action for himself.
>
> His presence added distinction, learning and wisdom to the Council. His death is a heavy burden, his memory a precious inheritance.

Patent Convention With Germany Revived

After an extended study of all the ramifications of the proposal that the Patent Convention of 1909 with Germany be permitted to lapse, the State Department decided to revive the convention, and notice to that effect was transmitted to the German authorities prior to May 11, which was the time limit for such notification. The revival of this convention gives the holders of American patents registered in Germany immunity from the working clause in the German patent law. Strong pressure was brought by the War Department and the chemical industry against the revival of the convention. The War Department is anxious to obtain the enactment of a working clause to apply to all patents registered in the United States. The American chemical industry has comparatively few patents registered abroad. On the other hand Germany has a large number of patents registered in this country which are not being worked.

Manufacturers of machinery in the United States were among those who were most strongly in favor of reinstating the convention with Germany. It was stated that it would cost machinery manufacturers millions of dollars to undertake the manufacture of their patents in Germany.

The effective date of the revival of the treaty is May 8, 1922. This means that no change can be made without 1 year's notice. The Patent Committee is going ahead with the new Stanley bill, which is the bill drafted by Henry Howard, president of the American Institute of Chemical Engineers. Since the urgency for legislation has passed, it is probable that action on the bill will lag, although the hope is expressed in some quarters that favorable action will be taken.

Annual Conference on Weights and Measures

The fifteenth annual conference on weights and measures will be held at the Bureau of Standards at Washington, May 23 to 26. These conferences are attended by government officials interested in weights and measures and by weights and measures officials of states, cities and counties. The sessions also are attended by manufacturers of apparatus and by representatives of industries interested in the general subject. A feature of each of these conferences is the display of manufacturers' exhibits of weighing and measuring apparatus.

The program includes an address by the Secretary of Commerce. C. A. Briggs, of the Bureau of Standards staff, has taken as his subject "The Metric System: How Would It Be Put Into Effect?" H. W. Bearce, also an official of the Bureau of Standards, will discuss "The Fundamental Standard of Length."

Technical and Industrial Photography to Be Fostered by New Society

At a meeting held in the Chemists' Club, New York City, on May 10 the organization of a society of technical and industrial photographers was consummated. The new society will be known as the Technical Photographic and Microscopical Society. Officers elected were as follows: President, James McDowell, of the Sharp & Hamilton Manufacturing Co., Boston, Mass.; secretary-treasurer, T. J. Keenan, editor of *Paper;* vice-presidents, J. H. Graff, of the Brown Co., Berlin, N. H., and B. Grotta of the Atlas Powder Co., Tamaqua, Pa.

A luncheon meeting of the society at the Hotel Astor, New York, is scheduled for June 15, at which time the members will be addressed by speakers prominent in the field of industrial photography. At this meeting additional steps will be taken for the establishment of a permanent organization, and an invitation is extended to all individuals or organizations interested in technical and industrial photography to attend or send representatives to this meeting.

The aim of the organization is to promote the advance and extension of photography in its applications in industry and business by co-operation among those engaged in the work and among the industries which the art serves. The membership will be made up not of photographers primarily, but of technical men who depend upon photography for aid in their control and research problems. Industrial and technical photography should not be confused with commercial photography, although these two branches often overlap, and the commercial photographer in many instances has done much for the full appreciation of the value of photography in industry and science. The problems of industrial photography are many-sided and interwoven so much with the knowledge of other sciences—namely, administration, engineering, chemistry, physics, optics and mathematics—that it is absolutely impossible for them to be covered by the average commercial photographer.

The Field of Technical Photography

The society will be concerned in work done with the ordinary camera as a tool of management, making photographic records of control and record boards, photographs of accidents and damages, photographs demonstrating evidence of waste and salvage, demonstration of safety ideas and accident prevention, for copying drawings and documents, standardizing records, as an aid to the engineer making progress reports of construction, and illustrations for field investigation, trade reports and industrial reports.

Another important field is in photomicrographic and macrographic work. This work, which formerly was only done by the scientist in pure research, is now more and more used to solve daily commercial and industrial problems. It is of increasing importance in metallography, textile, pulp and paper industries, cement, explosives, colloidal solutions, physical chemistry, bacteriology, rubber, leather and paint industries. The study of the raw material or the finished product is, however, only a small part of the work. The biggest value is in ability to record and compare the result of the different chemical and physical processes of production.

A third field of interest covers photographic work needing specially constructed equipment. Many industrial and technical problems in photography require specially designed apparatus and equipment, of which it is only necessary to mention a few, illustrating the immense scope of this work, as for example, special equipment making it possible to take photographs of physical phenomena and illustrating the workings of physical laws, photomicrographic moving picture machines, and special moving picture cameras, making it possible to study the detail of motions or the breaks or stress of physical tests.

Society Plans Exhibit

An exhibition of technical and industrial photography showing some of its unique and interesting applications will be given by the new society at the Chemical Exposition in New York in September. The exhibit will include samples of work on textiles, pulp and paper, leather and other industries, besides a display of new apparatus used in modern technical photographic laboratories.

Research Last Branch of C.W.S. to Be Cut—Sentiment on Chemical Warfare Changing

After July 1, unless the Senate should increase greatly the amount to be appropriated for the Chemical Warfare Service, numerous activities of the Service will have to be skeletonized and reduced to a standby status. Research will suffer least of all. It is intended to maintain research at the expense of every other activity.

Evidence is reaching the Chemical Warfare Service that the adoption of the so-called gas treaty has not been entirely adverse to the development of chemical warfare. The discussion of the treaty has had an educational effect in that it has acquainted additional thousands with the fact that chemical weapons are the most humane which can be used in warfare.

Gradual Change in Sentiment Toward C.W.S.

Formerly a considerable portion of the army itself looked upon chemical warfare with much skepticism. The General Staff was avowedly hostile to the importance which Congress attached to the Service and was inclined to belittle its possibilities. Sentiment in the army itself has changed to the point where practically every officer is an advocate of chemical warfare. A notable exception is General Pershing. No satisfactory explanation ever has been put forward for the change in the views on this subject of the General of the armies. It is fully believed that he expressed his real personal views in his testimony before the Military Affairs Committee, and that he was influenced at the time the treaties were being negotiated by the desire of the Secretary of State to align the United States with what would be generally understood throughout the world as the more humane policy.

Much significance is attached by the army and navy air services to the capture of a naval squadron by Chinese air forces. In the face of effective bomb dropping the whole squadron soon ran up the white flag. While the bombs used were of the high-explosive character, it is pointed out that even more prompt results could have been obtained had they been gas bombs and the loss of life probably would have been avoidable.

Columbia Announces Summer Courses

A series of summer courses in advanced branches of chemistry and chemical engineering, physics, electrical engineering and mathematics is announced by Columbia University, New York City, for the session July 10 to Aug. 18, 1922. The courses in chemistry include general inorganic, colloid chemistry, physical chemistry, food chemistry and organic chemistry. The chemical engineering program includes courses in fuel chemistry, illuminating gas, industrial chemistry and research engineering. Full details will be sent upon application to the secretary of Columbia University, New York City.

House Bill Would Provide for Development of Helium

The conservation, production and exploitation of helium gas under the Interior Department is contemplated in a bill introduced by Representative Kahn of California. The bill transfers all helium activities to this department and would forbid the exportation of helium except upon approval of the President. Helium would be first supplied to meet requirements of the War and Navy Departments, the surplus to be leased or sold to citizens of the United States or to commercial companies, corporations, institutions of learning or research or other agency so incorporated that the control of said companies, corporations, institutions of learning or research or other agency cannot pass out of the control of American citizens.

The bill provides that the Secretary of Interior shall purchase gas and acquire extraction rights in gases and to lease or purchase lands or the gas and oil rights in lands for the purpose of conserving and producing helium. It also directs the Department of the Interior to explore for, drill and develop such lands, rights in land, gases and rights in gases, for the purpose of securing such helium as may be required, and to store, sell or dispose of any natural gas, petroleum or valuable byproducts obtained in such development and to store the helium so produced.

Under the provisions of the bill, the Secretary of the Interior would be authorized to carry on experimental work relative to the production of helium and to acquire, establish and operate or cause to be operated such plants, accessories and facilities and to acquire rights pertaining thereto as may be necessary for the production and storage of helium.

The bill carries an appropriation of $5,000,000 for development purposes. It directs the Secretaries of War and Navy to submit annually to the Interior Department their estimated requirements for helium to be supplied or conserved for the next fiscal year.

Senator Moses Contributes His Plaint to Testimony of Dye Investigation

Senator Moses of New Hampshire, one of the instigators of the dye investigation, contributed to the testimony before the committee for the first time on May 10, when he called several matters to the attention of the committee through William P. Pickhardt, director of Kutroff, Pickhardt & Co., New York City. Through Mr. Pickhardt, Senator Moses presented to the committee a series of memoranda and correspondence, which Mr. Pickhardt said represented some of the objections held by consumers and by Senator Moses to the protection sought by the American organic and chemical industry.

It was evident from th s correspondence that the New Hampshire Senator has been active in gathering information for the Amoskeag Manufacturing Co., of New Hampshire, and in aiding it to obtain licenses for the importation of German dyes. The correspondence was included in the record of testimony.

Consumers Complain of Licensing Delay

As evidence that there is cause for complaint on the part of consumers of dyes, Senator Moses called attention to the case of the Amoskeag Manufacturing Co. in obtaining an import license for indanthrene blue BCS. Application for the license had been made in this case on Nov. 14 and it was granted on Dec. 3, according to Mr. Pickhardt. Twenty-seven barrels of this dye were imported for three consumers by his company, but after the dye had been distributed to these consumers the dye and chemical control section of the Treasury had ordered it all returned to New York because of a fear that the dye was not as represented and was in reality merely a substitute for an American dye which would give the same satisfaction to users. Later on, Mr. Pickhardt said, further experiments and tests showed the dye to be as was represented and the shipment was released and the dye again was put on the importable list, Feb. 16 last.

Senator Moses had also requested him to present to the committee, Mr. Pickhardt said, a memorandum prepared by F. S. Dickson, chief of the dye and chemical control section of the Treasury Department, dealing with the authority for importation of German dyes through the reparations commission and the Textile Alliance, under the peace treaty. The New Hampshire Senator also had Mr. Pickhardt place in the record a report made to the Textile Alliance by Edward S. Chapin, its representative in Paris, and another report by Mr. Chapin to the State Department, and other correspondence on various phases of the general situation, including correspondence with Mr. Pickhardt and the Amoskeag Manufacturing Co.

Describes Activities of Kuttroff, Pickhardt & Co.

History of the activities of his firm, which prior to the war was the exclusive agent in the United States of the Badische Anilin- und Soda-Fabrik, one of the largest members of the present German cartel, was begun by Mr. Pickhardt following his presentation of the material prepared by Senator Moses. Mr. Pickhardt said that there had been so much talk about his own activities that he wished to give the committee a complete and detailed history of them, particularly with regard to his efforts to import German dyestuffs since the signing of the armistice.

Imported dyes handled by his concern since the armistice, he said in response to a question, were very much in the minority in value and a much smaller percentage in quantity of the total of American and foreign dyes handled.

Delay in getting German dyes needed by American consumers following the armistice was "due to a desire on the part of special interests to eliminate importers from the dye industry," Mr. Pickhardt said, and this desire had been placed above the desire of the State Department, which was solely to obtain dyes needed by American consumers.

Say Consumers Are Back of Manufacturers

Thomas Frusher, of the United States Woolen Co., stated that "90 per cent of the consumers of the country are opposed to the embargo, but they say that if the dye men need another year, why, give it to them," he declared. "I want to help the American industry, but I don't want an inefficient government organization telling me that we can have this or must try a substitute for that."

Mr. Frusher deplored the necessity of obtaining a license to import dyes which are not made in this country. His objection was based on the delay involved in obtaining a license, a circumstance which Mr. Frusher laid at the door of those charged with administering the system. He urged that the government publish a monthly list of dyes made in the United States and that consumers be permitted to import without license all dyes not named therein.

Bureau of Mines Asks Aid of Industry in Compiling Coal Storage Data

The Bureau of Mines has issued a call to industries using coal for help in compiling exact information on the problems involved in the storage of coal. Every coal user is requested to give the Bureau the benefit of his views and conclusions on the subjects of handling and transportation costs and the investment, fixed charges, etc., involved.

While there has been much agitation of the possibilities of coal storage for giving more regular mining and movement of coal, there is very little exact information available. It is for such exact data and working costs that the bureau is calling upon the industries.

Among the specific points on which information is desired are the following: Method of storage, location with reference to point where coal is used, quantity stored, methods of preventing spontaneous combustion, method of handling fires, devices used for observing temperature, deterioration in stored coal, danger point as regards temperature, tonnage per acre, depth of pile, kinds of coal stored, cost of plant, maintenance and handling and effect of climate on stored coal.

Information on these subjects should be sent to F. R. Wadleigh, Fuel Division, Department of Commerce, Washington, D. C.

Senate Drags Through "A's" of Chemical Schedule Strongly Supporting Committee Amendments

If the progress made by the Senate on paragraph 1 of the chemical schedule is a criterion, snow will fly long before the discussion of the measure is concluded. Consideration of the tariff began on April 20. It has been demonstrated clearly that the committee has the votes to put through practically all of its amendments. Despite this fact, progress has been very slow. The Senate has been held in session for much longer periods each day than is the custom. The rules in regard to interruptions are being enforced with more than the usual rigor, but despite the application of the spur, it has been very difficult to bring the Senate to the point of voting on the amendments.

While the acid paragraph is regarded as an important one, the commodities contained in it would not have provoked the amount of discussion devoted to them had it not been for the fact that this is the first paragraph of the bill. This naturally has led to much discussion of principles underlying tariff making.

Senate Stands by Committee

When the Senate does reach the point of a vote, very frequently no roll call is required. When the roll is called, the support for the committee amendment is overwhelming. For instance, the committee increased the duty on lactic acid from 1½ cents to 2 cents per pound. The vote on that amendment was 40 to 23. The committee proposal to make the duty on arsenic acid 3 cents per pound and on white arsenic 2 cents per pound was carried by votes of 40 to 18 and 34 to 16 respectively.

That the majority is standing with the committee is evidenced further by the fact that amendments to increase rates of duty are being voted down. Senator McCormick, of Illinois, for instance, proposed to increase the duty on formic acid from 4 to 6 cents. It was contended on behalf of this amendment that a 6 cent duty is necessary to place the American industry on an equal footing with manufacturers of that acid in Germany, nevertheless the proposal was voted down decisively. In the consideration of that item, Senator McCumber explained that the specific duty of 4 cents a pound practically is the equivalent of the 25 per cent ad valorem rate assessed in the House bill. In that connection Senator McCumber explained again that it is the policy of the committee to impose specific duties wherever possible so that the amount collected will be the same regardless of the country of origin. This led Senator Hitchcock to ask if it is the purpose to shut out chemical imports from Germany. Senator McCumber replied that the 4-cent rate will not reduce the volume of formic acid being imported.

Foreign Markets and Competition

During the debate figures were presented showing that we are selling more chemicals to Germany than we are purchasing from that country. Senator McCumber expressed the belief that such a condition would not be lasting. "We know," he said, "something about the cheap labor and the cheap production of chemicals in Germany. I do not expect we are going to continue to sell chemicals to Germany."

"For 50 years," declared Senator McCumber, "we have sold Great Britain two to three times as much as we have bought from her, the balance of trade always has been immensely in our favor, yet Great Britain was able to buy our products. I think in a very short time Germany will drive the United States out of the markets of South America and many other countries, and that she will produce a sufficient balance of trade in her favor to use the same amount of money for purchasing American products. I do not think there has to be an exact balancing of trade as between any two nations."

In reply to the suggestion that the allied countries could pay their obligation to this country only in goods, Senator McCumber expressed the opinion that it would be better to lose the money then to allow these countries to pay us in goods when that would mean the closing of our own mills and factories. He also expressed the opinion that prices never will recede to the pre-war level. He pointed out that despite the deflation which has taken place, the volume of currency per capita in the United States at this time is double the pre-war volume.

Long Debate on Arsenic

The proposal to put a duty on arsenic—a commodity which can be produced easily in quantities in excess of domestic requirements—occasioned lengthy debate. It was justified by the committee on the ground that the smelters are compelled to produce arsenic so as to prevent damage to vegetation, and that they should be permitted to obtain at least the cost of its recovery. It was pointed out that with the development of the smelting industry in Japan, that country is offering arsenic at American ports at less than the cost of production. Unless this duty is granted, it would have the effect of handicapping our ability to export metals in that the losses on arsenic would have to be added to the cost of metal production.

Engineer Volunteers Help to Government in Reaching Muscle Shoals Decision

William McClellan, president of the American Institute of Electrical Engineers and a member of the executive board of the Federated American Engineering Societies, appeared before the Senate Committee on Agriculture, May 9, to give his views in regard to the handling of the Muscle Shoals project.

He emphasized the desirability of protecting the existing construction and equipment against deterioration and advocated the formation of an engineering board of review to recommend to Congress a general plan of procedure.

Dr. McClellan bound himself to place at the disposal of Congress a committee of engineers with commercial experience who would recommend a general plan for the handling of the project from a business standpoint. He said he would arrange, through the American Institute of Electrical Engineers or through the Federated American Engineering Societies, for the services of such a committee, which would be composed of disinterested men of thoroughly established reputation.

Government Needs Aid of Engineers

He also told the committee that the government should not act except on the basis of unbiased, competent, professional and business advice. "It is perhaps not unfair to say," he asserted, "that all those engineers and business men who have made detailed studies of the project have done so for some reason of their own and did not look at it from the government's standpoint. The disposal of Muscle Shoals is not a technical, engineering proposition. It is a commercial matter. The only way for the government to get an impartial review of the commercial and engineering features of the situation is for the committee of the Senate and the committee of the House jointly to request a group of not less than five engineers, who have had adequate commercial experience in large projects, to take all of the data, statements and reports which have been submitted and report to the committees what the government should do.

"The government under no circumstances," continued Dr. McClellan, "should alienate its nitrate plants until an adequate plan is agreed upon for the completion of these plants or the construction of nitrate plants at some more favorable points, should such places be found. During the period of investigation the works at Muscle Shoals can be adequately protected against deterioration. Such protection of interrupted construction work is very common among commercial companies. The government can well afford to appropriate money to render streams navigable and to regulate flow, particularly at headwaters, so as to improve the stream for power purposes."

Senator Caraway of Arkansas charged that the fertilizer trust had instituted rival offers for the nitrate plants in an effort to prevent Congressional acceptance of any offer. He likened delay in consideration of the project to that in the construction of the Panama Canal.

Division of War Minerals Supply Formed for Survey of Mineral Industries

Effective May 1, a division of war minerals supply was established in the Bureau of Mines. The new division has been charged with responsibility for matters relating to the supply of strategic minerals involved in war plans of the government, the maintenance of a proper balance of trade among the mineral industries of the nation and such related duties as may from time to time be assigned to it. H. S. Mulliken, who has for some time acted as special assistant to the director of the bureau, has been given charge of the work of this division.

The division will co-operate with the General Staff of the War Department, the United States Geological Survey, and a special committee of the A.I.M.E. in the proposed study of sources of supply and potential production of certain especially selected war minerals.

The head of the division will serve as chairman of the committee on strategic minerals of the economic liaison committee. He has further been placed in administrative charge of all activities in the production of helium that may devolve upon the Bureau of Mines, and will serve as one of the bureau's representatives on the army and navy helium board.

Bureau of Foreign and Domestic Commerce Will Establish Chemical Commodity Section

A commodity division which will specialize on the export problems of chemical industries will be set up in the Bureau of Foreign and Domestic Commerce of the Department of Commerce on July 1. This division will be comparable to the special services inaugurated last year in the interest of cotton and cotton goods, electrical goods, industrial machinery, lumber, paper and paper products and other export industries.

It was the intention a year ago to organize a chemical division, but it developed that there were numerous other industries in which the desire for this government effort was greater. It has been found, however, that while the more highly organized chemical companies are not greatly interested in receiving such assistance as the chemical commodity division could furnish, the smaller manufacturers are very much interested in obtaining this type of service. It will furnish them with much information which they could not attempt to gather for themselves.

No chief for the chemical division has been decided upon as yet, but an announcement is expected in the near future.

New Jersey Chemical Society Meeting

At a meeting of the New Jersey Chemical Society in Newark, N. J., May 8, J. F. Norris, professor of organic chemistry at Massachusetts Institute of Technology, spoke on "Recent Developments in Organic Chemistry." Prof. Norris discussed organic catalysts and other important industrial developments in the science, emphasizing the importance of pure research.

D. M. Goetschius, of the Standard Chemical Co., Pittsburgh, Pa., was scheduled to speak on "The Alpha Particle and Related Phenomena," but was prevented by sickness from attending.

Personal

Earl D. Babst, president of the American Sugar Refining Co., was the guest of honor at a dinner given at the Southern Hotel, Baltimore, Md., on May 5, in recognition of the completion of the company's new plant in this city. Governor Ritchie and Mayor Broening were among the prominent guests.

Baltzar De Mare, metallurgist and more recently steel superintendent for the Midvale Steel & Ordnance Co. for approximately 20 years, now has been appointed general manager of the Union Electric Steel Co., Carnegie, Pa.

Dr. Paul M. Giesy, formerly with the Calco Chemical Co., Bound Brook, N. J., is now research chemist with E. R. Squibb & Sons, at their Brooklyn, N. Y., plant.

Paul F. Holstein is now associated with the Buffalo Foundry & Machine Co. as its representative in Chile.

Charles O. Lavett has resigned his position as engineer of tests and field erection with the Buffalo Foundry & Machine Co. Mr. Lavett was in active charge of the research laboratory for this company and has been responsible for considerable of the development in "Buflovak" drying and evaporating apparatus. He has been with the company for about 15 years.

F. G. Liljenroth, of Stockholm, Sweden, formerly with E. I. du Pont de Nemours & Co., has just visited the United States.

William J. Priestley, formerly steel superintendent, naval ordnance plant, South Charleston, W. Va., has been appointed works manager, Pittsburgh Crucible Steel Co., Midland, Pa., succeeding H. P. Barnard, resigned, and has assumed his new duties. Prior to going to the naval ordnance plant, Mr. Priestley was a division superintendent at the Lehigh plant of the Bethlehem Steel Co. He was graduated from Lehigh University, class of 1908.

Robert C. Stanley, formerly first vice-president of the International Nickel Co., was recently elected president. Mr. Stanley has ordered a reorganization of personnel, involving as its chief feature a new department of development and research with headquarters at 67 Wall St., New York City. This department will be under the direction of A. J. Wadhams as manager. Associated with him will be Paul D. Merica, director of research.

R. T. Stull was relieved of the superintendency of the ceramic experiment station of the Bureau of Mines at Columbus, Ohio, May 1, and made supervising ceramist for the bureau as a whole. He will act under the direction of the chief mineral technologist and will have supervision in technical matters in ceramics and such related investigations of non-metallic minerals as may from time to time be assigned to him. Mr. Stull will have administrative as well as technical supervision of field work in the kiln investigation carried out in co-operation with the four heavy clay products associations, including the laboratory car "Holmes" and its crew. He will make his headquarters at Columbus, Ohio, but his services will be fully available for consultation by all branches of the bureau concerned with ceramics. George A. Bole has been designated acting superintendent of the Ceramic Experiment Station at Columbus, Ohio.

C. K. Williams, head of C. K. Williams & Co., Easton, Pa., manufacturers of paints and varnishes, has been elected a member of the committee of manufacturers of the Philadelphia sesquicentennial by Mayor Moore.

Obituary

Thomas S. Doherty, manager of the Delaware Chemical Engineering Co., of Wilmington, Del., died at his residence May 1. He was 67 years of age.

Henry Marion Howe, dean of American metallurgists, passed away Sunday, May 14, after a protracted illness. A biographical notice will be published in a later issue.

William Shepard Manning, Jr., assistant general manager of the Solvay Process Co., Syracuse, N. Y., committed suicide May 8. He suffered from insomnia and had just returned from a health resort on the Hudson River, where he had been for 3 weeks.

Edward Menge, of East Liverpool, Ohio, former president of the National Brotherhood of Operative Potters, died at his residence, April 30, after an illness of about a year's duration. He is survived by his wife and one son.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Overcapacity, Overproduction and Overcompetition

Sydney Anderson, the chairman of the joint commission of agricultural inquiry, has given us his opinion that there are at least three basic difficulties that are undermining business progress. He lists these in three words—overcapacity, overproduction and overcompetition. Others may differ with the distinguished investigator as to the relative importance of these underlying problems, but certainly they are worthy of our very careful consideration.

Overcapacity is a subject which has had the attention of the chemical industries many times within the past few years. Only recently in these columns we have had occasion to point out the difficulties of gaging productive capacity in terms of our distant mental concept of pre-war production. Such a starting point for appraising our industries fails to take account of the normal increase in the volume of manufacturing. This over a long period of years has been shown to average almost 4 per cent each year. In other words, if business had followed its normal and ordinary trend, our productive capacity today would be at least a third greater than in 1913.

Perhaps in the aggregate we have not materially exceeded this figure, but many individual industries have been extended far beyond their normal limits. No less an authority than Walter Renton Ingalls is responsible for the statement that in a part of our industrial field we now have an excessive capacity varying from 50 to 100 per cent. That this applies with particular emphasis in the chemical and metal industries, there can be no doubt. Here military demands of a stupendous character were followed by a post-war boom and an artificial and overdeveloped export trade. Naturally the period of readjustment and deflation has been most trying in these industries and there has been a tendency to cling to capacities far in excess of any possible demands.

The second problem cited by Mr. Anderson is perhaps not so evident. Production today is far beneath the normal, although probably no farther than is the present consuming capacity. But it is the constantly recurring surpluses that interrupt our progress and result in unpleasant situations such as the one from which industry is just now emerging. Overproduction is the natural sequence of overcapacity, although not necessarily so. Rather it is because in a highly specialized division of labor and industry it is impossible quickly to adjust production to the changing requirements of consumption. As the saturation points are exceeded for the individual commodities, surpluses pile up and industry suffers. The consumers' gains by the lower prices are more than swallowed up in the resulting unemployment and industrial stagnation.

In the minds of some of our legislators there is no such evil as overcompetition, which has been listed as the third of our underlying problems. The business man, however, who has witnessed its destructive effects is likely to regard it as the most serious of the three. The very commendable desire to make two chain stores grow where but one grew before is often the beginning of a process which when carried to its extremes results in price cutting and other demoralizing business practices. It is in the highly competitive situation especially such as follows a period of overproduction, that most of the losses of industry are incurred.

It is scarcely fair to list these industrial ailments without some mention of the palliative measures which are already being undertaken. Business men, economists and government officials are giving serious thought to these problems. The National Foreign Trade Convention which met last week in Philadelphia has tried to show that through the development of international commerce we can provide an outlet for the products of our overbuilt industries. Secretary Hoover and his co-workers in Washington have attempted to provide accurate statistics of production and consumption in the belief that through their use industry can avoid the constantly recurring peaks and valleys of the business cycle. And finally we have the recent impetus given to the study of the scope and activities of the trade associations—a development which is throwing new light on the meaning of competition and its relation to business conditions.

Thus the three "overs" of industry are being studied from many different angles and probably no small part of the present gradual improvement in business is directly traceable to the cumulative effects of such fundamental thinking.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

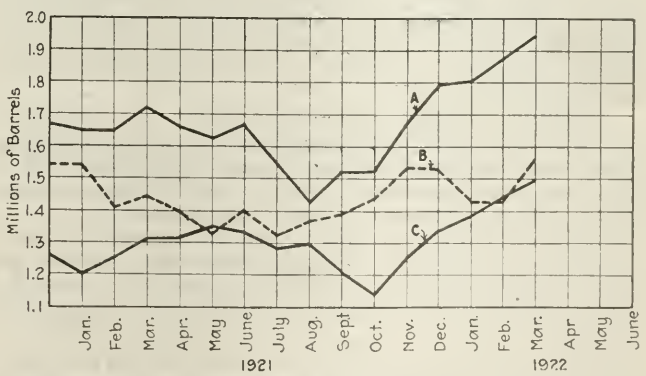
This week	**160.20**
Last week	159.77
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

This week's index number shows a net gain of 0.43 due primarily to the increase in the price of crude cottonseed oil, caustic soda and saltcake. Slightly lower prices were reported for 66 deg. sulphuric acid, ammonium sulphate, caustic potash and aniline oil but the cumulative effect was not sufficient to offset the upward tendency of the index number.

Record Petroleum Production During March and April

During the month of March the petroleum industry set new high records in all directions. The production of crude oil totaled 46,916,000 bbl., which may be compared with the previous record output last January of 43,141,000 bbl. Consumption of crude oil amounted to 48,840,000 bbl., which makes it the highest on record. The previous maximum was in August, 1920, with a total of 48,732,000 bbl. Imports amounted to 14,004,000 bbl. which have been exceeded only once—viz., in November, 1920, with a total 14,136,000 bbl.

The huge production, combined with heavy imports, re-



MONTHLY CHANGES IN DAILY AVERAGE RATE OF—

(*A*) Domestic production of petroleum plus imports of crude oil.
(*B*) Estimated consumption of domestic and imported petroleum.
(*C*) Domestic production (petroleum transported from producing properties).

(Data from U. S. Geological Survey)

sulted in an increase of 12,000,000 bbl. in stocks, in spite of the heavy consumption. Stocks amounting to 220,233,000 bbl. are far in excess of anything heretofore recorded.

Apparently, however, there will be a slight recession during April. The American Petroleum Institute's estimated daily average for the 4 weeks of that month have been as follows:

	Week Ended			
	April 8	April 15	April 22	April 29
Oklahoma	365,000	363,200	363,500	374,350
Kansas	81,500	81,000	82,200	82,000
North Texas	52,100	52,300	52,250	52,300
Central Texas	168,150	153,800	149,950	149,300
North Louisiana and Arkansas	141,200	128,450	120,150	118,750
Gulf Coast	114,100	114,950	111,650	114,600
Eastern	115,000	115,000	118,000	118,500
Wyoming and Montana	70,900	72,150	69,050	71,900
California	325,000	330,000	330,000	330,000
Total	1,432,950	1,410,850	1,396,750	1,411,700

Synthetic Organic Chemicals

The striking expansion that has occurred during the last 4 years in the manufacture and distribution of synthetic organic chemicals for scientific and industrial research is evidenced by the fact the recent price list of the Eastman laboratories contains the names of approximately 1,300 different compounds. One interesting innovation in the present list is the inclusion of the melting points, boiling ranges and other purity criteria for the larger share of the chemicals. Such data are of special value to most of the users of these products and should have the effect of encouraging improved quality and higher standards of purity in this line of chemical manufacture.

The New York Market

New York, May 15, 1922.

The chemical market has been noticeably steady during the past week and aside from slightly easier prices for one or two minor commodities, the general list has undergone no important declines. One of the leading features of the week's trading was the pronounced interest in solid caustic soda for export. Standard brand material is extremely scarce and outside brands have brought $3.80 per 100 lb. for July shipment. The demand for oxalic acid has increased materially and the market was sharply advanced on spot and at the works by leading factors. Prussiate of soda has recorded an additional advance, with the consumers showing an increased interest. Other prussiates remain in the same firm position as previously reported. Bichromates have been neglected of late and both the soda and potash salts are slightly easier on spot. Barium chloride has eased off somewhat and prices were a shade lower in several directions. Carbonate of potash has been in fair demand. Copper sulphate is still very active, with prices quite firm on prime material. Tin oxide was reduced 2c. per lb. by makers. A slightly easier feeling was noted on caustic and permanganate of potash.

General Chemicals

Arsenic—Small-lot trading is about the best way to characterize this market. Prominent factors quote spot and prompt shipment of prime white powdered at 7@7½c. per lb. The red variety is quoted around 11½@12c. per lb. The general demand is not up to the expectations of the manufacturers.

Aluminum Sulphate—The demand for the commercial variety has improved considerably and several large tonnage sales have been made by first hands at $1.50 per 100 lb. The iron-free is quoted at $2.50 per 100 lb. Imported material is quoted at the same price as the domestic.

Bichromate of Potash—Spot goods are offered at 9¼@10c. per lb. by second hands, while producers quote 9¾@10c. per lb. for prompt shipment. Trading is generally quiet in this item, with first hands getting practically all of the passing business.

Bleaching Powder—Leading sellers are holding the market at $1.60 per 100 lb., f.o.b. works, in large drums. Export containers have been sold at lower levels and $1.40 per 100 lb. was quoted in some directions. Trading is generally quiet.

Caustic Soda—There has been no let-up from the firm position of this product. The export demand is extremely strong, with only a few odd lots available for early shipment. Prices are quoted around $3.90 per 100 lb. f.a.s. Outside brands can be bought a shade under this price, although some factors are reported sold up through July. Quotations at the works for contracts remain quotably unchanged.

Copperas—Producers offer prime green crystals at $20 per ton. The demand is rather quiet in all directions and the market has uncovered no features of interest.

Citric Acid—There were sales recorded at 45@46c. per lb., depending upon the quantity and seller. The demand is only moderate. Offerings were not heavy and leading dealers are looking for a stronger market with the coming hot weather.

Fluoride of Soda—Producers quote 9c. per lb. as the low figure for this material and up to 10c. per lb. for smaller quantities. The market is about up to the expectations of the manufacturers, with small lots featuring.

Oxalic Acid—Prices have been sharply advanced on this product. The best quotation heard late in the week was 13c. per lb. f.o.b. works. Spot goods were quoted at 13¾@14c. per lb. Several large sales were reported during the advance and the general demand has shown considerable improvement.

Prussiate of Soda—Higher prices have been established for this material and the market closed firm at 18¾c. per lb. on spot. Offerings have noticeably decreased and this has given additional strength to the item. Shipment material is higher, with sellers asking 18½@18¾c. per lb.

Vegetable Oils

Linseed Oil—The market for this commodity was very firm in the early trading, but was rather quiet during the latter part of the week. Leading crushers named 90c. per gal. for raw oil, in carload lots, shipment over the next 4 months. Oct.-Nov.-Dec.-contracts ranged from 92@93c. per gal. Large consumers seem to have filled requirements for nearby oil and it is believed that trading may show some brief signs of weakness. Foreign oil sold at 83c. per gal., duty paid, May shipment.

Castor Oil—Trading was somewhat quieter although prices ruled steady in sympathy with the strong seed market. Quotations remained unchanged on both the AA and No. 3 grades.

Coconut Oil—Business during the interval has been less active than in the previous week, but there were several inquiries in the market for forward delivery oil and the general condition was somewhat firm. Ceylon type oil, May-June shipment from the coast, in sellers' tanks, was offered at 7½c. per lb., May-June shipment from N. Y. at 8c. per lb., sellers' tanks. Ceylon in barrels, carload lots, sold at 8¾c. per lb.

Palm Oils—The market for lagos oil was dull and prices were unsettled. There were sellers at 7⅛@7¼c. per lb., c.i.f. N. Y. Niger oil was quoted at 6⅛@6¼c., per lb., c.i.f.

The St. Louis Market

St. Louis, May 11, 1922.

The volume of business transacted for the first 10 days of this month has been very gratifying, and dealers expect that there will be a material increase in the demand for industrial chemicals as well as for fine chemicals during the next few weeks.

Prices generally are firm and advances have far exceeded the number of declines for some few weeks. One of the chief reasons for the firming up of the market is that the foreign competitor has found it necessary to increase his prices, thereby eliminating price disturbances.

Alkalis

Caustic soda remains normal in price, with a routine demand, no great volume of business having been reported. *Soda ash* has been quoted in this market as low as $2.15 per 100 lb. in bags, $2.35 per 100 lb. in barrels, though the prevailing price is around $2.20 and $2.40 respectively. Carload prices range around $2 per 100 lb. f.o.b. purchaser's

door. *Sal soda* continues to maintain a steady price with a good demand. *Sodium bicarbonate* is being handled rather recklessly by jobbers in this market, prices ranging from $2@$2.25 per 100 lb. in 5-bbl. lots.

General and Special Chemicals

One of the heavy *mineral acid* manufacturers reports a very good undertone in spite of the fact that the steel mills are greatly hampered in their operations by the present coal strike, and if it were not for this hindrance the acid market today would be a booming one. Prices are firm with no surplus stocks. In our last report it was stated that an advance in *citric acid* would not prove surprising, but to date this increase has not taken place. However, we believe that an advance in price ought to come, because there is a scarcity of stocks and foreign goods are now being held at a higher figure. Furthermore, there will be a much greater demand in the immediate future from the soft drink manufacturers. *White arsenic powder* is firm at 6½@7c. f.o.b. New York, with the demand very quiet and a scarcity of stock. *Solid calcium chloride* is now being quoted in 1- and 5-drum lots at $1.60 per 100 lb. f.o.b. St. Louis, with a differential of 5c. per 100 lb. in lots of 5 to 10 drums; the granular at $1.90 per 100 lb. f.o.b. St. Louis in lots of 1 to 6 drums, with a differential of 5c. per 100 lb. in lots of 7 to 15 drums. *Carbon bisulphide*, being one of the chemicals used as an insecticide, is commanding a prominent position and undoubtedly will continue to hold same for some time. *Glycerine* is a weak sister on the market at the present. The new price of 15c. has not stimulated buying and 14½c. has been quoted on firm orders. *Zinc sulphate* is now holding at $2.85@$2.90 per 100 lb. f.o.b. St. Louis and the market is stiffening in keeping with the advance in *zinc spelter*, which has increased approximately $15 per ton within the last 60 days. It is interesting to observe that for the first time since the close of the World War there has been a large demand for zinc from European countries. There is also a good demand for *zinc dust* originating from the dye manufacturers, and prices on this commodity are also stiffening in line with the spelter.

Vegetable Oils and Naval Stores

Linseed oil has recovered its full strength and producers are in a firmer position today than they have been for some time. On April 13 linseed oil was reported in this column at 86c. basis raw oil; today it is quoted at $1.07. *Turpentine* has gone as low as 85c. and as high as 96c. *Castor oil* has advanced ½c. and now is in good demand at 12¾c. in quantities of 200 gal., with an advance of 1c. for less quantities.

The Iron and Steel Market

PITTSBURGH, May 12, 1922.

The monthly report of steel ingot production was awaited with unusual interest, as estimates of the producing rate could not be made in April with the usual facility, since the coal strike caused curtailment of pig iron and therefore of steel production at some points, while there were increases at other points, not affected by the coal strike. Estimates made in these reports recently, that ingot production was running at a rate between 36,000,000 and 38,000,000 tons a year, are confirmed. From the report of production in April on the thirty companies that make monthly returns it may be computed that the average rate during April was 36,600,000 tons, with a probable error of a few hundred thousand tons. In January, February and March there were continuous and sharp increases, and March, with an average rate of 32,500,000 tons, as shown by the report for the month, probably opened with a 30,000,000-ton rate and closed with a 35,000,000-ton rate. Thus production must have increased somewhat during April, despite the coal strike, the gains overbalancing the losses.

Mills Adapting Themselves to Conditions

The mills and furnaces affected by the coal strike have done good work in promptly adapting themselves to the suddenly imposed condition. Coal has been bought in various markets, some of them quite distant, Kentucky figuring prominently. Not the least spectacular of the unusual movements is the bringing of beehive coke from Sloss ovens in Alabama to Steel Corporation furnaces in Ohio. At several steel plants piles of pig iron, regarded a few months ago as a drug on the market, are being used. The steel works in the Pittsburgh district are certainly not reduced to extremities, for there has not been a purchase of heavy melting steel by a consumer in the district for nearly 2 weeks, although the price done in the last purchases, $17.50, is far from prohibitive.

Prospects are that steel production, on the whole, will increase somewhat in the next few weeks. There is no sign that it will decrease from stocks of coal being exhausted, for the steel industry is obtaining, by various means, a great deal of coal. The Mingo plant of the Carnegie Steel Co., which was closed early in April, is resuming operations. The full rating of the plant is 600,000 tons of ingots a year.

Steel Market Strong

The steel market, as a market, is very strong, and is altogether in favor of sellers. Consumers who 2 months ago were reserved about buying are now urging the mills to accept additional orders and contracts. In some instances third quarter and even fourth quarter contracts are offered, the mill to name prices later. Premiums for early deliveries are occasionally offered.

Not a few of the independents' mills have advanced their asking prices and are able to make some sales at the advances. The Steel Corporation has made no regular advances, but in bars, shapes and plates is getting a slightly higher average than a week or two ago. In these products the tonnage and character of specifications have something to do with the price.

The market is still quotable at the regular prices named in the past few weeks, but in most products there are some sales at higher prices, in the case of less desirable orders or of prompt deliveries. Regular prices are: Bars, shapes and plates, 1.50c.; bands, hoops and hot-rolled strips, 2c.; standard steel pipe, 71 per cent basing discount; blue annealed sheets, 2.40c.; black sheets, 3.15c.; galvanized sheets, 4.15c.; automobile sheets, 4.50c.; tin plate, $4.75; plain wire, 2.25c. On nails there are two prices, the Steel Corporation's price of $2.40 and the independent price of $2.50.

Sheet bars are now quotable at $35, there being no possibility of less being done, while there are no regular offerings even at $35. At the March price of $29 sheet mills did not buy more than enough to cover their sales of sheets at old prices, based on 3c. for black, hence there is a disposition to ask more than the present market of 3.15c., with sheet bars $6 a ton higher.

Coal and Coke

Connellsville coal has advanced sharply, chiefly on account of Eastern buying, and is now quotable at $3.25@$3.50 for steam grade. Connellsville coke is quotable at $6.50 for furnace and $6.75 for foundry, with limited offerings and limited demand.

One or two sales of basic pig iron are reported at $25 valley, or $1 over last week's nominal quotation. One merchant furnace now quotes this price, not being entirely out of the market as formerly, and names $26 on bessemer. Foundry remains quotable at $24. Inquiry is quite limited.

Steel Corporation Tonnage

With only trifling exceptions the Steel Corporation's unfilled obligations decreased month by month from 11,118,468 tons on July 31, 1920, to 4,141,069 tons on Feb. 28, 1922. In some months early in 1921 the decrease in a month was almost equal to the shipments, there being scarcely any bookings. Last March the unfilled obligations increased by 353,079 tons, while April showed an increase of 602,769 tons. The March increase represented 25 per cent of a month's capacity, while the shipments were about 65 per cent, making the bookings about 90 per cent of capacity. In April shipments were about 70 per cent of capacity and the increase in unfilled tonnage 45 per cent, making the bookings about 115 per cent. The bookings are chiefly for relatively early delivery, there being not much construction work involving very extended deliveries.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 38 – $0.40
Acetone	lb.	$0 08 – $0 09	09½– 10
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9.25 – 9 50	9 75 – 10 25
Boric, crystals	lb.	.11 – .11½	.11¾– .12
Boric, powder	lb.	.11– .11½	.11¾– 12½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1.10 – 1 20	1.25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – 11½	.11¾– 12
Lactic, 44 per cent tech	lb.	.09½– 10	.10½– .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½– .05
Molybdic, c.p.	lb.	3.00 – 3.25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06 – .06½	.06¾– .07
Nitric, 42 deg.	lb.	.06½– 06¾	.07 – .07¼
Oxalic, crystals	lb.	.13 – 13½	13¾– .14
Phosphoric, 50 per cent solution	lb.	.08 – 08½	08¾– 09½
Picric	lb.	.22 – 24	24½– .30
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	16 00 – 16 50	..... – .....
Sulphuric, 66 deg., drums	ton	20 00 – 20.50	21 00 – 22 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33 00 – 34.00
Tannic, U. S. P.	lb.	..... –	60 – 75
Tannic (tech.)	lb.	.40 – .45	46 – .50
Tartaric, imported crystals	lb.	..... –	.27 – .28
Tartaric acid, imported, powdered	lb.	..... –	.28 – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 4.95
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½– .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¾– .04	.04¼– .05
Alum, chrome lump	lb.	.07½– 08	08¼– 08½
Aluminum sulphate, commercial	100 lb.	1.50 – 1.65	1 70 – 2.25
Aluminum sulphate, iron free	lb.	.02½– .02¾	03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07¼– .07¾	08 – 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07½	.07½– .08
Ammonium nitrate	lb.	.06 – .06½	.06¾– .07½
Amylacetate tech	gal.	..... –	2.00 – 2 25
Arsenic, white, powdered	lb.	.07 – .07½	.07½– 08
Arsenic, red, powdered	lb.	12 – 12½	12½– .13
Barium chloride	ton	103.00 –105.00	106.00 –110 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21¼– .22
Barium nitrate	lb.	.06½– .07	.07¼– .08½
Barium sulphate (precip.) (blanc fixe)	lb.	.03½– .04	.04¼– .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55.00	..... – .....
Bleaching powder	100 lb.	1.60 – 1.75	1.80 – 2.75
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05¼– .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½– .35
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½– .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27.00
Calcium chloride, granulated	lb.	.01½– .01¾	.02 – .02½
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.79 – .81
Carbon bisulphide	lb.	.06½– .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.09½– 10	.10½– .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½– .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½– .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½– .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.05¾– .06
Chloroform	lb.	..... –	.35 – .37
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	20 00 – 22.00	23.00 – 30.00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½– .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	5.50 – 5 60	5.65 – 6.15
Cream of tartar	lb.	..... –	.25 – .26
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.08½– .09	.09½– .10
Fullers earth, f.o.b. mines	net ton	16.00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30.00 – 32.00	..... – .....
Fusel oil, ref	gal.	..... –	2.15 – 2 50
Fusel oil, crude	gal.	..... –	1.30 – 1.50
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.15 – .15½
Iodine, resublimed	lb.	..... –	4.05 – 4.15
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09⅝– .12
Lead arsenate, powd	lb.	.14 – .14½	.14¾– .15½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07¾– .08	.08½– .09
Magnesium carbonate, technical	lb.	.08 – .08½	.08¾– .09
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2.60	2 65 – 2.85
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1.80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phogene (see carbol chloride)		..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.09½– .10	.10⅛– .10½
Potassium bromide, granular	lb.	..... –	.17 – .20
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – .05½	.05½– .06
Potassium chlorate, powdered and crystals	lb.	.06½– .06¾	.07 – .08¼
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6.00 – 6.25	6.30 – 7.00
Potassium iodide	lb.	..... –	3.10 – 3.15
Potassium nitrate	lb.	.07⅜– .07½	.08 – .09
Potassium permanganate	lb.	14 – .15	.15½– .22
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	28½– .29	.29¼– .29½
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07½– .08
Salammoniac, gray, granular	lb.	.07¼– .07½	.07⅝– .08
Salsoda	100 lb.	1.40 – 1.45	1.50 – 1.80
Salt cake (bulk)	ton	20.00 –25.00	..... – .....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.90 – 2.00	2.10 – 2.50
Soda ash, dense	100 lb.	1.95 – 2.05	2.10 – 2.60
Sodium acetate	lb.	.05 – .05¼	.05½– .06
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07¼– .07½	.07¾– .08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½– .04¾	.04¾– .05¼
Sodium chlorate	lb.	.06 – .06½	.06¾– .07
Sodium chloride	long ton	12 00 –13 00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½– .25
Sodium fluoride	lb.	.09 – .09½	.09¾– .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.90 – 3.95	4.00 – 4.25
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03¼	.03½– .03¾
Sodium nitrite	lb.	.08¾– .09	.09¼– .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½– .04	.04¼– .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.18½– .19	.19¼– .19½
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.25
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	1.00 – 1.15	1.20 – 1.50
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04½– .04⅝	.04⅞– .05½
Sodium sulphite, crystals	lb.	.03½– .03⅝	.03¾– .04¼
Strontium nitrate, powdered	lb.	.09½– .10	.10¼– .12
Sulphur chloride, yellow	lb.	.04½– .05	.05½– .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30.00 –40.00	..... – .....
Talc—domestic powdered	ton	18.00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09¼– .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14¾– .15½
Zinc chloride, gran	lb.	.05½– .06	.06½– .06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½– .08	.08¼– .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.15 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.55 — .57
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00½
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.25 — .27
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½— .07
Naphthalene, balls	lb.	.08 — .08½
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17½
Ortho-amidophenol	lb.	2.50 — 2.60
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	.12 —	.15
Ortho-toluidine	lb.	.16 —	.20
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.14 —	.16
Paranitroaniline	lb.	.75 —	.77
Para-nitrotoluene	lb.	.60 —	.70
Para-phenylenediamine	lb.	1.50 —	1.55
Para-toluidine	lb.	1.05 —	1.15
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	.15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls.	lb.	.25 —	.25½
Salicylic acid, U. S. P.	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal.	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal.	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Quotations same as previous report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.15 —	$5.20
Rosin E-I	280 lb.	5.25 —	5.30
Rosin K-N	280 lb.	5.35 —	6.50
Rosin W. G.-W. W.	280 lb.	7.00 —	7.25
Wood rosin, bbl.	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.93 —	93½
Wood turpentine, steam dist.	gal.	.85 —	....
Wood turpentine, dest. dist.	gal.	.70 —	.70
Pine tar pitch, bbl.	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	10.00
Retort tar, bbl.	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.90
Pine oil, pure, dest. dist.	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.65 —	3.75
Blood, dried, f.o.b., N. Y.	unit	3.55 —	3.65
Bone, 3 and 50, ground, raw	ton	27.00 —	28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.85 —	2.90
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	3.75
Tennessee, 78-80%	ton	7.00 —	7.50
Potassium muriate, 80%	ton	31.00 —	33.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Prices remain same as report of May 10.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.10¼ —	$0.10½
Castor oil, AA, in bbls.	lb.	.11½ —	.12
China wood oil, in bbls.	lb.	.14 —	.14¼
Coconut oil, Ceylon grade, in bbls.	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls.	lb.	.09¼ —	.09½
Corn oil, crude, in bbls.	lb.	.11 —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	.10 —	.10¼
Cottonseed oil, summer yellow	lb.	.12½ —	.12¾
Cottonseed oil, winter yellow	lb.	.13½ —	.13¾
Linseed oil, raw, car lots (domestic)	gal.	.90 —	.91
Linseed oil, raw, tank cars (domestic)	gal.	.86 —	.87
Linseed oil, in 5-bbl lots (domestic)	gal.	.93 —	.94
Olive oil, denatured	gal.	1.15 —	1.17
Palm, Lagos	lb.	.07¼ —	.07½
Palm, Niger	lb.	.06⅛ —	.06¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls.	lb.	.12¾ —	.13
Rapeseed oil, refined in bbls.	gal.	.83 —	.84
Rapeseed oil, blown, in bbls.	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.09¾ —	....

FISH

Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All prices remain quotably unchanged.

Refractories

Quotations same as previous report.

Ferro-Alloys

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 76-80% Mn, domestic	gross ton	67.00 —	69.00
Spiegeleisen, 18-22% Mn	gross ton	34.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	56.00 —	58.00
Ferrosilicon, 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.00 —	3.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$6.00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19.00 —	20.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19.00 —	20.00
Coke, foundry, f.o.b. ovens	net ton	6.75 —	7.00
Coke, furnace, f.o.b. ovens	net ton	6.25 —	6.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	12.00 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.26½ —	.27
Manganese ore, chemical (MnO_2)	net ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.47 —	.50
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13 —	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.50 —	2.75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	2.75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13¼

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.00
Aluminum, 98 to 99 per cent.	19.00
Antimony, wholesale lots, Chinese and Japanese	5.50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	30.625
Lead, New York, spot	5.25
Lead, E. St. Louis, spot	5.125
Zinc, spot, New York	5.525–5.55
Zinc, spot, E. St. Louis	5.025–5.05

OTHER METALS

Silver (commercial)	oz.	$0.70½
Cadmium	lb.	1.15–1.20
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.05
Platinum	oz.	85.00
Iridium	oz.	150.00@170.00
Palladium	oz.	50.00@ 55.00
Mercury	75 lb.	55.00

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—The Rose City Cotton Oil Mill Co. is planning for the rebuilding of the portion of its plant, recently destroyed by fire, with loss estimated at about $45,000. Alfred Kahn is general manager.

FORT SMITH—The Twin City Glass Co. has commenced the construction of its proposed local plant, with main building 50x100 ft., to be equipped for the manufacture of bottles and other glass containers. It is proposed to commence production late in June, giving employment to about 100 operatives. Harry Hart is president.

California

GLENDALE—The International Chemical Products Co., 710 East Broadway, has awarded a contract to the R. L. Kent Co., 130 South Brand Blvd., for the construction of a first unit for a new plant on property recently acquired on West Colorado St., comprising about 2½ acres of land. The structure will be 2-story, 25x100 ft., and will be supplemented with other units at a later date. The plant will be equipped for the manufacture of special printing inks and kindred products. George W. Strang is general manager.

Connecticut

ELMWOOD—The Park Brick Co., Elmwood, near Hartford, is considering plans for the rebuilding of its plant, destroyed by fire April 29, with loss approximating $150,000, including equipment.

Idaho

CŒUR D'ALENE—The Callahan Zinc-Lead Co., 61 Broadway, New York, N. Y., is reported to be planning for the purchase of local property, for which negotiations are now under way, for the establishment of a new plant. The company has secured options on the property of the Marsh Mining Co., in the Hecla district, and proposes extensive operations in this section.

Illinois

ROCK ISLAND—The Service Rubber Co., 401 Central Trust Bldg., has plans nearing completion and will take bids late in May for the construction of a new 3-story plant, 60x300 ft., on local site, estimated to cost about $100,000 with machinery. Cervin & Horn, 311 Safety Bldg., are architects. J. T. Crowley heads the company.

Indiana

ELWOOD—The Macbeth-Evans Glass Co., Chamber of Commerce Bldg., Pittsburgh, Pa., is completing plans for extensions and improvements in its local plant to cost about $35,000. Work will be commenced at an early date.

GARY—The National Tube Co., Frick Bldg., Pittsburgh, Pa., a subsidiary of the United States Steel Corp., has plans nearing completion for the construction of its proposed new plant on the Lake Front, Gary, recently authorized by the parent organization; work will begin at an early date. The new steel mill will consist of a series of buildings, estimated to cost close to $15,000,000, with machinery. William B. Schiller is president; R. C. Patterson is chief engineer in charge.

Iowa

MARSHALLTOWN—The City Council has preliminary plans under way for the construction of a new filtration plant at the municipal waterworks. O. G. Herm is city engineer.

Louisiana

STERLINGTON — The Federal Petroleum Co., Monroe, La., has acquired property on the Ouachita River, Sterlington, for the construction of a new assembling and distributing plant. The company purposes extensive operations in this vicinity, and will develop a large refined oil output.

MONROE—The Southwest Pulp & Paper Co., 342 Madison Ave., New York, N. Y., will take bids during June and July for considerable equipment for installation at its proposed new plant on the Monroe-Columbia Highway. The initial works will aggregate about 70,000 sq.ft., and will be equipped for an output of approximately 100 tons of refined pulp per day. A power plant will also be erected. The new mill is estimated to cost close to $250,000. Joseph G. Mayo is president and managing director, with headquarters at 206 Broadway, Norwich, Conn.

Maryland

EASTON—The New Brick & Tile Co., Moreland Bldg., recently organized with a capital of $50,000, will take bids at once for the construction of its proposed new 1-story plant on local site for the manufacture of brick, drain tile and other burned clay products. It will cost about $42,000, including equipment. J. Fletcher Clark is secretary and treasurer.

BALTIMORE—The Baltimore Gas Appliance & Mfg. Co., Bayard and Hamburg Sts., is considering plans for the construction of an addition to be equipped as a porcelain-enameling department. H. W. Hunter is president.

Massachusetts

CAMBRIDGE—The Whittemore Brothers Corp., Albany St., has awarded a contract to the Scully Co., East Cambridge, for the rebuilding of the portion of its polish manufacturing plant, recently destroyed by fire. The new structure will cost approximately the amount of the fire loss, $65,000, and work will be commenced at once.

Michigan

BENTON HARBOR—The City Council has plans under way for the construction of a new filtration plant at the municipal waterworks. Pearce, Greeley & Hansen, 39 West Adams St., Chicago, Ill., are engineers.

DETROIT—The Detroit Sand Lime Brick Co., 507 Vinton Bldg., will soon commence the construction of its proposed new plant on property lately acquired on the Oakwood side of the River Rouge, comprising about 16 acres of land. The main structure will be 125x400 ft. A portion of the machinery installation will be of special type. William Niemann is secretary and treasurer.

Mississippi

WOODVILLE—The Dampf & Morgan Co. has acquired the property of the Woodville Oil Mill, and plans to convert the structure for a paper mill. Plans are being prepared for a number of improvements and alterations.

New Jersey

TRENTON—Lenox, Inc., Mead St., manufacturer of fine chinaware, has awarded a contract to the Karno-Smith Co., Trenton, for the erection of a 1-story building at its plant.

PASSAIC—The Paterson Parchment Paper Co., 6th St., has commenced the erection of a new 2-story plant extension, 40x120 ft., to be used for general operating service. It will cost about $50,000. The Solomon-Abbott Co., 175 Fifth Ave., New York, N. Y., is engineer.

PATERSON—Fire, May 1, destroyed a portion of the plant of the Olive Oil Soap Co., 85 Fulton St., with loss reported in excess of $100,000, including building, equipment and materials.

New York

POUGHKEEPSIE—The Corrugaed Rubber Co., 25 West 43rd St., New York, will take bids at once for the erection of the first unit of its proposed plant in the Fairview section, Poughkeepsie, to be 1-story, 60x200 ft., and estimated to cost about $90,000, including machinery. W. L. Fairchild is general manager. W. J. Beardsley, 49 Market St., Poughkeepsie, is architect.

NEW YORK—The American Smelting & Refining Co., 120 Broadway, is arranging an appropriation of $750,000, for extensions and betterments at its Colorado properties, including the installation of new equipment. The work will include the construction of an addition to the smelting plant at Durango, to cost approximately $250,000, and improvements in the Rawley properties near Salida, to cost $100,000.

OLEAN—The Vacuum Oil Co., 61 Broadway, New York, will commence the immediate erection of the superstructure at its plant additions at Olean, comprising a number of buildings, estimated to cost about $500,000, including equipment. The White Construction Co., 95 Madison Ave., has the building contract.

BROOKLYN—A. Aron, 335 Johnson Ave., has awarded a contract to Thomas Drysdale, 250 Baltic St., for the erection of a 3-story fat rendering plant, 50x70 ft., estimated to cost about $25,000. Joseph Himmelsbach, 136 Liberty St., New York is engineer.

ENDICOTT — The Binghamton Limestone Co., care of the Kellogg-Jones Co., O'Neill Bldg., Binghamton, has preliminary plans under way for the erection of a new plant on site selected at Endicott, for the manufacture of brick and kindred products.

North Carolina

CHARLOTTE—The Virginia-Carolina Chemical Co., Richmond, Va., has plans under way for the erection of a new local plant for the manufacture of fertilizer products.

Ohio

SALEM — The Sumatra Rubber Specialty Co., recently organized, has acquired a local building and will install machinery at once for the manufacture of rubber goods of various kinds.

YOUNGSTOWN — The Newton Steel Co., manufacturer of steel sheets, etc., is considering tentative plans for the construction of a series of new sheet mills, comprising about 6 individual units, estimated to cost about $750,000 with machinery.

LANCASTER—The Fairfield Glass Co. has preliminary plans under consideration for the construction of a new local plant for window glass manufacture, consisting of a number of buildings, estimated to cost in excess of $2,000,000. Leopold Hambourg is general manager.

CLEVELAND—The Industrial Fibre Co. of America, Waldorf Ave., S. W., and West 98th St., has filed plans for the erection of a 3-story and basement addition, 84x100 ft., estimated to cost about $60,000. Work will be placed under way at once.

Oklahoma

SHIDLER — The Phillips Petroleum Co., Bartlesville, has work nearing completion on a new gasoline-extraction plant, estimated to cost close to $1,000,000, and forming one of the largest works of its kind in the country. Operations will be commenced in the first 13 units at an early date; more units will be constructed at a later date, with installation to comprise gas engines, air compressors, etc.

Pennsylvania

PITTSBURGH—The Fleischmann Co., 701 Washington St., New York, N. Y., has acquired property at Western and Allegheny Aves., 75x192 ft., for a consideration of $25,000, as a site for the erection of its proposed new yeast-manufacturing plant, to be 3-story and estimated to cost about $100,000, including equipment. It is planned to commence construction early in the summer.

PHILADELPHIA—The Powers-Weightmann-Rosengarten Co., Moore and 35th Sts., manufacturer of chemicals, has filed plans for the erection of an addition to its plant, 2-story, 42x80 ft., estimated to cost about $16,000.

NEW CUMBERLAND—The New Cumberland Paper Co. will commence the immediate erection of a new 1-story plant on local site, 60x90 ft. The building contract has been let to Harry Hollacher, New Cumberland.

PHILADELPHIA — The Nustone Products Corp., 3450 Richmond St., manufacturer of sanitary products, ware, etc., has awarded a contract to John M. Yardley, 1716 Samsom St., for the erection of a new 1-story plant, 140x192 ft., on Schiller St., near Allen Ave. Work will be commenced at once. Ritter & Shay, North American Bldg., are architects.

Tennessee

GALLATIN—The City Council has plans under way for the construction of a new

filtration plant at the waterworks. W. H. Blyce, First National Bank Bldg., is consulting engineer.

Texas

LUBBOCK — The Quanah Cotton Oil Co. has completed plans for the first buildings for its new cotton oil mill, and will commence erection at an early date. The plant will be of 4-press type. Other units will be constructed at a later time.

MARSHALL—The Marshall Brick Co. will commence the immediate installation of new machinery at its plant for the manufacture of dry-pressed brick, forming a new department for this branch of production. The initial capacity will be about 20,000 bricks per day, and which will be increased at a later date.

SHERMAN—The oil refinery of the Buffalo Oil & Producing Co., South Sherman, has been acquired by F. M. Thompson, C. C. Mayhew and associates, all of Sherman, at a receiver's sale. The new owners will organize a company and operate the plant. A number of improvements will be made.

Virginia

NORFOLK—The Robertson Fertilizer Co. has awarded a contract to the Chemical Construction Co., Charlotte, N. C., for the rebuilding of its plant at Money Point, destroyed by fire several months ago. Work will be placed under way at once.

Washington

KENNYDALE—The Republic Creosoting Co. is arranging for the immediate rebuilding of the portion of its plant on Lake Washington, recently destroyed by fire. F. C. Powell is general manager.

West Virginia

THOMAS—The City Council is planning for the installation of a new waterworks system, including a filtration plant. Bonds will soon be voted.

CHARLESTON — The Warner - Klipstein Chemical Co., comprising a recent merger of the Warner Chemical Co. and the E. C. Klipstein & Sons Co., has plans under way for extensions in its plant for considerable increase in capacity. F. J. Kaufman is resident manager.

Capital Increases, etc.

THE CENTRAL GLASS WORKS, INC., Charleston, W. Va., has filed notice of increase in capital from $500,000 to $600,000.

THE SPECIALTY RUBBER WORKS, Hackett St., Newark, N. J., has filed notice of change of name to the Goodyear Rubber Mfg. Co.

THE PLANTATION CONSOLIDATED OIL CORP., Bowling Green, Ky., has filed notice of increase in capital from $150,000 to $350,000.

THE UNION OIL CO. OF CALIFORNIA, Union Oil Bldg., Los Angeles, Cal., is disposing of a bond issue of $10,000,000, the proceeds to be used for general operations, financing, expansion, etc. W. L. Stewart is president.

THE SIZER STEEL CORP., Buffalo, N. Y., has arranged for a bond issue of $1,250,000, the proceeds to be used for general expansion, operations, etc. The company has recently acquired the plant of the Hammond Steel Co., Syracuse, N. Y. C. B. Porter is president.

THE NATIONAL ZINC CO., 61 Broadway, New York, N. Y., has filed notice of dissolution under state laws.

THE DIXIE BELL REFINING CO., Louisville, Ky., has filed notice of change of name to the Louisville Refining Co., to operate oil refineries.

THE AMERICAN WOODPULP CORP., 347 Madison Ave., New York, N. Y., has filed notice of increase in capital from $70,000 to $370,000.

THE HURRICANE IRON & MINING CO., Columbia, Tenn., has filed notice of increase in capital from $60,000 to $100,000.

COSDEN & CO., 120 Broadway, New York, operating oil refineries in the mid-continent field, Okla., has arranged for a preferred stock issue of $3,252,900, the proceeds to be used for general operations, expansion, financing, etc.

The receiver for the ZEE ZEE RUBBER CO., Yardville, N. J., is arranging for the sale of the plant of the company.

THE LAMBERSON JAPANNING CO., 2334 West Kinzie St., Chicago, Ill., has filed notice of increase in capital from $5,000 to $150,000.

The receiver for the STOCKTON RUBBER CO., Trenton, N. J., will dispose of the plant and property of the company.

New Companies

THE JOHNSON PRODUCTS CO., Newark, N. J., has been incorporated with a capital of $500,000, to manufacture celluloid specialties and other composition products. The incorporators are Frank E., Horace C., Jr., and Charles J. Johnson, 138 Paris St.

THE OVERBROOK GLASS BOTTLE CO., Jeannette, Pa., has been incorporated with a capital of $50,000, to manufacture glass products. S. H. Grimes, Jeannette, is treasurer.

THE ALLEN RUBBER CO., Boston, Mass., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture rubber goods. Charles Langmaid is president; and Max Laserson, Fabyan St., Dorchester, Mass., treasurer.

THE LINN PRODUCTS CO., 125 South Jefferson St., Chicago, Ill., has been incorporated with a capital of $35,000, to manufacture soaps, washing powders, etc. The incorporators are Robert White, Leon Hamburger and Perrin C. Miller.

THE GREENVILLE PAPER CO., Greenville, S. C., has been incorporated with a capital of $20,000, to manufacture paper products. J. W. Keys is president; W. S. Mills, vice-president; and J. C. Keys secretary, all of Greenville.

EUGENE SUTER & CO., INC., New York, N. Y., has been incorporated with a capital of $400,000, to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are Eugene Suter, F. Russell and H. C. Tomlinson, Jr. The company is represented by A. C. Coxe, Jr., 15 Broad St., New York.

GRUESSNER'S, INC., New Brunswick, N. J., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Alexander and Anthony Gruessner, 4 French St., New Brunswick.

THE NAUGATUCK TIRE & RUBBER CO., Wilmington, Del., has been incorporated with a capital of $1,500,000, to manufacture automobile tires and other rubber products. The company is represented by the Corporation Service Co., Equiptable Bldg., Wilmington.

THE POPE CHEMICAL CO., Boston, Mass., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. Nicholas DuVally is president; and A. B. DuVally, 57 Cambridge St., Boston, treasurer.

THE TEXAS-MEXICAN OIL AND REFINING CO., Lardo, Tex., has been incorporated with a capital of $125,000, to manufacture refined petroleum products. The company has preliminary plans under way for the construction of a refinery on local site. J. N. Galbraith is president; Miles T. Cogley, vice-president; and J. N. Galbraith, Jr., secretary, all of Lardo.

THE GIRARD PAINT CO., Girard, O., has been incorporated with a capital of $25,000, to manufacture paints, varnishes, etc. The incorporators are J. H. Drage and F. H. Bushong, both of Girard.

THE ALUMINO THERMIC CORP., 15 Exchange Place, Jersey City, N. J., has been incorporated with a capital of $300,000, to manufacture chemicals and chemical byproducts. The incorporators are Hugh G. Spilsbury, Charles H. Hunter and Merle I. St. John.

THE CENTURY PAPER CO., Indianapolis, Ind., has been incorporated with a capital of $30,000, to manufacture paper products. The incorporators are H. A. Rowley, W. N. Gillett and Robert W. Fleischer, all of Indianapolis.

THE OIL PRODUCERS REFINING CO., New Castle, Del., has been incorporated under state laws, with a capital of $40,000, to manufacture refined oil products. The incorporators are M. M. Toner, New Castle; G. H. Reed and R. L. Spurgeon, Wilmington, Del. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia, Pa.

THE ASHLEY-BEHRENS MFG. CO., 8370 Grand River Ave., Detroit, Mich., has been incorporated with a capital of $20,000, to manufacture waxes, varnishes and kindred products. The incorporators are G. Leon Ashley, Wilbur J. Behrens and Norman F. Thomssen.

THE MONITOR PAINT & CHEMICAL CO., 88 North St., Boston, Mass., has filed notice of organization to manufacture chemical specialties. John V. O'Donnell heads the company.

THE HARLAND OIL CO., Wilmington, Del., has been incorporated under state laws, with capital of $1,000,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE L. & P. DENNIS & SON CO., 926 Main St., Crisfield, Md., has been incorporated with a capital of $100,000, to manufacture fertilizer products. The incorporators are E. Benson Dennis, James H. Sterling and William M. Wooster.

THE PARAMOUNT PAINT & VARNISH CO., Brooklyn, N. Y., has been incorporated with a capital of $5,000, to manufacture paints, varnishes, etc. The incorporators are S., V. and M. Isaacs. The company is represented by Levinson & Feinsod, 277 Broadway, New York.

THE NATIONAL INK WORKS, INC., Camden, N. J., has been incorporated with a capital of $100,000, to manufacture ink and affiliated products. The incorporators are Edward F. Dennis, Edmund Kirkbridge and Joseph A. McHenry, Jr. The company is represented by Rudolph S. Ayers, 428 Market St., Camden.

THE AMERICAN ANILINE WORKS, INC., Philadelphia, Pa., has been incorporated with a capital of $25,000, to manufacture chemicals, dyes and kindred products. G. L. Armour, 455 West End Ave., New York, N. Y., is treasurer.

THE GARDINER-MCKINNES CO., New York, N. Y., has been incorporated with a capital $121,000, to manufacture chemicals, chemical byproducts, paints, etc. The incorporators are B. and G. N. Gardiner and J. P. Green. The company is represented by Phillips & Abery, 41 Park Row, New York.

THE LOCAL REFINING CORP., Oklahoma City, Okla., has been incorporated with a capital of $20,000, to manufacture refined petroleum products. The i corporators are M. H. Davis, R. L. Edwards and D. B. Richardson, all of Oklahoma City.

THE JACKSON MFG. CO., Trenton, N. J., has been incorporated with a capital of $150,000, to manufacture leather products. The incorporators are Maurice and Saul Black. The company is represented by Alexander Trapp, 147 East State St., Trenton.

THE CRESCENT CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by Michael J. Cavanaugh and Frank E. Lanagan, 1041 Washington St., Boston.

THOMAS SEALY, INC., New York, N. Y., has been incorporated with a capital of $400,000, to manufacture chemicals, chemical byproducts, paints, etc. The incorporators are Thomas Sealy, W. J. Doyle and L. M. Vandolen. The company is represented by Pallister, Greene & O'Connell, 233 Broadway, New York.

THE RICHARDSON OIL CO., 102-104 South Front St., Quincy, Ill., has been incorporated with a capital of $50,000, to manufacture oil products. The incorporators are John T. and E. Dean Richardson, and James A. Johnson.

THE RUWART MFG. CO., Jefferson City, Mo., has been incorporated with a capital of $250,000, to manufacture leather products. The incorporators are Henry, Joseph E., and William Ruwart, all of Jefferson City.

THE PURITAN OIL & SOAP CO., Boston, Mass., has filed notice of organization to manufacture soaps, oils and affiliated products. Alfred Boggild, 215 Endicott St Boston, heads the company.

Industrial Notes

DWIGHT P. ROBINSON & CO., New York, announce that a contract has been awarded them for the construction of a building to accommodate American commercial exhibits at the Brazilian Centennial Exposition to be held in Rio de Janeiro beginning Sept. 7. The building, which will be the "unofficial" exhibit building, will be constructed of American materials as far as possible. It will be purely a commercial proposition, having no direct connection with the exhibition plans of the American Government under the appropriation of $1,00,000 made by Congress recently.

THE PFAUDLER CO., Rochester, N. Y., announces that on May 1 its New York office was moved to Room 1103, 8 West 40th St.

THE BETHLEHEM FOUNDRY & MACHINE CORP. announces that on May 1 it moved to Room 1716, Grand Central Terminal, New York City.

THE WESTINGHOUSE ELECTRIC & MFG. CO. announces the reorganization of the supply sales department and the establishment of a merchandising sales department, which are the major changes in the organization, according to announcement made recently by H. D. Shute, vice-president of the company. The changes, which entail the promotion and transfer of a number of officers,

were effective May 1, at which time the new merchandising sales department began to function. J. J. Gibson, manager of the supply sales department, becomes assistant to vice-president in the new plant of organization. In his new position Mr. Gibson will have general supervision over the activities of both the supply sales department and the new merchandising sales department. A. A. Brown is appointed manager of syndicate operation; J. S. Tritle, manager of the St. Louis office of this company, becomes manager of the merchandising sales department; T. J. Pace, assistant manager of the supply department, becomes manager of the supply sales department; C. E. Allen, manager of the central station division of the Chicago office, becomes manager of the St. Louis office, succeeding Mr. Tritle; George Baily, assistant to the manager of the supply department, becomes supervisor of distributing agents; A. C. Morrow, assistant sales manager of the Westinghouse Electric Products Co., becomes assistant to the manager of the merchandising sales department, and J. J. Dorney, manager of the industrial division, St. Louis office, becomes assistant to the manager of the merchandising department.

THE REPUBLIC CARBON CO., INC., announces that its offices, including the sales office, have been moved to Milwaukee, Wis. The plant remains at Niagara Falls, N. Y., the only change being that of concentrating the executive forces in one office.

THE ALBERGER CHEMICAL MACHINERY CO., INC., has moved its general offices from Grand Central Palace to 103 Park Ave., New York City.

THE DARCO CORP. of Wilmington, Del., announces that all sales of Darco and other refining materials manufactured by this company will be handled through the Darco Sales Corp., 45 East 42nd St., New York City.

THE GENERAL CHEMICAL CO. has moved its New York office from 25 Broad St. to 40 Rector St.

Manufacturers' Catalogs

THE CALLOW ROCK LIME CO., LTD., 810 Salisbury House, London, England, has issued a pamphlet on "Chemical Lime." Pages 1 to 16 deal generally with the use of lime in the chemical industry, while the last 16 pages deal with the production and the chemical and physical properties of Callow Rock lime products. Copies will be sent on request.

THE DAYTON-DOWD CO., Quincy, Ill., calls attention to its latest bulletin covering Type CSU multi-stage automatically balanced centrifugal pumps. The booklet is well illustrated.

THE WESTERN WHEELED SCRAPER CO., Aurora, Ill., announces the publication of Catalog 50, on "Dump Cars and Machinery for Handling Earth and Stone." This attractive 160-page catalog is in three sections. The first section illustrates and describes dump cars, railroad trestle filling, railroad ditching, industrial haulage, levee and dam construction and coal storage; in the second section (the contractors' equipment section) elevating graders, dump wagons, scrapers and plows are illustrated and described, while the third section deals with road graders, planer attachments, track crushers, batch-boxes and industrial railways.

INGERSOLL-RAND CO., New York, in Bull. 10,004, describes Price type "PO" horizontal, single cylinder, single acting, direct-injection oil engine. Probably the most outstanding feature of the design of these engines is the shape of the combustion chamber and the arrangement and construction of the spray nozzles used for direct injection of fuel. With this system fuel injection and complete amonization are obtained without the use of high-pressure air, the ignition being at all times by the heat of compression only. Other noteworthy features are inclosed and oil-tight crank case; the pressure lubrication system for oiling all important bearings including cam rollers; the continuous filtration of lubricating oil; and the completely water-jacketed cylinder barrel and heads."

THE AMERICAN ATMOS CORP., New York City, has issued an interesting bulletin on the Paul breathing apparatus, which is illustrated and described.

THE HARDINGE CO., New York, has issued a new condensed bulletin on the Hardinge conical mill. This bulletin covers in a very concise manner the principle of operation of the mill, its adaptability to industrial and metallurgical grinding problems, and gives general dimensions covering the different types of mills, as well as tables showing sizes, powers, and capacities for different conditions of grinding.

Industrial Developments

CERAMIC—The Standard Sanitary Mfg. Co., Pittsburgh, Pa., has increased production by about 25 per cent at its Tiffin, O., plant during the past fortnight, giving employment to additional workers. Fires have been started in four additional kilns. A night schedule has been placed in operation in certain departments in addition to the regular day working basis.

The Hazleton Brick Co., Hazleton, Pa., is arranging for the immediate resumption of operations at its plant, following a shut-down for a number of months past.

The George J. Markley Co., Mineral City, O., has inaugurated a capacity schedule at its two local clay products plant. Employees have been granted an increase in wages of 5 cents an hour.

The Thomas Maddock's Sons Co., Trenton, N. J., manufacturer of sanitary ware, is running on a full time, full capacity basis, with regular working force. The company is said to have orders on hand to insure this rate of output for a number of months to come.

Manufacturers of clay sewer pipe at Urichsville, O., have advanced the working schedule at their plants from a 9- to 10-hour day basis.

LEATHER — The Dunn-Green Tannery, Hudson, Mass., is arranging for the early resumption of operations at its plant for the production of chrome side leathers.

The Murray Leather Co., Woburn, Mass., has adopted a capacity basis of operation, on a schedule of 1,500 sides of high-grade leather daily.

The American Hide & Leather Co. has resumed operations at its plant at Lowell, Mass., following a shut-down for a number of weeks past.

RUBBER — The Republic Rubber Corp., Youngstown, O., has increased operations at its plant since the first of the month to double the operating capacity of previous weeks. A three-shift schedule has been adopted in the inner tube manufacturing department, succeeding a two-shift operating basis, while a double shift basis has been inaugurated in the truck tire department instead of single shift, as heretofore.

The Keystone Tire & Rubber Co., New York, N. Y., is operating at maximum capacity at its plant, and plans to soon run on an overtime schedule, on a basis of three 8-hour shifts.

The Studebaker-Wulff Rubber Co., Marion, O., is arranging for an immediate advance in production at its plant; the working force will be increased. During the past fortnight the company has booked orders for 15,000 casings and 18,000 inner tubes.

Tire plants at Akron, O., are running on a normal basis, with total production approximating 80,000 tires a day. A call has been issued for 1,000 additional skilled workers at once, divided among the different mills. It is expected that the "peak" production period of 1920 of 100,000 tires daily in this district will be reached early in July.

OIL—The Standard Oil Co. has resumed operations at the lubricating oil unit of its refinery at Wood River, Ill., which has been closed down since last July.

The Sinclair Oil Corp., New York, N. Y., is increasing operations at its different oil-field properties and oil refineries.

IRON AND STEEL—The Minnesota Steel Co. has placed its blast-furnaces and open-hearth plant at Duluth, Minn., in operation. Production will soon begin at the new sheet mills, now nearing completion.

The Midvale Steel & Ordnance Co., Philadelphia, Pa., is arranging plans to blow in its blast furnace at Coatesville, Pa., on May 22, which has been idle for some time.

The Hydraulic Steel Co. has resumed operations at its sheet mill at Canton, O., following a protracted idleness.

The Shelby Iron Co., Birmingham, Ala., is arranging for the early resumption of operations at its furnace, now undergoing repairs.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., is running on a full 100 per cent basis, and will maintain this schedule for an indefinite period.

The McKinney Steel Co., Cleveland, O., has resumed operations at six open-hearth furnaces, developing close to normal production.

The Wickwire-Spencer Steel Corp., Buffalo, N. Y., is arranging for early increase in operations at its plant, now running at about 70 per cent of normal.

METALS—The American Smelting & Refining Co. has resumed operations at its smelter at Hayden, Ariz. The copper department of the company's smelting plant at El Paso, Tex., has also been placed in service. Four out of five of the company's smelters in Mexico are now in operation.

MISCELLANEOUS — The Semet-Solvay Co. has placed 60 additional coke ovens in operation at its plant at Birmingham, Ala. The bulk of distribution is to the furnaces of the Republic Iron & Steel Co.

The Enamel Products Co., Elyria, O., has adopted a capacity schedule at its plant, with orders on hand to insure production for a number of months on this basis.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet-at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., June 5 and 6.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

CHAMBER OF COMMERCE OF THE UNITED STATES is holding its tenth annual meeting in Washington, D. C., May 15 to 18.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL ASSOCIATION OF PURCHASING AGENTS EXPOSITION (the "Informashow") will be held in connection with the seventh annual convention of the association at Exposition Park, Rochester, N. Y., May 15-22.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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Making A Tariff

DEBATE in the Senate on the Fordney tariff drags its weary length through hours and days and weeks of futile argument. We have forgotten how many thousand items and how many more thousand amendments there are to consider, but we know that only a few hundred have thus far passed the critical attention of Senators who are opposed to the measure. But we find no difficulty in understanding the interminable delay resulting from such a gem as we quote from the *Congressional Record* of May 2.

> Mr. SMOOT—Acetic anhydride is not made from calcium carbide.
> Mr. KING—I did not say it was.
> Mr. SMOOT—It cannot be made in that way.
> Mr. KING—I did not say it was made that way.

The best that can be said for the debate was that it was conclusive and probably satisfactory to both sides. If we engaged in prize contests, we should be inclined to offer a substantial prize for the best essay of not to exceed 500 words on the relation of this verbal tilt to the welfare of American chemical industry.

The Chemical Engineer Of the Future

A SIGNIFICANT event has taken place marking a milestone of progress in chemical engineering education. Our news pages this week carry a detailed account of the meeting held last week in Brooklyn under the auspices of the American Institute of Chemical Engineers, at which representatives of twenty-two universities together with a number of leading chemical engineers in industry discussed the report of the Institute committee on chemical engineering education. Letters from a score of other institutions at distances which prevented their being represented indicate the wide interest which this conference aroused.

The fortunate auditor would find it difficult to focus in small compass the fine spirit of that meeting. The admirable report of the committee of the Institute presented by its chairman, Dr. ARTHUR D. LITTLE of Boston, formed the basis for discussion and kept the attention of the conference from wandering far afield. It was impressive to find that so many had been thinking progressively along educational lines. It was more impressive to find that both the producer and the consumer of the product—the university man on the one hand who trains the chemical engineer and the employer on the other who utilizes his services—should be so completely in accord as to desirable traits and qualifications. Finally, it was most impressive to realize that the university men were so unanimous in their agreement as to the broad principles of chemical engineering training.

A keen appreciation of what is meant by a chemical engineer made it much easier to arrive at substantial agreement. "A man not primarily interested in processes of manufacture, how to make sulphuric acid or sugar or paint, but primarily interested in the quantitative study of unit operations of chemical processes such as filtration, grinding, distillation, drying, etc." A thorough grounding in broad principles of science was urged and a tendency away from specialization, particularly in a four-year course. The recommendations adopted by the conference should be studied by everyone. A committee will be appointed to carry on the splendid work and take up the details. Much power to that committee! On its shoulders rests a great task, a unique privilege, a galvanizing obligation. The work brilliantly conceived and begun with a thoroughness which kindles enthusiasm must be pursued vigorously and with a real sense of consecration.

Why Not Reduce The Percentage Overhead?

ANY business that paid out 80 per cent of its total expenditure for overhead would be subject to criticism for poor management. But this is just the situation in which it looks as though Congress would like to place the Chemical Warfare Service. Ultra-economy, if followed to the limit proposed by the House of Representatives, will certainly not be real economy. It will be the worst of penny-wise policy. A service devoting 80 per cent to overhead—i.e., made 20 per cent financially effective—would not be pleasing to anyone. Least of all would it satisfy those who thoroughly appreciate the importance of defensive chemical warfare.

During the present fiscal year the C.W.S. organization is spending about $2,500,000; for the next year the House bill provides for it $500,000. Of this small sum 80 per cent will be needed simply for overhead, principally the maintenance and operation of the essential parts of Edgewood Arsenal, without permitting any productive effort in research, development or proving. General FRIES has estimated that at least $1,100,000 would be needed for the proper maintenance and operation of Edgewood and to provide for the essential items in chemical and mechanical research and proving. The proposition now is before the Senate for further action.

For some time the General Staff of the Army was seriously considering whether C.W.S. should be discontinued and its functions transferred to the Ordnance Department of the army. But a careful, and one might even say unfriendly, study of the situation made it clear that continuance of the chemical organization on an independent footing was absolutely essential, not only from a scientific but also from a military point of view. The navy too has studied the situation and is placing the responsibility for much of its chemical warfare research upon the C.W.S. organization. It is

evident, therefore, that this unit is regarded by both army and navy as an important and integral part of the military organization of the future. It is therefore only reasonable to ask that the Senate shall grant Chemical Warfare Service as large a percentage of the army appropriation for next year as was given during the current period. We urge upon the Senate the merit of amending the bill to appropriate not less than the minimum of $1,100,000 which General FRIES has so convincingly shown to be essential. With that sum the overhead would be only 35 per cent of the total, which is a vast improvement over 80 per cent.

Compromise in Flotation Litigation

NOT since the days of litigation between representatives of the vacuum filtration industry has the metallurgical world been treated to so long, spectacular and expensive a legal contest as has been waged between Minerals Separation, Ltd., and various American copper-mining companies. Beginning with the first suit against JAMES M. HYDE and the Butte & Superior Copper Co., and ending with the compromise between the same plaintiff and the Miami Copper Co., flotation litigation has held a prominent place in the highest courts of the land. In fact we had become so accustomed to a continuous performance that the compromise in the Miami case came as somewhat of a surprise to those who have followed the varying fortunes of the contestants.

With the compromise much that was vital in the controversy now becomes of purely academic interest. Abstruse scientific problems were involved, and it was hoped that, if litigation were necessary, one of the beneficial results would be shedding of light on these unsettled questions. Consequently to the scientific and technical mind there is in the termination of this litigation a consciousness of failure to achieve a very desirable end. Nevertheless we must justify the compromise on the ground of business expediency and leave to more competent means the determination of the scientific principles involved in the process. We shall learn more from non-partisan scientific investigators than from experts retained by contending factions.

The Institution of Chemical Engineers— A Message of Welcome and Congratulation

LAST fall at a dinner of the American Institute of Chemical Engineers, Sir WILLIAM POPE told us of the great desire on the part of many men prominent in chemical industries for a British society similar to the American Institute. There was something distinctly prophetic in the expressed wish, for now comes word to us that the Institution of Chemical Engineers was inaugurated on May 2 in London by a distinguished gathering of men prominent in the chemical industry of Great Britain.

The chemical industry of Great Britain has developed without the chemical engineer. As Sir ARTHUR DUCKHAM said in his address as chairman of the meeting, "We have a number of engineers with a smattering of chemistry and a number of chemists with a smattering of engineering, but what we want is men thoroughly trained in both subjects." The program of the new Institution has, as one of its principal aims, the development of a satisfactory curriculum for the training of chemical engineers. The problem is different from the one which confronts American educators in this field, for we have courses of training and a product to study. In England the courses and the product must be created. The creation of such an Institution in Great Britain required courage. Considerable conservative opposition was encountered, comparable to that which exists in some few lines of manufacture in this country. But American chemical engineers will welcome the inauguration of the Institution. The recognition of the profession in Great Britain will inevitably have a desirable effect on its prestige in America. We can hope that the future will bring to the new Institution a career as distinguished and as progressive as that of the American Institute of Chemical Engineers. The experience of the older organization should be of inestimable value to the one newly created, and we should extend to the English Institution a close, organized and fraternal liaison. Our compliments and congratulations are extended to the organizers.

Opportunities In Biochemistry

IN THE May issue of our very lively little contemporary *The Chemical Bulletin*, published by the Chicago and other Midwest Sections of the American Chemical Society, there is an illuminating article by CHI CHE WANG on "Hospital Chemistry." It confirms the position which we have maintained of the growing need of chemists in the practice of medicine. The author speaks with knowledge and authority of modern hospital requirements in clinical chemistry. Formerly a few qualitative tests of urine for albumen, sugar and "acetone bodies" were substantially all that was demanded, and could be made by almost any laboratory assistant. But blood tests and tests of the cerebrospinal fluid are becoming of leading importance. Indeed, he well says that any metabolic disorder is manifested in the blood before any noticeable change is brought about in the character of excretions. By the introduction of microchemical methods it has become possible to make quantitative determinations of a number of blood and urine constituents with a fraction of a cubic centimeter of material in less than an hour's time. With a total of less than 25 c.c. of blood, determinations may thus be made of fat, lecithin, chloresterol, chlorine, sodium, calcium, potassium, magnesium, phosphorus, sugar, creatine, creatinine, uric acid, urea-nitrogen, non-protein nitrogen, oxygen and alkali reserve. Emphasis is laid on the value of the study of nitrogenous compounds in the blood, and of blood gases in diagnosis. Also important is the study of determination of the mineral content as well as the alkali reserve of the blood plasma, and the measurement of the CO_2 tension of the alveolar air.

This work may not be entrusted with safety to the type of young person "majoring in chemistry" elsewhere referred to in the same journal, who determined the atomic weight of copper by dividing the weight of the crucible by that of copper. Or who held that a Pyrene fire extinguisher is filled with "carbon bicuspid." Or who did not make analyses in duplicate because he "didn't know which one to take." Work must be done with great accuracy because often the quantity of material available is very small, and it must also be done rapidly because also very often the patient is not in a condition to wait—and does not wait.

What is needed of hospital chemists therefore is ac-

curacy, economy with materials, alertness and swiftness, besides a good working understanding of biological and pathological chemistry. It may be asking too much of the physician to make him sufficiently proficient in the chemistry of metabolism and of growth so as to do his own testing. At all events, whether we ask it or not, very few practitioners of medicine are able to do this. The course of study in medicine is already so long that there is a serious question as to the wisdom of making it longer. That might cause a shortage in the profession. But every town of fair size needs a biochemical laboratory in charge of a competent chemist, familiar with the biological, physiological and pathological aspects of his profession.

Such a laboratory should soon pay for itself, in charge of a person with a proper sense of medical needs, practice and methods, and with enough of a head for business to manage his own affairs. If a chemist has the professional equipment but is, as many are, incapable of business, and who must work for somebody else on a salary, we've no doubt that successful apothecaries would be glad to set up such a laboratory and maintain it. The information indicates a widespread need of chemists that should be interesting to many who are now looking for work.

Bogus Degrees

WE CONFESS we have been severe in our criticism of foreign journals that advertise degrees for sale from American universities. And yet we think we were right. Any so-called American university that offers to sell degrees is not an honorable institution, and every one should know it. Academic life in the United States is distinctive, as is that of every country, but it is honorable. The sale of degrees is dishonorable, and is so regarded here as well as elsewhere. Indeed, the act of advertising degrees for sale is construed to be a fraudulent use of the United States mails, and those who engage in it are prosecuted. Thus one HELMUTH P. HOLLER, head of the "Oriental University" in Washington, D. C., was lately arrested on such a charge; he has been indicted, and his case will shortly come up for trial.

But there is no use in denying that in some states and in the District of Columbia a nasty situation exists. In New York State no institution may grant degrees unless it has at least $500,000 worth of property and conducts its affairs under the sanction and approval of the Board of Regents. The high character of the Regents of the State of New York makes this provision an assurance of scholarship and of proper administration. In a report made in 1912 by the Carnegie Foundation for the Advancement of Teaching it is said that the states of Pennsylvania and New Jersey had also made provision to prevent fraudulent and unworthy institutions from organizing or from prosecuting their unsavory business. There is no report on this subject available since 1912, and it is probable that other states have set their houses in order since then. But not all by any means, and the District of Columbia seems to lead in this kind of disorder, despite the excellent George Washington and Catholic Universities which are located there. Unless it has been changed since, and we doubt it, the sole requirement in the District of Columbia is that five citizens—and it makes no difference who they are or how ignorant they may be—shall sign a document stating that it is their intention to incorporate under whatever name they choose to take. The Recorder of Deeds on presentation of such a document is obliged to give them a certificate of incorporation—and there they are. Of such blights of mildew were the "Potomac University," that when it was examined had assets to the value of $450, with the president as a member of every faculty and the other members mostly imaginary. The Oriental University of Washington we have already mentioned; it is an old offender. The Odessa University used to sell degrees for $10. This, like the others, was "incorporated under an act of Congress" (which compelled the Recorder of Deeds to give anybody a certificate).

The trouble is that the latest available records are 10 years old. We wish that some competent body would make a careful investigation of the fake colleges and universities—so as to show them up for what they are and put them out of business if possible. Some state legislatures are too ignorant to know or to understand the vice of granting degrees to those who have not earned them. The action of the Kentucky State Legislature in almost prohibiting the teaching of evolution is an example of the cultural quality of some lawmaking bodies.

Fortunately the penalties for fraudulent use of the mails keep these degree factories rather quiescent in this country, and men of scholarship know the contumely which the purchase of a degree from the "Oriental University," for instance, would bring upon them. The butcher and baker and candlestick maker do not aspire to degrees, and as for chiropodists, they are all "Docs" by tradition as soon as they buy their knives and scissors—except in some states, where they must pass an examination to practice. Then they are licensed chiropodists in fact and "Docs" in a fiction of usage.

Another Russian Chemist Saved

LAST winter we voiced a wonder which had doubtless risen in many minds, a wonder as to the whereabouts and circumstances of many Russian chemists of note. Ample information has since accumulated that whatever their whereabouts, those who are left are certainly living in most pitiful circumstances, even verging on death by exposure and starvation. In those instances where they are not actually prevented, it appears that they are continuing their researches with a fine and unquenchable determination, handicapped by the lack of apparatus, chemicals and books, things which ordinarily would be regarded as essential.

At that time the figurative suggestion was made to "send out a search party to find OSTROMISTLENSKY; his contributions to the chemistry of rubber have been of high rank, and his splendid talent and understanding would be a godsend to the industry." Some weeks later contradictory reports were received—one that he was alive, another that he was killed at Moscow. We are now able to give the good news that Prof. OSTROMISTLENSKY has recently reached America and, we are informed, now is engaged in research work in the laboratories of the United States Rubber Co.

We welcome this savant! Doubtless he will give us much more than we give him. Which circumstance only urges us to even the account by sending generous aid to the pitiable workers he has left behind.

Readers' Views and Comments

Bad Paint and Good Medicine

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest the editorial in your issue of April 12, 1922, under the caption "Bad Paint and Good Medicine," in which you call attention to the able work of Dr. John M. Müller and his colleagues of the University of Pennsylvania on the element germanium. The action on the organism of Dr. Müller's aqueous germanium extracts brings to mind the properties of the waters of Ponce de Leon's fabled fountain of youth, and also recalls the fact that germanium does actually occur in waters of medicinal repute. Thus Bardet (*Compt. rend.*, vol. 158, 1914, p. 1278) found the element in the mineral waters of Vichy, where it may have exerted some therapeutic action, although present in homeopathic amounts.

I hope, however, that I will be pardoned for disagreeing with those parts of your editorial which locate all the sources of this new fountain of youth at the confluence of the Schuylkill and the Delaware. I am sorry to spoil your clever little story, with its local color and its stirring note of loyalty to alma mater, but the fact remains that your correspondent is the chemist to whom you have so kindly referred in your editorial, and that his alma mater is situated on the Charles and not on the Delaware. It must also be pointed out that this rediscovery of the element took place 6 years ago and that a half dozen universities have been working on the germaniferous material since that time.

The writer's original papers announcing the occurrence in workable quantities of germanium in certain zinc materials were published in 1916 and 1917 (Buchanan, *J. Ind. Eng. Chem.*, vol. 8, p. 585, and vol. 9, p. 661). Although the zinc materials there described made available the first real supply of germanium since the days of Winkler, there was nothing new in the announcement that germanium is frequently found associated with zinc. Urbain (*Compt. rend.*, vol. 149, 1910, p. 602) by spectroscopic methods had identified germanium in thirty-eight out of sixty-four blendes examined, while Hillebrand and Scherrer (*J. Ind. Eng. Chem.*, vol. 8, 1916, p. 225) had announced its detection, also by the spectroscope, in several blendes, notably in a Missouri sulphide.

The classical work of Winkler was performed on very low-grade material containing, according to Urbain (*Compt. rend.*, vol. 150, 1910, p. 1758) not more than 0.03 per cent germanium. It was therefore not surprising that the writer's announcement of a commercial material containing approximately 0.25 per cent GeO_2 should arouse the interest of many laboratories working on the rare elements. Among the first to obtain samples were Prof. Browning of Yale and Prof. James of New Hampshire College. At least two papers have been issued from Prof. Browning's laboratory (Browning and Scott, *Am. J. Sci.*, vol. 44, 1917, p. 313; Browning and Scott, *J. Phys. Sci.*, vol. 46, 1918, p. 663). Prof. James has published some of his work under the title "The Extraction of Gallium and Germanium From Zinc Oxide" (James and Fogg, *J. Am. Chem. Soc.*, vol. 41, 1919, p. 947). Material was also sent to Cornell University, to the University of Pennsylvania and to several others; from the two first named we have had the more recent work of Dennis and Papish (*Chemical News*, vol. 123, 1921, pp. 190 and 202) and that of Dr. Müller (*J. Am. Chem. Soc.*, vol. 43, 1921, pp. 1085 and 2549).

Although, as has been pointed out, a number of university laboratories throughout the country have been contributing to this new germanium literature, we are indebted to Dr. Müller and his co-workers for the first suggestion of an application of the element to human needs. We do not forget that since the days of the iatrochemists a new chemical species has always been hailed as a panacea; nevertheless we must believe that an element related to arsenic on the one hand and to carbon on the other has at least an even chance to prove itself of medicinal value. Germanium chloroform, for example, has been known since the days of Winkler.

New York City. G. H. BUCHANAN.

EDITOR'S NOTE: It is unfortunate that our information about Mr. Buchanan's alma mater was not as accurate as that about Dr. Müller's work on the therapeutic uses of germanium. Evidently the friendly rivalry between Harvard and Pennsy extends beyond the field of sport!

Too Much Specialization in Engineering Education

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a recent review of Prout's "Life of George Westinghouse" your distinguished consulting editor, Mr. Hendrick, expressed his regret that the chemical engineering industry had produced so few broad-minded leaders of the type of Westinghouse in the electrical engineering industry. Mr. Hendrick hinted, moreover, that this failure to produce chemical engineers of broad vision and imagination was due to causes not difficult to trace. I would suggest that one important cause can be traced in your illuminating tabulation, last June, of the curricula of chemical engineering courses taught in American colleges. A great many of those curricula obviously are not designed to produce graduates of broad vision and imagination. Some of them seem designed to exalt the department of chemistry at the expense of professors teaching cultural or broadening courses. Under such specialized curricula, a normal student of moderately wide interests entering college when he is 18 is changed in four impressionable years into a chemical-minded graduate so unsympathetic with everything except his specialized field that it is no wonder Mr. Hendrick lamented the lack of great chemical engineers to compare with Westinghouse and his type in electrical engineering.

There are some colleges in the country that have harkened to the many recent criticisms of engineering education—such as the famous Mann report—and are broadening their engineering curricula. These progressive institutions are swayed also by the important fact that less than half of the graduates of engineering colleges remain strictly in technical work. But on the

other hand, other colleges are narrowing their chemical engineering curricula, possibly because they observed from your tabulation that there were several curricula even narrower than their own, and this offered an excuse for a revision in favor of greater specialization. I believe that our extreme specialization in engineering education is a consequence of the American tendency to go to excess. European engineers are frequently amazed at the ignorance of American engineers in any field except their specialty; and, for that matter, many American employers suffer the same amazement.

I am not in favor of the 6-year engineering curriculum; I agree with your correspondent Edward Hart of Lafayette College that many students could not afford so long a college career. Moreover, four years of college atmosphere and all that it implies is sufficient at that stage of the ordinary young man's career. The comparison with the law school and medical school courses is not an apt one, because lawyers and physicians are not compelled to mix into business and industry to such an extent as is the engineer. Law and medicine remain distinct professions, with codes and points of view separate from the world around them.

While I am in favor of what T. A. Rickard and Prof. Burr call professional status for the engineer, I do not think that most engineers can sit back in offices and wait for work to come to them, but must enter industry and conform to (or improve) the conditions existing there. In such a capacity too narrow or professional-minded a point of view handicaps the engineer. As J. E. Spurr, editor of *Engineering and Mining Journal-Press*, said in a commencement address in Michigan: "The handicap of the college-bred man is a lack of initiative and a too great fear of doing this or that which is below his dignity." It seems to me that, instead of producing specialized technicians of rather narrow, unimaginative views, the engineering colleges should produce adaptable, broadly educated men well grounded in the fundamentals and larger applications of science. This can be done in four years if the curriculum is not too highly specialized.

By the way, I should like to express my appreciation of your improved editorials. No one could accuse your editorial staff of narrow, unimaginative views. Since the demise of the *Mining and Scientific Press*, your editorials are the best written and most inspiring of the engineering periodicals, in my opinion.

New York University. P. B. McDONALD.

Properties of So-Called Amorphous Metal

To the Editor of Chemical & Metallurgical Engineering

SIR:—Considerable attention has recently been given to crystalline slip in metals, particularly by Jeffries and Archer.[1] These contributions have shown clearly that ductility and related properties are characteristic of the crystalline state, but the occurrence of a high degree of malleability and ductility as peculiar to the metallic state has not been emphasized. Tammann[2] has pointed out that ductility is not a function of any particular space lattice, but depends on the lattice being built of the same kind of atoms between which no valencies are active. According to J. Stark[3] metallic crystals may be considered as made up of rows of positive ions between which are the more or less free negative electrons. Gliding may therefore take place along any plane separating two rows of ions without disrupting the structure, since all positions in the space lattice are equal. However, at the surface any appreciable slip requires the separation of the atoms.

If the force exerted along the gliding plane is sufficient to separate the surface atoms, why does the slip halt and not become a simple cleavage? This question, which is fundamental in the theory of metallic flow, has been asked and answered by Knight.[4] His answer follows the generally accepted amorphous theory. In the present note it is desired to point out that the conception of the amorphous layer as a supercooled liquid leads to some conflicts with experimental data and that on the other hand it is possible to explain the phenomena connected with crystalline slip on a somewhat different basis.

The properties of a metal after inelastic deformation have the following relations to those of the undeformed metal:

(1) Greater resistance to further deformation.
(2) Higher electrical resistance.
(3) Negative thermoelectric force to the undeformed.[5]
(4) Higher specific heat.[6]
(5) Lower density except in the case of bismuth.[7]
(6) Scratch hardness is the same.[7]
(7) Electrolytic potential anodic.[8]

The resistance to further deformation is logically explained by Jeffries and Archer as due to the absence of planes of slip in the amorphous material and a decreased density is logical for a supercooled liquid, but the reasons for the electrical properties present greater difficulties. The thermoforce has been found to be the same in both the liquid and the solid state for all metals except bismuth,[9] so that an assumption of a different thermoforce for the supercooled liquid than for the solid at the same temperature is unjustified. The greater electrical resistance of liquid metals is accounted for by the greater amplitude of vibration of the ions,[10] so that an assumption of higher resistance for supercooled liquid metal involves a greater freedom of motion of the atoms of a supercooled liquid than the solid has at the same temperature, which is not in accord with the higher specific heat of flowed metals. The specific heat of liquid metals is lower than that of solid metals.[11] Altogether, the amorphous layer—if one is present—does not have the properties of a supercooled liquid.

A further development of Stark's views of crystal gliding will explain the change of properties on inelastic deformation satisfactorily. If we consider the separation of the metal ions to a greater distance than they can be elastically displaced from their position in the space lattice, they will tend to take on the free electrons which are characteristic of the metallic structure. Such a process will result in electrons being held in common between two metal ions, a sort of forced molecule formation. As more of these pseudo molecules are formed, the resistance to deformation will increase, and since the number of free electrons is

[1] CHEM. & MET. ENG., vol. 24, p. 1057 (1921).
[2] *Nachr. Gesell. Wiss. Göttingen*, 1917, p. 247.
[3] *Stahl. v. Eisen*, vol. 41, p. 1609 (1921). See also W. Voit, *Ann. phys.*, vol. 60, p. 638 (1919).
[4] CHEM. & MET. ENG., vol. 25, p. 1036 (1921).
[5] McLean, *Proc. Roy. Soc.*, vol. 66, p. 165.
[6] Hill, *Verh. d. Deutsch. Phys. Gesell.*, vol. 3, p. 113 (1901).
[7] Desch, "Metallography."
[8] Fawsitt, *Proc. Roy. Edin.*, vol. 25, p. 2 (1906).
[9] H. Pelabon, *Ann. de Physique*, vol. 13, p. 169 (1920). K. Siebel, *Ann. Phys.*, vol. 60, p. 260 (1919).
[10] *Phys. Rev.*, vol. 14, p. 487 (1919).
[11] F. Wust, A. Meuthen and R. Durrer, *Ver. Deutsch Ing. Forschung-arbeiten*, No. 204, 1918.

lowered, the electrical resistance will increase and the thermoforce be more negative. The increase of specific heat would follow from the greater rigidity with which the atoms are bound.

If an "amorphous" layer exists, and it undoubtedly does in some cases, its properties are better explained on this basis than on the basis of it being a supercooled liquid. I regard the amorphous material as a disperse phase in which the particles are held together by half-bound electrons. Such a theory explains the properties of disperse systems in general without such mechanical assumptions as the key action brought forward by Jeffries and Archer. The question arises as to why it is not possible to have crystals entirely built up of disperse forms. The orthorhombic form of iron disulphide, marcasite, appears to bear such a relation to the isometric modification, pyrite.

The restoration of the original properties of the flowed metal by annealing follows from an increased freedom of the ions and electrons so that they may return to their normal position in the space lattice.

Chicago, Ill. REGINALD S. DEAN.

Ido, the New Universal Language

To the Editor of Chemical & Metallurgical Engineering

SIR:—There has been some talk lately about a world language, and the League of Nations is considering the adoption of such a language. The International Research Council is busy investigating the subject. Scientific men are quick to realize the advantages of such a medium of thought exchange.

Such a language, though, for scientific purposes must embody the following features: It must be easy to learn, either passively, for reading, or actively, for writing and speaking; it must be precise, so that the chances of ambiguity are reduced to a minimum and clearness will be an outstanding feature; and it must be one which will contain the least number of words new to the scientist—that is, as many as possible of its words must be easily and quickly associable with one's native language.

Such a language exists. It is Ido, the offspring of Esperanto—the refined and improved Esperanto. It is easily and quickly learned, and the scientific man can learn the Ido of science, his own field, in a marvelously short time. This is due to the short, compact grammar, which is typically American, in that it is a distinct time saver. It is very precise, much more precise than the natural languages, for in Ido one word represents one idea, and by means of a comparatively small number of affixes, that one idea can be presented in any of its forms, and without danger of being misunderstood. And Ido, being a language whose words are selected in accordance with the principle of the greatest internationality, presents less new words to be learned. Also the words are a trifle shorter than in any other language.

In fact, the language is far superior to any that has preceded it, and while it may have (it undoubtedly does have) some faults, still it is superior to its parent, Esperanto. Dr. Zamenhof deserves much credit for his work, but working alone, he made mistakes that he could not see, because he could see his work only from one angle, but when the Delegation for the Adoption of an International Language (which was appointed at the time of the World's Fair in Paris in 1901) met in 1907, the scientists which composed that committee decided against Esperanto as it then stood, but decided to adopt it in principle, in accordance with the project Ido, which was done, and so was Ido born.

Science has at its hand a tool for international comprehension better than any national language, a language devoid of idiotisms and illogical expressions, which will enable all to have a fair chance. Will science use that tool? I believe that it will. The present trend of events shows it.

A few opinions by recognized scientists will not be out of place before I close.

Prof. W. Ostwald, emeritus professor of Leipzig University, philologist and Nobel prize-winner for chemistry, says (International Language and Science): "As is well known, we scientific men suffer a good deal from the fact that the same words are frequently employed for vague ideas of daily life as well as for the perfectly definite concepts of science. This is indeed one of the most important reasons why new designations for scientific concepts should, so far as possible, be taken from the dead languages, such designations being thereby already international. It ought therefore to be a comparatively easy task to devise by means of this international material and the linguistic rules of the language of the Delegation a system of international names for the clearly defined concepts of the different sciences." Prof. Ostwald was the chief worker on the chemical terms of the language of the Delegation (Ido).

Prof. Otto Jespersen, philologist, University of Copenhagen, says (International Language and Science): "The result [of the work of the Delegation] is a language that everyone can easily master and which possesses the advantage over other languages that it is based on rational scientific principles, and therefore need not fear that some fine day it will be replaced by another and sensibly different language. Naturally improvements will be effected in details where the fundamental principles have not been sufficiently worked out, but the foundation is sound."

Prof. A. Meillet, of the College of France, says (in Les Langues dans L'Europe Nouvelle): "It is, on the other hand, easy to proceed more logically and consequently in a manner more satisfying and clear, concerning the word-formation, than Esperanto did. This is shown by the creators of Ido, a language founded on the same principle as Esperanto, but in which those principles were applied with greater rigor."

Ido is the crown of the international languages, and it is almost certain that the League of Nations will adopt it as the official language of the League. It is a popular language in Europe, and I am informed that Esperanto is there meeting with the fate of Volapuk—obscurity. EARL WALTER SUTTON.

Elyria, Ohio.

The Throwing Power and Current Efficiency of Zinc-Plating Solutions

In the report of the Baltimore meeting of the American Electrochemical Society in the issue of CHEM. & MET. for May 10 it was stated on page 878 that a paper on this subject was presented by Prof. W. G. Wood and T. Fuwa. The name of the first author should have been given as Prof. W. G. Horsch, who is research associate in the research laboratory of applied chemistry at the Massachusetts Institute of Technology, where the investigation which was the subject of the paper was carried on.

The Business Side of Chemical Manufacturing

This Is the Third Article of This Series and Continues the Study of Marketing With the Sales Department —The Functions of the Sales Manager and the Salesman—Their Methods of Work—Critical Suggestions in the Chemical Field

By CHARLES WADSWORTH, 3d

GROUPED under the inclusive title Sales Department are all of the remaining departments which contribute to the marketing process. Rather unsystematically we shall study the actual sales work first. The other departments are more easily considered in their relation to the sales department itself. The sub-departments fall conveniently into two groups. They may be called for want of better names the clerical and the technical groups. In the first group are the credit, traffic and collection departments. The procedure in these departments is almost routine. In a great many firms, after the policy has been established by the sales manager, the work is carried out by clerical labor of mediocre caliber. A very brief discussion of procedure will therefore suffice. The technical group, including sales research (sales engineering) and sales service or trouble department, is somewhat embryonic in the industry as a whole. It is becoming increasingly important and its importance is beginning to be realized. The interest for technical men is great because its operation by technically trained men is imperative. First, however, consider the sales department. Our discussion will be divided into two main parts, one devoted to the salesman and the other to the sales office and sales manager.

The Salesman

There is one widely prevalent myth which in many quarters has assumed the dignity of an axiom. It is to the effect that salesmen should know very little about production and method of manufacture. There are many reasons offered. One wise manager said that a technically informed salesman would lose many sales because he would argue with the customer about theory and the customer would become nettled if his theory were shown to be faulty. Frequently I have heard it stated that the inconsistencies between sales talk and manufacturing practice would make less convincing the salesman who knew manufacturing practice. This last comes sometimes from firms with splendid products and with reputations above reproach. I believe that the myth has its origin in interdepartmental jealousy. The salesman knew he could not enter the technical field and he therefore subconsciously evolved a case against the technical man in sales work. Fortunately the myth is being dispelled by the very much larger number of technically trained men who become salesmen and the increasing number of firms that give their salesmen a special technical training. It is a tenacious myth, however, and will always exist in some places.

A Vision of the Average Salesman

Let us again use the case method of study and develop the faults of the average salesman in the chemical field. We are the purchasing agent, and a card which is brought in to us says: "Mr. Addison Sims [to borrow an immortal name] of the Seattle Chemical & Equipment Co." The calling card is poorly composed. There is too much on it. It makes a poor impression. Mr. Sims enters. He enhances the poor impression, for he is not too well groomed and he is either awkward and ill at ease or aggressive. Those are minor points and would not matter greatly if he were equipped to dispel the initial impression by subsequent activity.

He wants to introduce a pump, or an evaporator, or a chemical. His selling technique is fair. He parrots the advantages of his product and the extent of its use. He has something for you to handle while he talks, a model, or a diagram, or a pound of material. He has voluminous tables of sales data from which he can sometimes calculate a price for a given piece of equipment, though usually, after a protracted search, he "will write you." He almost always tries to make some point of personal contact, golf or what not. But we ask a question just off the memorized field. What has their experience been with the corrosion of the rotor and shell? What factor do they use for the rate of heat transfer? How do they unload a tank car of material? He does not know! He will ask their technical department and let us know. This fact becomes clear that except for the few generalizations about the equipment or product, the salesman is powerless to give technical information.

In the end we know that "there are hundreds of our pumps in use, that the rotor was especially designed by our engineering department and by test has proved most efficient and that now is an advantageous time to buy." We want to know a lot more. We have already asked about corrosion. We want to know also what advantage that type of stuffing box has; a little about packing, perhaps; what pressure the pump will develop; what parts are replaceable; how long it would take to put in a new rotor and shaft; what their experience has been as to the desirability of protecting bearings from overheating and what make of 220-volt a.c. motor they will use on direct-connected pumps—but he can't help us. That is just about the average performance. The average of a number of hundreds. It may therefore be permissible to plead for the technical training of salesmen.

The Selling Campaign

Now for a moment let us cease being purchasing agent and become the shadow of the salesman who has just called on us. What does he do, or rather what should he do outside of the prospect's office? Two things: Organize his selling campaign and keep in intelligent touch with the home office. The first of these two duties is really intelligently performed. The

training of salesmen in using their time to the best advantage has reached a state approaching perfection. Of course, remember that we are talking averages and there are still many firms and many salesmen who squander their effort. But on the whole the prospect list is well picked, well planned and covered with systematic regularity. The degree of supervision exercised by the sales office varies from 100 per cent to zero, but on the whole it is high, which accounts to a large extent for good results in this field.

In general the list of prospects originates in the sales office and often the routing of trips and timing of calls comes from there also. The salesman is thus simply concerned with the mechanics of selling a series of customers. This procedure is entirely logical and closely resembles the division of work in the army between the line officers and the field officers. There are, of course, many salemen who direct their own campaigns, but this is rather the exception.

Contact With the Home Office

The second point, the contact which salesmen keep with the home office, is as close as the office requires, but it is in general not intelligent in the chemical field. There are usually order forms to turn in and order summaries. There are also cards for each call made, which give all the data possible—the date, the company, capitalization, officers, person seen, his position, general attitude, prospect of doing business, etc. This card is usually supplied to the salesman by the sales office, as mentioned above, partly made out, but the data which the salesman adds to the card are the basis of future action. The value of these data cannot be overestimated, and it is here that salesmen are most apt to fall down. Unless the questions are specific, the data will be vague, and yet if the questions are too definite, there is danger that anything outside the questions will be entirely missed. In fact, that is the greatest trouble with the system. A man who is a good salesman is apt to be a poor observer. He is not a receptive type. In addition, if he has no technical training, there will be innumerable stimuli to which he cannot respond and hundreds of hints which he will not understand. There is the cause of death of many companies. Their antennæ missed important messages—messages which became vital. Perhaps it was a simple statement that such and such a company was working on X. Lack of chemical knowledge was responsible for the salesman's failure to realize that X might conceivably be a substitute for his product. The company was therefore not prepared for the competition. Examples are legion of similar occurrences—even if the item had been reported without knowing its significance, the sales office might have discovered the danger.

Selling a Promising Field for Technical Men

Please do not understand me as saying that technically trained men would make good salesmen. That is not necessarily so. But many technically trained men could be trained to make good salesmen and they would make better salesmen of chemicals and chemical equipment than non-technical men would. There are not a few chemically educated salesmen who contributed to the composite picture of the salesmen just presented. They are often inadequately trained in their special field even though they possess technical background.

As a field for technical men selling is distinctly promising. Chemists would do well to consider it not only from the standpoint of a promising future as sales manager but also as a means of surveying the chemical field which few technical positions can offer.

The Sales Office

It is going to be impossible to study the sales manager's office by the case method, for there is too wide a variation. On the one extreme is the sales manager of a sulphuric acid plant, for example, who is also the only salesman. His product is perhaps sold on contract entirely and he makes all of the contracts himself. On the other extreme is the sales manager whose consumer is the wholesaler or retailer and who has to market several hundred products. He has many branch houses and district sales managers. His problems of personnel and distribution are problems which do not touch the other sales manager at all.

There are a number of things, however, with which all sales managers are vitally concerned. All of these focus on the main task of disposing of the company's products at the greatest maximum return over a period of years.

Future Demand

The first function of a sales manager which we shall take up is the estimation of the future demand. Assume that we have a manufacturing unit capable of producing 6,000,000 lb. a year. Our sales have steadily mounted and if we extrapolate the curve our sales next year should equal 7,000,000 lb. Shall we, as sales manager, warn the production department that we want increased capacity or not? If we ask for more capacity and do not sell the production, we are worse off than if we had not asked for greater output and lost additional sales. Very seldom is the curve of annual sales a steady curve of progress or decline. It jumps about and we are unable to discover all the reasons for such behavior. This makes prognostication difficult—so difficult, in fact, that a very great many sales managers make no attempt whatever to anticipate demand. If they sell all the factory produces, it is a good year. If they fall short, it is a bad year.

It is extremely unfortunate that this is the case. An analysis of sales data is not easy, but if it is intelligently done it will throw much light on the perplexing problem of future demand. The method of undertaking such analysis is too elaborate for a discussion of this kind, but it involves a study of deliveries of products to the different consuming industries or firms and a determination of the factors which have caused the variations in each case. It involves a study of other factors which affect the vigor of the consuming industry, and a careful estimate of general industrial conditions. There are very few firms in this country at the present time which did not have to take a staggering loss in the last 18 months because of a drop in the inventory value of the raw materials which they had in stock. If some one in the organization had only had his eyes on this very point—future demand—there would have been much less distress, for deflation would have taken place earlier. The fact that some firms anticipated the situation shows that it could have been done.

Markets; Evaluation and Differentiation

Markets are the medium in which the sales manager lives. He must therefore have accurate data as to the points of consumption of his product. This is usu-

ally recorded in one of two ways—card catalogs and maps. Maps, with numbers written in to indicate quantity of consumption at given points, are valuable visual aids in laying out sales campaigns. Catalogs are more elaborate and on the whole more valuable. Cards can be filed geographically and will usually carry all the information about an individual consumer. Such information is included as: The officers of the company; the products, quality and quantity consumed; their attitude toward the company's product; the sales made to the consumer, etc. The data are obtained largely through visits of salesmen, and it has already been pointed out that inaccuracies and omissions are unfortunately numerous. From the catalog, however, it is possible to gage the importance of specific territories.

This is the first step in planning for the amount of sales effort to be expended on a given place.

There are other factors which modify the decision, however, so that it is not always the point of maximum consumption where the maximum effort is expended. The first modifying factor is competing products. Competition in chemicals has been almost entirely a matter of price. In very few cases has there been intelligent study of consumers' needs and a definite bid for a market on a basis of quality or special fitness. It would be a source of distinct surprise to many manufacturers of chemicals to realize how much the specifications of even crude manufactured products have changed. This means simply that a firm which had specialized and advertised special qualities instead of stressing price only could have nearly monopolized the market. Examples are almost non-existent in chemistry. In a closely allied industry, however, there is tartar for textile mills—a large percentage of mill men know only Durfee's and use it exclusively. You may not believe it is better material, but the trade thinks so. It has been advertised as a specialty for years.

However, since competition is largely a matter of price in chemicals, the sales manager's decision to specialize in a given territory will be based on the knowledge that he is able to meet price competition. This, of course, involves an accurate knowledge of competing products, a knowledge of their strong and weak territories, accurate and immediate information of price changes. Such information cannot be obtained without many contacts in industry. A friendly broker often will furnish information. A consumer who is intimate with the firm, but who buys on competitive bids, is another source. Consumers who buy only from the firm often receive tempting concessions from the firm's competitors and report them. (Parenthetically, it might be added that the last class is almost non-existent now—the last 2 years has snapped almost every business tie. "Buy from Beelzebub if he has it cheap!" is the cry.) Finally, the company's salesmen are perhaps the most important source of such information.

Data gradually and continuously accumulate in the sales manager's office and he is thus able to make clearer and more definite decisions as to where his main effort will be expended.

How One Firm Picked Its Market

Unfortunately a very large number of firms still do not pick their markets—they drift into them. This situation is so prevalent that it is a distinct joy to discover a firm such as Blank & Co. This firm manufactures a product which is sold in relatively small quantities daily to the same people—in other words, a constant daily order is filled. This particular firm manufactures 2 or 3 per cent of the total quantity of product in that district. One other firm manufactures between 90 and 95 per cent of the total, yet that small firm is impregnable, and all because the general manager, who is also the sales manager, used his head. First, the quality is there and everyone knows it. Second, the small firm will not accept a large order. One large order might be a very appreciable percentage of the firm's production. The small company might have to make great concessions in order to keep the customer. The large competitor could easily arrange to give away the product in order to gain a large customer, but the small company distributes to scores of small consumers who are satisfied with the quality. The loss of one or even a dozen is not dangerous. The large company knows that any single small consumer is not worth trying to get because in a fight for small customers it would get much the worst of it. Three other larger companies have been absorbed by the large company in recent years, yet the small company is treated with respect and as an equal. That is sales policy and correct choice of markets.

Hundreds of other factors can legitimately influence the choice of markets. Transportation cost is a very obvious one. Selling cost is an often neglected factor. One consuming industry may be preferred to another because it has a constant and not a seasonal demand. Sometimes a special campaign must be directed toward an industry where the custom is to sign up for a year's contract during a definite month. Frequently the seller makes an effort to create such a precedent in an industry. It will scarcely be worth while to go further on this point. The real issue after all is not so much "How shall we pick our markets?" but to realize that there is a choice and that all consumers may not be the best customers. Nor does this include the credit aspects of the case, which will be discussed later.

Method of Selling

Shall We Deal With the Dealer?

How shall we sell? Shall our salesmen deal with consumer or broker, or shall we sell all of our output through a selling agent? This question is coming up for more serious consideration than formerly. Perhaps it was due to the lack of knowledge of or distaste for sales problems on the part of chemical manufacturers, but whatever the cause this particular question of sales policy received small consideration. Sometimes a dealer saw a good thing in it and contracted for the output or a large percentage of it. That settled the policy for that firm. It usually never occurred to it that by selling direct it might save the dealer's profit. Here again it is not the solution to the problem, nor even all of the factors that enter the problem that concerns us, but the fact that there is a problem.

Very frequently a dealer will have the confidence of a large consuming trade and that confidence he is justified in capitalizing by selling at a profit. The manufacturer from whom he buys could not compete in that field even with the same product at a lower price. A broker may have developed a reputation for locating the cheapest spot material. The manufacturer would have to offer big inducements to win the consumer

away from such a broker. Again a dealer by reason of his ability to distribute many products diminishes his selling overhead per unit and a manufacturer of a few commodities would find the additional profits gained by selling direct much less than might be expected.

However, it is more than likely that the balance is in the other direction. I mean that a firm is more apt to let it go via broker or dealer than tackle the difficult problems of selling, which problems if tackled would yield desirable and profitable results. Between the firm which sells 100 per cent of its output direct to the consumer and the firm which delivers its product to a selling agent there are all degrees of independence. There is no best way, although it is a safe generalization to say that under ordinary circumstances a firm should make an effort to sell direct to the consumer.

What's Your Price?

There are three general methods of determining selling prices. The first method sets a definite standard price for a carload of material (or other given unit) and allows a rebate for multiples of that unit. In other words, one carload at $4 per 100 lb., ten carloads at $3.90 per 100 lb. The second method allows no rebate per quantity consumption. The consumer of one carload gets the same rate as the consumer of 100 carloads. The third method is to set a minimum price below which salesmen cannot go and above which they will go as high as possible. Obviously the method adopted will depend on the type of consumer, the type of product and the temperament of the firm. All three are in use at the present time by firms of the highest reputation. Method 1 is frequently used when the producer sets a premium on the large consumer, and it is very obviously a concession to the large consumer. There is considerable justification in this procedure, for obviously the selling cost is less per unit product in the case of large consumers. Method 2 is often used by large firms which are in a position to dictate to a consuming industry and by firms which deal with an industry composed of many individual units. Method 3 is, I suppose, most widely used. It offers the greatest flexibility, although the tendency is generally toward the stability and prestige which a fixed price gives.

During the past 2 years any fixed selling policy has suffered. Too many firms have been hard up for cash to permit stability in anything except monopoly selling. Price cutting has been piratical and production cost has frequently been greater than selling price because of the imperative need of cash. This has forced even financially stable firms down to unhealthy price levels in order to meet a competition which they knew to be temporary because of their competitor's proximity to bankruptcy.

Even in normal times price regulation is apt to be unsystematic and not based on any accurate idea of production and selling costs but simply empirically upon what the market will bear. Such a policy is all right if the margin is high, but often a firm loses money without knowing it because it has no studied policy of price setting.

Selling Equipment

Entirely different considerations will govern the policy of the equipment house which sells to the chemical industries and in whose sale policies the chemical industry is vitally interested. There are two general classes into which we can group them. The first class includes those who sell once and for all time, and the second class has every hope of repeat orders. A thickener should last 10 to 20 years, whereas a pump may wear out in 90 days. It is obvious that the firm which sells a thickener will have to make a satisfactory profit on its first installation. The pump manufacturer could give away the first one if the purchaser would be willing to standardize on that make.

Terms

How many business houses there are which have given no thought to the terms of payment for their material. Someone they knew, perhaps a competitor, gave terms called 2/10/30, which means 2 per cent off for cash in 10 days, net 30 days. So they adopted that slogan. Perhaps they were strong enough to allow 60 or even 90 days before payment is due. Perhaps 1 per cent cash discount would have been sufficient. Almost certainly all of their customers should not have had the same terms. Usually the terms are a matter of form and the manufacturer pays little attention to them provided he gets his money some time. Very few if any chemical firms have adopted the admirable trade acceptance plan made possible by the Federal Reserve Bank. This subject will be discussed a little more fully under the Credit Department.

Sales Manager as Chief of Salesmen

So far we have discussed those functions of the sales manager which had nothing to do with the personnel of the sales department. In the average book on sales management this is given priority consideration and most of the discussion of the department is the organization of the personnel, the relation of the sales manager to the organization and the individual, and the personal qualities which should predominate in a sales manager.

Generalizations as to personal qualities are somewhat unsafe, for two very different personalities frequently make splendid records in the same sales manager position. A man may get the co-operation of salesmen by commanding and dominating them, by fraternizing with them, by setting an example of energy and enthusiasm. Who shall say one method is better? It is safe, of course, to say that a sales manager must have qualities of leadership. His salesmen look to him for guidance, encouragement, enthusiasm and reprimand. He must put his policy and his personality across to his men. The sales manager's task with personnel is really no more important than that of any other department head. Much more has been written about it, because the results of failure or success are more immediately obvious. For that very reason they are more easily remedied and therefore not so insidious nor ultimately so vital as the personnel problems in the factory, for example, where the personnel problem is not considered so vital. The most desirable result obtained from so much discussion of the sales manager's personnel problems has been the focusing of attention thereon. It is now without question the healthiest phase of sales manager work. The average sales manager has his salesmen well organized, contented and on their toes. When a sales manager fails, it is probably not because he has not attended to problems of personnel.

In discussing salesmen we mentioned the relation of

the individual to the department and the methods of keeping in contact. It is necessary only to remember that the salesman is a unit in the general campaign and a person as well. The sales manager, then, has to utilize that personality in the general scheme. Multiply that by the number of salesmen and you have the sales manager's personnel problem. A steadfast belief in the relative futility of writing about the way to handle men will cut this discussion short. A few days' observation of a man who is successful in dealing with men is worth infinitely more than any treatise on the subject.

Unlike the purchasing agent's job there is no almost universally applicable system which the sales manager can follow. Unless a system is designed for the specific problems of that company and possessed of considerable flexibility, it is certain to prove inadequate to the needs of the sales department.

A big job and a vital one! Why don't you try selling? You might make a success of it.

Duplex Iron in a German Foundry

In commenting on a paper read before the Baltimore meeting of the American Electrochemical Society by George K. Elliott, entitled "Cast Iron as Produced in the Electric Furnace, and Some of Its Problems," Richard Moldenke read an abstract of a recent paper in *Giesserei Zeitung* on the methods recently installed in an iron foundry in Plauen.

Nothing but low-grade cheap scrap—of which 20 per cent is steel—is charged into the cupola; 5 tons of liquid iron is transferred to a basic electric furnace. Four or five heats are made each day. Iron is held under the ordinary carbide slag about 60 minutes, ferrosilicon and manganese rabbled in, the entire contents poured into a large ladle and the thin slag carefully skimmed. Castings poured from this metal produced very few defectives, showed entire freedom from pinholes, low shrinkage, and no hard spots; the iron was tough but not hard, machined easily, and its strength was increased 30 to 40 per cent. Comparative analyses:

	Cupola Iron	Electric Duplex
C	3.35	3.0
Si	1.65	2.15
Mn	0.35	0.55
P	0.06	0.06
S	0.23	0.05

Low phosphorus in the cupola iron is to be expected in Germany. Sulphur has actually been reduced to 0.01 when molding troubles have held the metal in the electric furnace for an unusually long period.

Cost tables in the original article indicate that the very low price of poor scrap enables such a process to compete with direct cupola melting. Current consumption averaged 160 kw.-hr. per ton of metal.

Effect of Back Pressure on Oil Production

In the study of the effect of regulated back pressure on oil production, the Bureau of Mines has found that wells being produced under several pounds back pressure are not declining as rapidly as other wells in the field. This investigation is of especial interest, as if it can be demonstrated that pressures up to 10 to 15 lb. can be carried on the wells without affecting the production, it will result in saving large quantities of gas, now wasted, by producing the wells at atmospheric pressure.

Timber Preservation Grows in Importance

The increased demand for permanent timber structures is shown in a recent report of the Service Bureau of the American Wood Preservers' Association. Over 2,400,000,000 board feet of timber for various purposes were pressure treated in 1921 by the 122 wood-preserving plants in operation throughout the United States, thereby surpassing the 1920 record by nearly 17 per cent. Approximately equal amounts were treated with coal-tar creosote and with zinc chloride, the standard wood preservatives. To treat this wood 51,375,360 lb. of zinc chloride, with an absorption of ½ lb. per cu.ft., and 79,384,326 gal. of creosote, with an absorption of 5 to over 20 lb. per cu.ft., were required.

Ease of handling and the permanence of well-treated wood at low cost are given as the reason for the increased demand.

Production of Phosphate Rock in 1921

According to conservative estimates made by the United States Geological Survey from the incomplete returns available April 1, the quantity of phosphate rock sold in the United States in 1921 was about 1,968,000 long tons, valued at $10,928,300, as compared with 4,103,982 long tons, valued at $25,079,572, in 1920.

The total production of Florida was approximately 1,675,000 long tons, valued at $9,036,000. Tennessee followed with an approximate total of 293,000 long tons, valued at $1,892,300, which included a small quantity of brown rock from Kentucky. The Western States were reperesented by only one producer, and South Carolina dropped out entirely.

The general business depression of 1921 is illustrated in the decline of the production of phosphate rock. The decrease in the selling price of agricultural products, combined with the high freight rates, prevented farmers from purchasing fertilizer, and the low rates of exchange discouraged exporters in the industry.

Porosimeter Used in Ceramic Investigations

The porosimeter developed in the studies of the oxidation of ceramic wares during firing, being conducted at the Columbus, Ohio, station of the Bureau of Mines, has proved a great aid in the control of the latter part of the burn, more especially for paving blocks where a low porosity is essential. A preliminary survey of the relation among porosity, vitrification and rattler test has been made.

Production of Gypsum in 1921

According to conservative estimates made by the United States Geological Survey from the incomplete returns available April 1, 1922, the quantity of gypsum mined in the United States in 1921 was approximately 2,870,000 short tons, as compared with 3,129,142 tons in 1920. The combined value of the crude and calcined gypsum sold was approximately $20,820,000, as compared with $24,533,065 in 1920.

Bureau of Mines Work on Bentonite

Work has been completed at the ceramic experiment station of the Bureau of Mines, Columbus, Ohio, on bentonites, which are probably aggregates of alkaline hydrated silica and kaolinate. Some of their characteristics are conchoidial fracture, high colloidal content, high water of plasticity and drying shrinkages. Their burned color varies from light buff to brown.

Atmospheric Pollution From Sulphuric Acid Plant Fumes

A Discussion of the Importance of the Fume Problem to the Chemical Manufacturer From the Standpoint of Public Health, Legislation and Economical Operation—Work of the Atmospheric Pollution Committee of the American Institute of Chemical Engineers

By JAMES R. WITHROW
Professor of Industrial Chemistry, Ohio State University

MOST sulphuric acid plants in America are remarkably free from atmospheric pollution, when one considers the ease of escape of the gases and escape products of this industry. The long history of the atmospheric pollution question in the smelting industry is well known. The chemical industries have never been accustomed to such deliberate pollution since the early days of the old Le Blanc soda process. In the first place, the chemical plants are rarely in isolated places, where such wholesale pollution would be a temptation. In the second place, the very nature of the chemical industries makes the conservation and utilization of the polluting gases and escape products of pecuniary importance. The smelting industry, too, is now rapidly stamping out the fume evil.

This does not mean that thoughtless, careless or even criminal pollution of the atmosphere never happens in the chemical industry. Probably no one could successfully maintain this. There will always be thoughtless, careless or even criminal management, as well as workmen. It is inevitable, however, that the number of such operators will gradually approach a minimum. Nevertheless, it is just these few who give occasion to those who, from whatever motive, attack the industries of such a nature that atmospheric pollution is at all possible by them. It must be admitted that the operating management can at times become so absorbed in "production against time" that a "little" escape will be overlooked or even winked at.

Most chemical companies, however, give this matter serious attention. Some of these maintain a staff to control their "escape" and reduce it to the utmost. In spite of such precautions, the growth in density of population makes this whole matter one of increasing concern. It is for the manufacturer to increase his vigilance against "escapes" and give more publicity to his real interest in the matter.

Chemical Manufacturers Neglect Publicity

It comes as a shock when one is told, as the writer has been, by an officer of a state Board of Health, that chemical manufacturers have no interest in the health welfare of their men or community. This opinion was doubtless held in good faith and may even have been true of a few plants, for at one time it was more justified than it is now. However, unless the writer's observation has been misleading indeed, it does not represent the spirit of any great group of chemical manufacturers today.

This allegation of non-acceptance of responsibility in the chemical industry is probably due to the failure of manufacturers to realize the desirability of publicity on the subject. This neglect has been a mistake. Publicity, if sincere, eventually works for good and promotes public confidence. It works both ways too, for it will make it easier for the manufacturer to cooperate with government in such matters for the public good. The slogan, "The less legislation the better, other things being equal," certainly holds true for business. Nothing would be worse than ill-advised or drastic legislation which ultimately would result from a state of ignorance and lack of mutual confidence on the side both of industry and the public. Litigation and injunction are all too frequent at the present time. Manufacturers, therefore, must take even more advanced steps than heretofore.

Importance of the Sulphuric Acid Industry to the Public

The importance of conserving the sulphuric acid industry by helping it to eliminate its fume nuisance troubles which so frequently damage agricultural interests and antagonize urban ones speaks for itself. The elimination of fume nuisance is all the more necessary because of the very fact of this acid industry's growing importance in chemical manufacture, in the pickling of iron and steel before finishing such products as wire, tin plate and galvanized products; its importance in the refining of petroleum and, most of all, because of the quantity used, in the manufacture of superphosphate fertilizer for the development of agriculture.

The desirability of greater uniformity in fume nuisance legislation has been pointed out by Baskerville. There is need of a better chemical knowledge of means of detecting fume escape and the extent of atmospheric pollution, to help plants defend themselves against polluting the neighborhood atmosphere, as well as against losses in production. Work is in progress on suggested improvements of current methods and certain investigational studies in this field are known to be under way, but greater publicity should be given to the experience of the industries with these methods for the benefit of industry as a whole. Satisfactory methods and standards are still uncertain matters. We should arouse comment, suggestion and criticism calculated to bring out every point of view and all available assistance in the abating of fume nuisance near sulphuric acid and other plants. Before positive legislation is passed regarding the operation of such plants, it behooves the chemist, chemical engineer and manufacturer to anticipate such action and to furnish proper and adequate methods for establishing the standard to be adopted.

The importance of sulphuric acid manufacture to agriculture and the arts makes the public interested in conserving this acid industry. This does not warrant the industry in maintaining a nuisance by its escaping

fumes. In fact, the public will insist upon not being imposed upon and, therefore, as the population concentrates in our Eastern and other manufacturing centers the problem must be handled with candor and expedition. The acid maker must be a good citizen with his plant as well as individually. He cannot hope to rest long on his accomplishments like the Western smelter manager who once said that he had no more court troubles since he had been able to show that he had purchased the same fume-poisoned horse nearly two dozen times and each time from a different farmer upon whose premises it was alleged to have died from smelter fumes—a familiar form of graft known in the West as "smoke-farming."

Even when such acid plants have been unwisely placed, though they are not excused in law for creating a nuisance, we probably cannot insist upon their closure or removal. The loss in such an event would be heavy and the community itself would suffer through loss of work for labor and through curtailed production. We must, therefore, meet the situation squarely in good faith and abate the nuisance entirely or at least reduce it to a minimum.

What Constitutes a Nuisance

The public recourse to our courts of justice tends to hold in check a general pollution of the atmosphere or the creation of a general nuisance. What constitutes a nuisance in this country depends on the state in which the question arises. Baskerville has suggested that the ideal remedy would appear to lie in federal legislation controlling the industries, defining the term "nuisance" in connection with fumes from sulphuric acid manufacture and to what extent atmospheric pollution can be permitted without creating such a nuisance. Whether this can be accomplished in our present stage of development in this country is debatable. As the situation now stands, the sulphuric acid industry in the United States is hampered by the varied interpretation in our courts of the term "nuisance."

To hold in check both the inefficient operator of such plants from running wild on the one hand and the unscrupulous lawyer from taking advantage of the present legal conditions on the other hand, it might very well be that federal legislation would be the eventual recourse.

The chaos in this country at present is readily understood when the decisions made in the different states regarding what constitutes a nuisance are reviewed. Local legislation appears in a hopeless situation. Baskerville[1] has pointed out that New Jersey might have one interpretation while New York might have another and so on throughout the Union, ranging in interpretation from one extreme to another. Decisions in Iowa, Massachusetts, Texas and Vermont held that a noxious trade may be a nuisance if it inflicts serious discomfort on people passing by on a public highway no matter how distant from the source of nuisance. On the other hand, the City of New York imposes a stipulated fine for creating a nuisance, but the fact that an order of arrest cannot be issued before one month from the date of initiation of nuisance, and this nuisance may continue until the end of the month, when the fine be assessed, makes the ordinance ridiculous.

The United States appears far behind Great Britain, for instance, in the uniform legislative control of escaping fumes from chemical plants. As early as Jan. 1, 1864, a British Parliamentary act was in operation, not stopping, but regulating, the amount of hydrochloric acid gas escaping into the atmosphere from plants using the Le Blanc process. The act was to lapse in 1868, but at that time it was made permanent. In 1874 sulphuric acid wet process copper works were included, without pollution limits. Two years later a committee of alkali manufacturers was appointed to watch the proceedings of the Royal Commission, which was investigating noxious gases generally. In 1882 an enactment was made that industries manufacturing "chemical manure," salt, nitric acid, sulphate of ammonia, chlorine and sulphuric acid, and those depositing or discharging alkali wastes and creating nuisances from fumes, be added to the list of industries to be inspected and regulated. The object of the act was to prevent damage to the health of the people in the neighborhood of such establishments. Since 1898 the chief inspector has especially emphasized the sulphuric acid industry in his annual report due to the numerous complaints.[2]

The Alkali Commission, self-appointed, also assumed control in England of investigations on methods of analyses of these acid gases and fumes.[3]

The act of 1907 requires that the samples must be taken from the chimney just after the gases leave the Gay-Lussac tower. This obviously gives one source of information necessary in efficient operation, but leaks occurring before the chambers cannot be checked up readily, since the quantity of acid produced from the tonnage of sulphur or ore burned would have to be known to detect these leaks by using this method alone. The quantity of SO_3 and SO_2 escaping from the burner room or leaks in a Glover tower or the chambers, for instance, may be many fold greater than the SO_2 or SO_3 found in the chimney by such a governmental regulation inspection system.

In Germany explicit uniform legislation does not exist. The usual requirement is that the gases from the Gay-Lussac towers shall not contain more than a certain proportion of SO_2 according to the locality. In some places in Prussia the gases may not contain more than 0.02 per cent SO_2 by volume as stated by Ingalls.[4] Wislicenus points out that the danger of such regulations in the hands of local authorities is that politics may play too strong a hand in the proper exercise of controlling atmospheric pollution.

What Fume Control Could Accomplish

It is evident that the control of fume escape from sulphuric acid plants is important from the following points of view, which illustrate what it would or might accomplish: (1) Betterment of health conditions in the neighborhood; (2) elimination of damage to vegetation; (3) elimination of litigation; (4) improvement of production yields.

The effect of these gases on the workmen is very difficult to ascertain. After a short time the men become accustomed to the effects of the gases and they appear no longer irritated by them. The ultimate effect on their health, however, is not known, since no study

[1] *Eng. and Min. J.*, vol. 87, p. 884, 1909.

[2] *J. Soc. Chem. Ind.*, vol. 18, p. 681, 1889; vol. 19, p. 742, 1900; vol. 20, p. 893, 1901; vol. 21, p. 1135, 1902; vol. 22, p. 862, 1903; vol. 23, p. 784, 1904; vol. 24, p. 728, 1905.

[3] *J. Soc. Chem. Ind.*, vol. 21, p. 1490, 1902.

[4] *Mineral Industry*, vol. 14, p. 682, 1907.

appears to have been made thereon and the matter has been given little publicity.

The good accomplished in Great Britain by acts of Parliament and by the Alkali Commission due to co-operation does not seem to have had its influence in America except to the extent it may have raised general commercial efficiency of operation. The appointment of such a body or commission by manufacturers in this country, even if our legislative bodies do not take action, should result in the saving of large sums of money as well as eliminating litigation and friction. The good work of the Selby Smelter Commission carried out under the direction of the U. S. Bureau of Mines, in investigating the nuisance created by the Selby Smelter & Lead Co. of Contra Costa County, Cal., due to dust, SO_3, H_2SO_4 fumes and SO_2 mainly, with small amounts of lead and arsenic compounds, was a valuable contribution.

Losses in Acid Plants

We should not feel that this problem exists, however, only among smelters. Sulphuric acid plants are more frequently concerned than in the past. That the fume problem from sulphuric acid plants is a real one may be deduced from the operation data of a certain sulphuric acid plant, which has recently been sued in court for damage done to surrounding farm lands. During the period from Jan. 1 to June 30, 1920 (inclusive), 13,936 tons of chamber acid was produced. On the basis of sulphur burned, for the same period of time 902 tons sulphuric acid was lost. Therefore it was calculated that about 229 tons of sulphur may have been dissipated into the air through leaks in chambers, backfires in burners or through the exit flue. This was a percentage loss of 6.06 per cent on the basis of sulphur burned, or a pollution of the air to the extent of 5,046 lb. of SO_2 per day, or in the neighborhood of 30,000 cu.ft. if all the loss followed this route. As a matter of fact, it is extremely improbable that high exit gas accounts for all this loss, although undoubtedly much did go this way. The loss at this plant is high, but not necessarily much above the average practice throughout the United States, though at most plants the loss is probably not due to any great extent to SO_2 escape. Thorpe[5] states that the yield in practice from burning brimstone averages 96 to 98 per cent.

Efforts at Amelioration

With respect to amelioration of SO_2 escape, smelter experience is suggestive. In some instances court rulings have regulated the extent of pollution by ordering curtailment of production so that the amount of SO_2 pollution may not exceed a specified quantity. Other plants have striven to keep down the ratio of SO_2 in the air by dissipation of gases by means of large stacks and by the use of the Wislicenus lattice-top smokestack.[6]

Chemical absorbents such as water, sulphuric acid, metallic oxides and hydroxides, dicalcium phosphate, silica gel, lime and limestone, moist scrap iron, charcoal and such materials have been suggested, but not extensively put to practical use for rather obvious reasons. Because of the high dilution of the SO_2 gas, mechanical water concentrators have been suggested by Wedge[7] in addition to the chemical absorbents mentioned above.

Even if any one of the above were a commercial success, as the Tennessee cases undoubtedly are, smelter fume solution would not necessarily solve the sulphuric acid fume problem in its entirety. Enforcement of efficient operating practice would probably be more efficacious.

Frequently bad operation appears to be the cause of excessive fume distribution over a community by a plant using SO_2 or SO_3 in some form. Even in efficiently operated plants, however, as indicated by the chief inspector's report of the alkali works regulation acts, the fume problem assumes varying degrees of annoyance and has not been solved. Some plants in this country are so well managed that they are seldom if ever a nuisance. In operation a leak may escape notice of the employees, because they have become so accustomed to these odors, while the annoyance to persons outside of the plant may be considerable. Therefore the sense of smell cannot be relied on. Proper methods of control in the plant, able to detect any undue loss or escape of constituents, are essential in efficient operation of sulphuric acid plants.

The analysis of the neighborhood atmosphere is necessarily the first consideration in any investigation of this kind. At present the iodine and $KMnO_4$ oxidimetric and the alkalimetric methods are employed in attempts to detect and evaluate escape of gases and check operation of plant. These methods, however, are known to be not as satisfactory as they should be.

Active Interest Among Chemical Manufacturers in the Fume Question

The New Orleans meeting of the American Institute of Chemical Engineers furnished a good index of the keen interest of chemical producers in this whole question of atmospheric pollution from chemical sources. The discussion of the sulphuric acid fume problem at that meeting was one of the best discussions drawn out by a paper before the Institute for several years. Many ideas and points of view were brought out. The Institute appointed a committee to report upon the matter. Among the suggestions in the discussion of this subject in the Institute and the various meetings of its committee, a few should be mentioned to show the nature of the interest aroused.

1. It was suggested that a co-operative committee of the chemical industries subsidized by the manufacturers would enable America to progress rightly in the question and assist in solving the fume nuisance not only from sulphuric acid plants but from all chemical industries evolving SO_2 and other noxious gases. If someone does not initiate this, it will come by bunglesome legislation; nothing can stop it. Therefore the sooner the question is met the greater convenience the chemical industries will be to the communities at large and the better will trouble with these communities be evaded.

2. It was brought out that this whole problem is closely connected with that of industrial health hazards, which is receiving able attention. The economic and business relation to the community of this fume question makes it a broader one than merely health hazard, important as that matter may be.

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[5] Dictionary of Applied Chemistry, Vol. V, p. 327.

[6] Met. & Chem. Eng., vol. 9, No. 11, p. 606, November, 1911; Met. & Chem. Eng., vol. 10, No. 2, p. 96, February, 1912; *J. Ind. Eng. Chem.*, p. 425, 1913.

[7] *Eng. and Min. J.*, vol. 95, p. 628, 1913; *J. Soc. Chem. Ind.*, vol. 39, p. 370, 1920.

3. Attention was called to the experience at Ducktown, Tenn. No SO_3 was found with the SO_2 in the stack gases if the barium chloride absorption solution was boiled in the dark, upon an electric hot plate. An SO_2 concentration of 342 parts per million within 50 yd. of the stack dropped to zero at 2 miles distance. The Selby Smelter Commission method was used in the 6-liter samples rather than 24-liter samples. *N*/500 iodine gave a sensitiveness of 0.18 part per million of SO_2.

4. The psychological and real estate trading features of complaints were brought out in cases where plants even moved into a wilderness and had towns subsequently grow up adjacent, entirely dependent upon the industry.

5. Damage to trees from sulphur derivatives in power plants' stack gases due to sulphur in the fuel was pointed out from Cleveland and other cities. The astoundingly great volumes of SO_2 in any metropolitan district from the sulphur in the coal consumed was also emphasized.

6. It was pointed out that the problem should be solved rather than dismissed as excusable or unavoidable. The public will not long stand for such an attitude.

7. It was pointed out that enforced stoppage of pollution makes the manufacturer more attentive to production efficiency, and in spite of his initial protest and resistance, legislation eventually works out in many cases in his favor. The huge Tennessee sulphuric acid production is a case well in point, as is also the making of sulphuric acid from liquid sulphur dioxide at the Tacoma smelter.

Work of the Committee of the Institute of Chemical Engineers

Subsequent to this discussion at New Orleans, President Wesson of the Institute of Chemical Engineers appointed a committee to take up the suggestions and make a report of action the Institute should take in the matter. This committee carried on active correspondence. Two of its members made long trips, one to Utah and the other to the Tennessee copper region. The committee gathered many data and many conflicting suggestions. After 10 months' work all preliminary disagreements were finally ironed out and such material as could be unanimously agreed to was presented to the Institute, where the report was unanimously adopted and the committee discharged.

This final report incorporated all of the essential suggestions of a preliminary tentative report, which was presented at the Detroit meeting of the Institute,[8] and that report was materially strengthened. All members of the committee took an active interest in its work, and it is believed that the report of the committee constitutes the most advanced position taken by a body of chemists or engineers on the fume subject in this country.

The matter of sulphuric acid plant fume was not the exclusive consideration, but the committee was selected entirely of men interested in this question, because the fume question from sulphuric acid plants has to do with our most fundamental acid industry. It is quite possible that further suggestions could have been adopted by the committee and still more advanced position taken. Nevertheless, the position taken is a substantial one. There is now definitely on record the keen interest which manufacturing chemists possess in this matter, and the report of the committee places squarely upon the shoulders of the Manufacturing Chemists' Association the responsibility for further advances and action in this matter. It is believed that that organization will not shirk its responsibility or ignore its part, since its members officially represent manufacturing organizations.

It is particularly worthy of note that while there was strenuous difference of opinion among members of the committee as to modes of action, yet the reasonable attitude of every member, because of the keen interest in improving the situation for the benefit of both the public and the industries, resulted in the inevitable unanimous agreement upon the report.

Committee Report

Extracts from the report as adopted by the American Institute of Chemical Engineers at its Baltimore meeting, December, 1921, follow. Its details will show more fully than any discussion could the real advances that were made by this committee:

> To the American Institute of Chemical Engineers:
>
> Gentlemen: Your committee begs leave to report:
>
> That we have confined our attention to atmospheric pollution by chemical manufacturing processes only.
>
> Your committee is aware of research being carried on by various investigators along the line of atmospheric pollution in connection with smelter fumes, and it urges these to proceed with the publication of their results at the earliest practicable date for the benefit of the chemical industry and the public.
>
> Your committee recommends that the Institute should stand for the principle that the public is not interested in the chemical efficiency of any particular chemical process liable at times of causing atmospheric pollution but only in the question as to whether it, the public, is in fact being injured. For instance, an arbitrary limit on the number of grains of SO_2 per cu.ft. in an exit gas means nothing unless taken in connection with the height of the exit above the surrounding country capable of being injured, having clearly in mind that the essential factor is the actual concentration at the area of possible damage. Any contemplated legislation or regulations should be drawn up having these facts clearly in mind.
>
> We call to the attention of the Institute that, in the Anderson smelter case at Salt Lake City (as the most recent notable smelter case), the court recognized the conclusions of Dr. Swain's committee[9] as to facts of the limit of injury to vegetation by sulphur dioxide. This concentration was established by careful investigation, such as that by Dr. O'Gara. The most notable conclusion thus established and accepted in court was that in order to produce injury to vegetation by sulphur dioxide it is necessary to have a concentration of at least one part per million by volume for a period of 3 hours in contact with the plant under optimum conditions. Swain's report states that the optimum conditions would be: "It is now conceded that there are four predominant factors which operate in this connection: (1) Humidity, (2) light, (3) temperature, (4) duration of exposure.
>
> "Of these four factors, that of the relative humidity of the atmosphere is perhaps the most important. The concentration of sulphur dioxide, which is necessary to produce markings on the less resistant plants when the relative humidity is very low, is seven or eight times that which is necessary if the humidity is very high. . . . Light is also one important factor. During the

[8] Chem. & Met. Eng., vol. 21, No. 1, July 6, 1921.

[9] Report of Dr. Robert E. Swain as Commissioner of the United States District Court for the District of Utah in the case of John A. Anderson et al., plaintiffs, vs. American Smelting & Refining Co. and United States Smelting & Refining Co., defendants. This report dated Feb. 28, 1921, and addressed to the Hon. Tillman D. Johnson of the United States District Court, Salt Lake City, Utah.

See also Chem. & Met. Eng., vol. 22, No. 25, p. 1145, June 23, 1920; vol. 24, No. 11, pp. 459 and 463, March 16, 1921; vol. 24, No. 16, p. 709, April 20, 1921.

night-time plants require much higher concentration of sulphur dioxide to produce typical markings than they do in daylight, other conditions being constant. . . . Temperature is a third factor, but of importance only in that a temperature of 5 deg. C. is a necessary optimum condition. . . . "It is now generally conceded that a concentration of at least one part per million over a period of 3 hours is necessary to produce undoubted injury to the most sensitive crops."

The committee urges that all chemical manufacturers recognize the far-sighted policy of settling promptly and out of court all just claims, and fight to the limit all unjust claims because of the far-reaching damage which may result not only to themselves but to the entire industry by precedents accidentally established through erroneous court decisions.

We recommend to the attention of the Institute and to operating engineers and manufacturers the extensive studies made in the various smelter fume cases of the country, that much suggestive help and guidance may be obtained as a result of earnest and exhaustive research on the subject, and that the trend of court opinion and decision in these cases may be obtained not only in regard to atmospheric pollution in general, but particularly in regard to sulphur dioxide and sulphuric acid fumes. A partial list of sources of information in this field is as follows:

1. Report to Supreme Court of the United States—October Term, 1914. State of Georgia, plaintiff, vs. Tennessee Copper Co. and the Ducktown Sulphur, Copper & Iron Co., Ltd. By J. T. McGill of Vanderbilt University.
2. Report to Supreme Court of the State of California in and for the County of Solano, 1915. People of the State of California, plaintiff, vs. Selby Smelting & Lead Co. United States Bureau of Mines Bulletin 98, Report of Selby Smelting Commission.
3. Report to United States District Court of Utah, Feb. 28, 1921. John A. Anderson et al., plaintiffs, vs. American Smelting & Refining Co. and the United States Smelting & Refining Co. By Dr. R. E. Swain of Leland Stanford University acting as commissioner of the court.

Your committee is glad to report, as an evidence of the widespread interest in the problem of atmospheric pollution, that the advisory committee on atmospheric pollution of the Meteorological Office of the British Air Ministry in London have written through their superintendent, Dr. A. S. Owens, to Dr. Charles Baskerville of your committee, discussing his work on the detection of sulphur dioxide and offering to co-operate on any program which your committee or the Institute might inaugurate, to save time from overlapping of effort.

As an indication of the real interest of this committee in the problem, it needs only be mentioned that of the committee members, Henry Howard was formerly of the Merrimac Chemical Co., and now of the Grasselli Chemical Co.; A. M. Fairlie is consulting chemical engineer to the Tennessee Copper Co. in sulphuric acid development at Copperhill, Tenn.; C. B. Clark is in charge of fume problems of the General Chemical Co.; A. E. Marshall is consulting chemical engineer and former manager of the Davison Chemical Co., Curtis Bay, Md., for many years experienced with British practice; the late Charles Baskerville was chairman of the committee on occupational diseases of the American Chemical Society; A. B. Conner is chemical engineer of the Detroit Chemical Co.; James R. Withrow, chairman, is in charge of the investigations of the sulphuric acid fume problem work of the Engineering Experiment Station of the Ohio State University.

Sulphur, Pyrites and Sulphuric Acid in 1920 and 1921

The quantity of sulphur produced in 1920—1,255,249 long tons—was the largest produced in any year except 1918, when the output reached 1,353,525 long tons, according to the United States Geological Survey. The shipments in 1920, amounting to 1,517,625 long tons, exceeded those of any other year. Two mines in Texas and one each in Louisiana and Nevada furnished all the sulphur produced in this country in 1920. The value of the shipments in 1920 is estimated at $30,000,000. The sulphur produced in 1921 amounted to 1,879,150 long tons, which is about one-third more than was produced in 1920. On the other hand, the shipments in 1921 were nearly one-third less than in 1920, amounting to only 954,344 long tons, as against 1,517,625 long tons. It is therefore evident that large stocks of sulphur are now on hand. In 1920 and 1921, as in former years, more than 99½ per cent for the sulphur produced in this country came from Texas and Louisiana.

The exports of sulphur in 1920 amounted to 477,450 long tons, valued at $8,994,350, and in 1921 to 285,762 long tons, valued at $4,524,788, according to records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce. It is therefore apparent that the exports of sulphur decreased about two-fifths in 1921 and that there was a drop in value of $3 a ton from 1920 to 1921. The imports of sulphur dropped from 136 long tons in 1920 to 50 long tons in 1921, and the value decreased about $7.50 per long ton.

Pyrites

The production of pyrites in 1920 was 310,777 long tons, valued at approximately $1,597,000. This quantity was almost twice that produced in 1921—157,118 long tons—estimated to be worth about $700,000. In 1920 California led in production, contributing 128,114 long tons, which was only a few hundred tons less than in 1919, and 98,252 long tons in 1921. The average value per ton for the total pyrites produced in the United States was somewhat less in 1921 than in 1920, being about $5 for 1920 and $4.45 for 1921.

The reports received from producers indicate that the market for pyrites has been very poor for the last 2 years, because the manufacturers of sulphuric acid, who have heretofore been the principal purchasers of pyrites, are now using more native sulphur, which is not only cheaper but more easily handled. The slack market is also reflected in the imports of pyrites, which fell off about one-third in 1921 from those in 1920. The imports in 1920 amounted to 332,606 long tons, valued at $1,660,832. About 200,000 long tons came from Spain, 100,000 long tons from Canada, and small quantities from France, Cuba, Chile and Hongkong. The imports in 1921 amounted to 216,229 long tons, valued at $818,852. The price per ton of the imported ore was about $1 less in 1921 than in 1920.

Sulphuric Acid

Sulphuric acid was produced in thirty states in 1920 to the amount of approximately 5,600,000 short tons, of 50 to 66 deg. Bé. computed as 50 deg. Bé. acid. The estimated value of this acid is $59,000,000. Production of the stronger acids amounted to 502,970 short tons, valued at approximately $10,600,000. Figures relative to the production of sulphuric acid in 1921 will be compiled by the Bureau of the Census.

Records of the Bureau of Foreign and Domestic Commerce show that 14,494 short tons of sulphuric acid, valued at $738,188, was exported from this country in 1920, and 5,409 short tons, valued at $87,979, was imported.

Studies in the Carbonization of Coal: Characteristics of Low-Temperature Coal Tar*

A Continuation of the Study of the Composition of a Commercial Low-Temperature Tar—The Nitrogen Bases, Alcohols, Sulphur Compounds, Saturated, Unsaturated and Aromatic Hydrocarbons—Review of the Results Obtained by Previous Investigators

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EDITOR'S NOTE: In the preceding section of this report, which was published in CHEMICAL & METALLURGICAL ENGINEERING for May 17, 1922, pp. 923 *ff.*, the authors outlined a scheme for the examination of low-temperature tars and compared the composition of a commercial tar (Carbocoal) with that of coke-oven and gas works tars. In the present installment, the nitrogen bases, alcohols, sulphur compounds and hydrocarbons present in low-temperature tar are given detailed discussion similar to that accorded the phenols in the previous paper.

The Nitrogen Bases

Percentage of Bases. The percentages of bases in low-temperature tar were determined in four of the five phenol-free fractions of the tar distillate by a gravimetric method similar to that used for the tar-acids (*cf.* Fig. 1). Since the quantity of bases contained in the first fraction (20-173 deg.) was too small for quantitative extraction with 20 per cent sulphuric acid, however, recourse was taken to a titration method, using methyl orange as indicator.[26]

The results of these analyses are recorded in Fig. 7, where the percentages of bases in each tar-fraction are plotted against the average boiling point of that fraction during distillation. The rapid rise of this curve indicates that the pitch probably contains a greater quantity of these compounds than the distillate.

Examination and Classifications. The crude tar-bases, recovered and purified as indicated in Fig. 1, formed a non-viscous, dark brown liquid mixture with a strong odor of pyridine. Having ascertained that the decomposition resulting was negligible, a sample was rapidly distilled to dryness to obtain a clear distillate for the later tests.

The bases showed a negative carbylamine reaction, and with nitrous acid evolved insufficient nitrogen to be measured. Primary bases could therefore be present only to a negligible extent. A saturated solution of sodium nitrate precipitated a mixture of nitrosamines from a hydrochloric acid solution of the bases. After purification their nature was verified by the Liebermann and diphenylamine reactions. The tests were both pronounced, and demonstrated the presence of secondary amines.

Hinsberg's benzene-sulphonyl-chloride method was used to separate the secondary from the tertiary bases. A precipitate of sulphonamides was formed, which was completely insoluble in alkali. On acidification, 80 per cent of the sample passed into the acid layer. The Carbocoal bases, therefore, contained no primary, about 20 per cent secondary, and 80 per cent of tertiary bases. The purified tertiary bases recovered by this method and the sulphonamides prepared from the secondary bases rapidly reduced a 1 per cent aqueous solution of potassium permanganate, indicating unsaturation.

Fractionation and Specific-Gravity Determinations. The density of the mixture of low-temperature bases was 0.993, and that of the high-temperature bases was 1.060 at 15.5 deg./4 deg. C. Comparative fractional distillations showed that the bases from low-temperature tar are lacking in any preponderant single component analogous to quinoline in the high-temperature

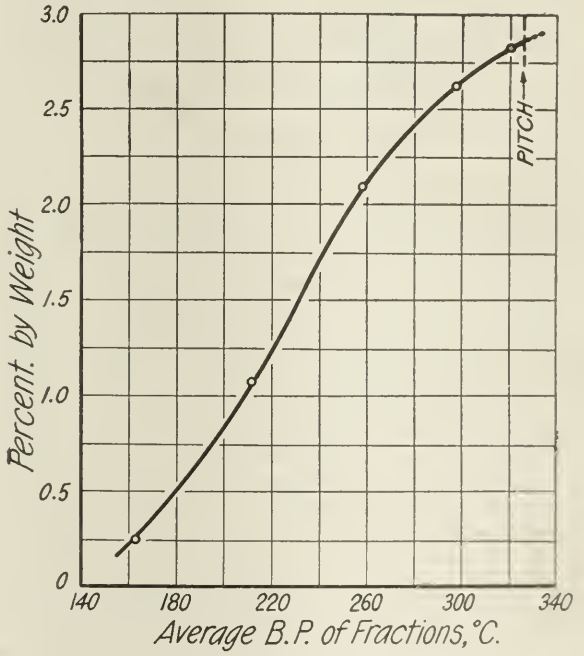

FIG. 7—RELATION OF BOILING POINT OF TAR FRACTIONS TO PERCENTAGE OF BASES CONTAINED IN EACH

bases. Following the practice employed with the tar-acids, the bases were re-fractionated with a 10-in. Vigreux column, and six fractions obtained in each case. The specific gravities of the fractions, determined after drying over solid potassium hydroxide, are plotted in Fig. 8 against the corresponding average boiling points (determined graphically). These curves demonstrate that the low-temperature bases are in general quite different in composition from those in

*Condensed from a thesis presented by Roland P. Soule in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Faculty of Pure Science of Columbia University in the City of New York.

[26] W. Gluud and P. K. Breuer, *Ges. Abhandl.*, vol. 3, p. 227 (1918).

ordinary coke-oven and gas-works tar. This is contrary to the case of the tar-acids (Fig. 6).

The smallest difference in density between the low- and high-temperature bases occurs in the low-boiling fractions. The first fraction of the low-temperature bases had a strong odor of pyridine, and was the only fraction appreciably soluble in water. With α-dinitrochlorbenzene it showed the characteristic red-violet color of the pyridine derivative. In common with ordinary tar, therefore, low-temperature tar contains some pyridine.

In the distillates between 230 and 260 deg. the densities of the bases are about 0.07 lower than those of

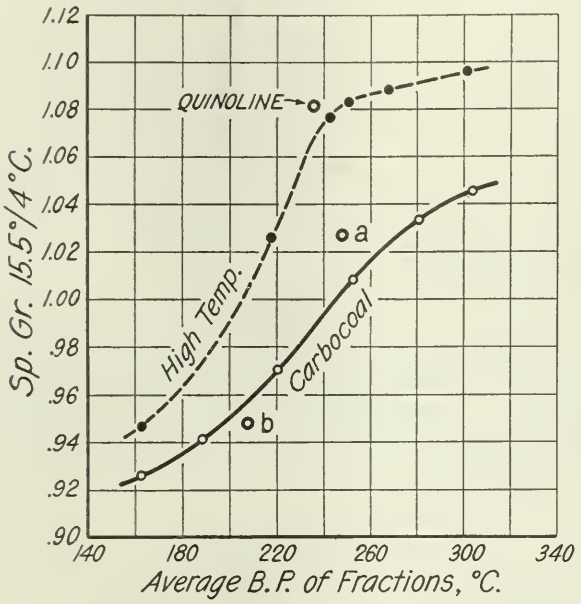

FIG. 8—BOILING VS. SPECIFIC GRAVITY OF BASES

the corresponding fractions of the quinoline-containing high-temperature bases. This difference indicates in the low-temperature bases a greater degree of hydrogenation of the nucleus, the presence of aliphatic side-chains of higher molecular weight, or both. Such compounds are exemplified by point *a*, N-methyltetrahydroquinoline and by point *b*, 2 methyl, 3 ethyl, 1:4:5:6 tetrahydropyridine. Since unsaturated bases are also present, compounds of the type of dihydroquinoline may occur in the mixture.

Average Molecular Weights. The relative[27] molecular weights of the various fractions of low- and high-temperature bases were determined by the ordinary Beckmann cryoscopic method, using benzene as the solvent. It was found that as the boiling points of the fractions increase the difference between the respective molecular weights varies in much the same fashion as the difference in specific gravity (Fig. 8), the maximum variation being 15 to 20 in the middle-boiling fractions. Hence the lower densities of the Carbocoal bases seem chiefly ascribable to the presence of aliphatic side-chains of molecular weight higher than those of the higher-temperature bases. This conclusion gains weight from a consideration of the analogous relationships between the principal hydrocarbons of low- and high-temperature tars discussed below.

Previous Investigations. Jones and Wheeler[2] were unable to obtain more than traces of nitrogen bases in the small amount of tar at their disposal. Parr[3] reported an average of 0.23 per cent of "amines" on the basis of the crude, dry tar in the fractions boiling below 260 deg. C. Gluud[26] announced 0.46 per cent of "pyridine" in the Lohberg coal tar mentioned above (Table II). These investigators did not interest themselves in the nature of the bases.

Pictet[1] found 0.2 per cent of bases in the "vacuum tar" of Montrambert coal. He reported primary amines to be present, and identified the fraction 198-203 deg. as a mixture of toluidines. Pyridine and other tertiary amines appeared to be absent. Ultimate analysis of the picrates of the higher fractions showed them to be the dihydro-derivatives of quinoline and iso-quinoline. The significance of the absence of tertiary bases in this tar and their presence in low-temperature tar is discussed in the section on secondary carbonization reactions.

Alcohol and Sulphur Compounds

Alcohols. A sample of the low-temperature distillate freed of tar-acids and bases was boiled with metallic sodium, but no evolution of hydrogen or loss in weight of sodium was observed. Alcohols are therefore absent. Pictet[2] found 2 per cent of alcohols in "vacuum tar." The lowest-boiling component proved to be hexahydro-*p*-cresol; the others were isomers of monatomic phenols, a mixture of which they yielded on simple standing for a month. No other investigator has reported alcohols in low-temperature coal tars.

Sulphur Compounds. Hydrogen sulphide was determined (0.08-0.1 per cent) in the first two fractions of the low-temperature distillate, but most of this compound is to be found in the gaseous and aqueous products of distillation. A negative phenylhydrazine test showed the absence of carbon disulphide. Thiophene is indeterminate by the indophenine, thallin and mercuric salt tests in the presence of the large proportion of unsaturated hydrocarbons, which cannot be removed alone. No analyses of sulphur compounds are reported in the literature.

The Saturated Hydrocarbons

Examination of the Hydrocarbon Mixture. The neutral oils remaining after the extraction of the tar-acids and bases constitute the hydrocarbons of low-temperature tar. When freshly distilled, the lower fractions are pale yellow and the higher fractions amber colored. After standing for several weeks, all of the fractions become quite black in color, and deposit on the walls and bottoms of the bottles a thin, black coating. This is evidently due to the spontaneous polymerization or oxidation of a very small portion of the unsaturated compounds present, and is more marked in the lower than in the higher fractions. The density of fraction 20-173 deg. increased 0.012 on standing for 4 months.

The specific gravity of the total mixed hydrocarbons in the fresh distillate was found to be 0.891 at 25 deg./4 deg. as opposed to 1.028 of the coke-oven hydrocarbons distilled under similar conditions. Fractional distillation of the Carbocoal hydrocarbons shows the presence of no preponderant single compound such as the naphthalene of high-temperature tar. Since only a few very fine flakes of white crystals could be obtained in fractions cooled to —30 deg. C., only traces of solid aromatic hydrocarbons, such as naphthalene

[27] Pyridine bases are slightly associated in benzene solution.

or anthracene, can be present in the low-temperature tar.

Composition of the Mixture: Separation of the Classes of Compounds. All fractions of the hydrocarbons from low-temperature tar instantly reduced a 1 per cent aqueous solution of potassium permanganate, and rapidly decolorized a solution of bromine in chloroform. Unsaturated hydrocarbons were therefore present in considerable quantity. Means for the qualitative detection of the other classes of components are lacking, however. Previous investigators have reported in low-temperature tars the following groups of hydrocarbons, listed in the order of their chemical activity:

1. Unsaturated (olefinic and cyclic).
2. Aromatic (liquid).
3. Naphthene (saturated cyclic).
4. Paraffine (liquid and solid).

Determination of the Percentage of Paraffine Plus Naphthene Hydrocarbons in the Neutral Residues. This analysis was accomplished by the treatment of 15 to 20 g. samples with 75 c.c. of 98 per cent sulphuric acid.[28] Each sample was agitated for half an hour in a glass-stoppered separatory funnel, and the weight of the residual oils determined. The results were corrected for polymerization[29] of the unsaturated hydrocarbons by a method based on redistillation of the residual saturated oils and subtraction of a quantity equivalent to the weight of the dissolved polymers. All determinations were made in duplicate, and the means of the closely agreeing values are plotted in Fig. 2. The percentage of saturated hydrocarbons thus obtained (13.9 per cent) is much lower than any previ-

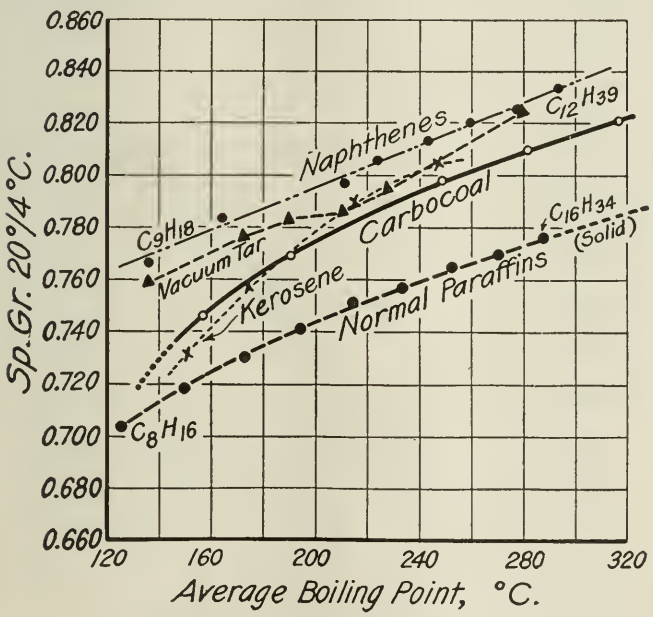

FIG. 9—SP.GR. OF SATURATED HYDROCARBONS

ously reported (Table II). This is explained in the section on secondary carbonization reactions.

Estimation of the Naphthenes. The indices of refraction and specific gravities of the redistilled saturated hydrocarbons were determined. Fig. 9 shows that the graphical relation between the densities and boiling points of these residual oils offers a method of approximating the proportions of paraffines and naphthenes. The densities plotted for the naphthenes are those reported[30] for hydrocarbons of formula C_nH_{2n} isolated from crude petroleum. It is apparent that the position of the Carbocoal curve between the naphthene and paraffine curves may be used as a basis of estimating the proportions of these groups of hydrocarbons. No great accuracy can be claimed for such an approximation, since the densities of the naphthenes vary slightly according to the nature of the hydrocarbon, although they are much less erratic than the corresponding indices of refraction. Representative values were selected, however, and it is believed that a fair picture may thus be obtained of the composition of the saturated hydrocarbons from low-temperature tar. The distillate thus contained 8.8 per cent naphthenes and 5.1 per cent paraffines.

An interesting sidelight on the nature of these hydrocarbons from low-temperature tars is given by a comparative examination of oils of the same boiling point from crude petroleum. A kerosene from the mid-continental field was washed thoroughly a number of times with oleum until no test was given for unsaturation. The water-white oil thus obtained after washing with alkali and redistilling possessed the same fragrant odor as the saturated hydrocarbons. The refractive indices and specific gravities (*cf.* Fig. 9) of the fractions of this refined kerosene reveal a striking similarity between these two groups of oils, one obtained from coal and the other from petroleum.

Previous Investigations. Previous investigators have interested themselves primarily in the qualitative study of individual compounds. Fischer and Gluud[31] cooled a dilute acetone solution of the oils to about —70 deg. C. with liquid air. They estimated that the "benzine" fraction (below 200 deg.), the "illuminating oil" fraction (200-300 deg.), and the "lubricating oil" fraction (above 300 deg.) each contained 10 per cent of paraffines. The paraffines boiling between 200 deg. and 300 deg. were liquid ($C_{10}H_{22}$ to $C_{19}H_{40}$) and those in the higher fractions were solid ($C_{24}H_{50}$ to $C_{29}H_{60}$).

Ultimate analysis has been employed by other investigators for the same purpose. Jones and Wheeler[2] reported a mixture of naphthenes with a small quantity of paraffines in the saturated fraction 35-125 deg. C. of their low-temperature tar, but concluded from the high percentages of carbon in the fractions boiling between 150 and 300 deg. that they "must consist of naphthenes only, or, what is less likely, of mixtures of paraffines with hydrocarbons richer in carbon than the polymethylenes." Solid paraffines ($C_{26}H_{54}$ and $C_{27}H_{56}$) were crystallized from the fraction 200-260 deg. at 30 mm.

Pictet[1] examined the six fractions of "vacuum tar" obtained between 135 and 285 deg. after extraction with liquid sulphur dioxide, and reported all to have the general formula of the naphthenes. He was able to identify the hexahydro-derivatives of mesitylene and durene. The only solid hydrocarbon found was a naphthene, melene ($C_{30}H_{60}$).

The Non-Saturated Hydrocarbons

The unsaturated and aromatic hydrocarbons constitute the second largest group in the low-temperature tar. The distillate contains 41.5 per cent of these compounds, while the tar-acids amount to 42.7 per cent.

[28] H. G. Evans, *J. Soc. Chem. Ind.*, vol. 38, p. 402T (1919); F. B. Thole, *ibid.*, vol. 38, p. 39T (1919).
[29] B. T. Brooks and Irwin Humphrey, *J. Am. Chem Soc.*, vol. 40, p. 822 (1918).
[30] C. F. Mabery, *Proc. Am. Acad. Arts and Sci.*, vol. 40, p. 323 (1914); Markownikoff and Ogloblin, *Berl. Ber.*, vol. 16, p. 1873 (1883); Konowaloff, *Chem. Z.*, vol. 14, p. 113 (1890).
[31] F. Fischer and W. Gluud, *Ges. Abhandl.*, vol. 2, p. 295 (1917); vol. 3, p. 39 (1918).

The low density and congealing point of the total hydrocarbon mixture point to the absence of ordinary solid aromatic hydrocarbons and to the preponderance of the unsaturated components. The specific gravities at 20 deg./4 deg. of the non-saturated fractions were calculated, as shown in Fig. 10, from the densities of the total neutral oils and of the saturated hydrocarbons, and from the known percentages of saturated hydrocarbons in the neutral oils. The curve thus obtained is too high for the densities of the olefines, and indi-

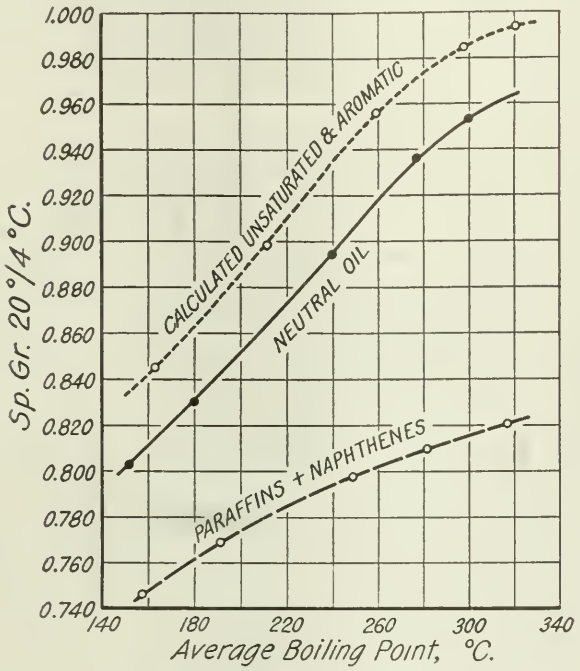

FIG. 10—SPECIFIC GRAVITIES OF HYDROCARBONS FROM LOW-TEMPERATURE TAR

cates that the unsaturated hydrocarbons are cyclic in character.

Recovery of the Non-Saturated Hydrocarbons. The only method that appears to offer a means of recovering the non-saturated (unsaturated and aromatic) hydrocarbons comparatively free from naphthenes and paraffines is extraction with liquid sulphur dioxide. Although the fraction 20-173 deg. is miscible with this solvent[32] in all proportions at —35 deg. C., the separations accomplished are sharper and more specific in hydrocarbon mixtures of high molecular weight. While non-saturated hydrocarbons can be recovered in this manner, doubt must be cast on their purity, therefore, because of the variation in the effect of the solvent throughout the wide range of compounds involved. In particular it is to be expected that the lower fractions will be found admixed with a portion of the naphthene and paraffine hydrocarbons.

Using a ratio of three parts by volume of oil to five parts of liquid sulphur dioxide and the apparatus and method described by Bowrey,[33] a hydrocarbon mixture constituting a representative sample of the combined fractions was resolved into two parts; an extract containing the non-saturated and a small quantity of low-boiling saturated hydrocarbons, and a residue composed principally of saturated hydrocarbons.

Examination of the Non-Saturated Hydrocarbons. The oils recovered from the sulphur dioxide layer were washed with alkali and subjected to three very slow fractionations with a Vigreux head. The distillates were water-white at first, but after exposure to the atmosphere for only a few minutes became amber colored; the higher fractions showed a violet fluorescence. All fractions could be distilled at atmospheric pressure with only slight decomposition. The specific gravities and indices of refraction of the seventeen fractions collected were determined. Fig. 11 shows these specific gravities, both observed and calculated, plotted against the average boiling points of the respective fractions.

It was expected that admixture with saturated hydrocarbons would cause the observed values in the lowest-boiling fractions to fall below those calculated. The calculated curve is too incomplete to establish this point, but the "vacuum tar" data also plotted in the figure show the same effect. Although it is very probable that low-boiling saturated hydrocarbons were present in this extract, the large number of fractionations to which they were subjected would be effective in eliminating most of them from the restricted fractions selected for analysis as chemical individuals.

The striking resemblance between the non-saturated hydrocarbons from low-temperature tar and "vacuum tar" extends to the respective refractive indices and average molecular weights, which were determined in selected fractions by the usual Beckmann cryoscopic method. The close agreement between the physical constants of these hydrocarbons shows that the non-saturated compounds from the former apparently belong in general to the same class of cyclic, unsaturated hydrocarbons described by Pictet.[1] In this series he

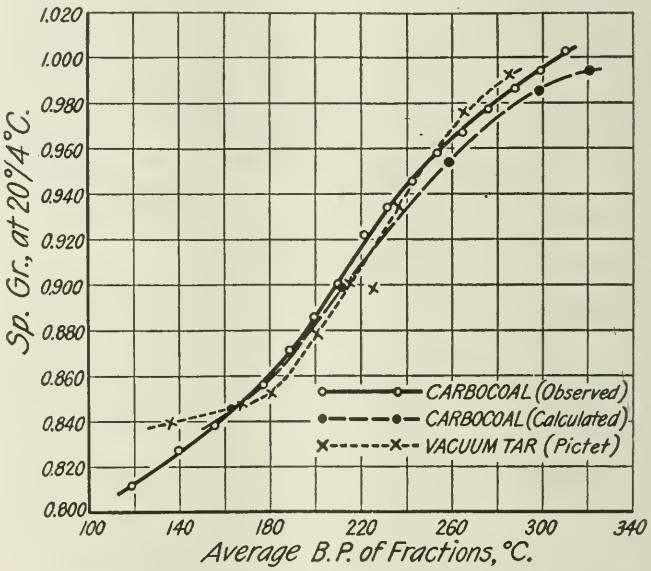

FIG. 11—SPECIFIC GRAVITIES OF NON-SATURATED HYDROCARBONS

was able to identify dihydro-*m*-xylene, dihydromesitylene, dihydroprehnitene and hexahydrofluorene. The higher-boiling members of the series have from three to five double bonds (basis of molecular refraction), and are apparently polycyclic. No aromatic hydrocarbons were detected.

Aromatic Hydrocarbons in the Non-Saturated Oils. The very low congealing temperatures of all of the fractions demonstrate the absence of solid aromatic hydrocarbons of the type occurring in ordinary high-

[32] *Cf.* R. J. Moore, J. C. Morrell and G. Egloff, MET. & CHEM. ENG., vol. 18, p. 396 (1918).

[33] S. E. Bowrey, *J. Inst. Pet. Tech.*, vol. 3, p. 287 (1917); *Chem Trade J.*, vol. 60, p. 426 (1917).

temperature coal tar. Evidence also is not lacking to indicate that no considerable percentage of liquid aromatic hydrocarbons can be present. The densities and indices of refraction of the non-saturated hydrocarbons are notably lower than the corresponding constants of aromatic hydrocarbons of the same boiling point. Moreover, close conformity has been demonstrated between the physical properties of the non-saturated hydrocarbons of Carbocoal tar and a series of unsaturated, cyclic compounds among which no aromatics were detected.

Summary

(1) A commercial low-temperature tar has been compared with coke-oven and gas-works tars. The density and "free carbon" content of the crude, dry tars and the density, "free carbon" and air melting point of the pitches remaining after fractional distillation under similar conditions have been determined. The values for the low-temperature tar have been shown to be notably lower than the corresponding figures obtained for the coke-oven and gas-works tars. The fractionation curves of the three tars, however, are very similar.

(2) The phenols have been extracted from each fraction and estimated gravimetrically. The percentages of phenol and the cresols have been found by methods involving nitration and the determination of specific gravities and freezing points. Derivatives of the naphthols are present, but α- and β-naphthol are absent.

(3) The percentage of phenols in low-temperature tars increases with the yield of tar from the coal carbonized, the quantity of non-phenolic oil remaining relatively constant. In general, coals of the highest volatile content yield the most phenols.

(4) The nitrogen bases are 80 per cent tertiary, 20 per cent secondary, and contain no primary compounds. Both types show unsaturation. No preponderant compound is present. Pyridine has been detected in the first fraction, but the higher boiling bases differ from those in ordinary coal tar in that they have lower densities and higher molecular weights. These differences are ascribed to the presence in the low-temperature bases of partly hydrogenated nuclei and of side-chains longer than those characterizing high-temperature bases.

(5) Contrary to the "vacuum tar" of Pictet, low-temperature tar contains no alcohols.

(6) Hydrogen sulphide is present in the lowest fractions, but carbon disulphide is absent. Thiophene is indeterminate in the presence of unsaturated hydrocarbons, which can not be removed.

(7) The neutral oils derived from low-temperature tars are characterized by low density and viscosity, and by the absence of more than traces of compounds solid above —30 deg. C. No single hydrocarbon preponderates in quantity. Unsaturated hydrocarbons are present, and on standing cause darkening and gradual increase in density of the oils. By the use of 98 per cent sulphuric acid, the saturated and non-saturated hydrocarbons have been separated. Correction is made for polymerization. The proportion of napthenes has been determined from the specific gravities of the residual saturated hydrocarbons.

(8) The non-saturated hydrocarbons recovered by liquid sulphur dioxide have been shown by determinations of density, index of refraction and molecular weight to belong to the same series of cyclic unsaturated hydrocarbons as those occurring in "vacuum tar." Solid aromatic hydrocarbons are absent; liquid aromatic hydrocarbons can be present only in traces.

Acknowledgment

The authors take pleasure in acknowledging the kindly co-operation and many courtesies of Dr. H. A. Curtis of the Clinchfield Carbocoal Corporation, South Clinchfield, Va.

New York City.

A Study of the Effect of Impurities on Storage Batteries*

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THE increasing use of storage batteries for starting and lighting of automobiles augments the importance of knowing more of both the theoretical and practical functioning of the cell. Among other factors, the necessary purity of materials to insure capacity is of prime importance to the manufacturer. Also, since the introduction of foreign materials in the adjustment of electrolyte during the service of the cell is not an impossibility, the magnitude of the effect of this introduction has been a source of annoying doubt, even though experience abetted by theory has compiled a generous number of proverbs as to the harmful effect of traces of "impurities."

The literature contains frequent references to the injurious effect of foreign materials, but specific data are lacking. The acids nitric, hydrochloric and acetic attack the structure of the plate, but the concentrations at which these acids are harmful have not, to the writer's knowledge, been previously published. Of the metals, the most concrete reference is in "Accumulators," by Dolzalek, in which it is stated that those metals existing in more than one valence and which are above lead in the electromotive series cause an abnormal loss of capacity on standing. Those metals which are below lead plate out on the negative electrode, resulting in local action and the rapid discharge of that plate. Vicarey[1] has done considerable work on the detrimental effects of ammonia, and advises the manufacture of storage batteries at points as far distant from human habitation as possible, to eliminate this deleterious gas. With the present-day experience in the frequent use of ammonium salts in plate manufacture, the conclusions of Vicarey are but of amusing historical interest.

Standardization of Cells

In interpreting data upon storage cells it must be remembered that lead cells cling tenaciously to individual rights of performance. This is especially true with reference to capacity and rate of self-discharge. Therefore, in order to distinguish the effect of the added impurity with greater certainty from the idiosyncrasies of the individual cells, the latter were put through preliminary cycles of charge and discharge until the ampere-hour output had attained a constant and characteristic value. This established the history of the cells prior to their employment in the test and prevented the use of abnormal cells. The standardization of each

*A portion of data incorporated in thesis for M.S. degree at Purdue University in a paper read and presented at the forty-first general meeting of the American Electrochemical Society at Baltimore, April 27-29, 1922.

[1] *Trans.*, Faraday Society, 1905, vol. 1, p. 271; 1906, vol. 2, p. 222.

test cell was the more important because it was impracticable to allot more than two cells to each combination owing to the number of combinations studied. In spite of the limited number of cells, the observations are therefore considered substantially indicative, but are not presented as quantitatively final in every case.

Contaminating Agents

In each series two uncontaminated cells were included, making eighteen cells in all, from which the average capacity and life of the entire group of batteries could be very reliably determined. The metallic impurities used were antimony, arsenic, cadmium, iron, magnesium, manganese, mercury, nickel, platinum, tin, silver and zinc. These were introduced as solutions of their salts. The contaminating acids employed were acetic, hydrochloric and nitric. The impurities were in all cases added in definite percentages of the electrolyte by weight.

The characteristics of storage battery performance which might be adversely affected are classified under four headings:

1. The ampere-hour capacity or output of the battery on discharge.
2. The voltage characteristics on charge and discharge.
3. The rate of self-discharge of the charged battery upon standing.
4. The life of the active material, which is conditioned mainly by the rate of mechanical disintegration in successive cycles.

Experimentally, the changes in these characteristics were determined by measurements of (1) the ampere-hour capacity on discharge immediately following charge; (2) voltage characteristics on charge and discharge; (3) loss of capacity on standing for definite time intervals after charge; and (4) the relative life compared with uncontaminated cells.

Experimental Observations

The effect of the impurities on the ampere-hour output of the charged battery was surprising. It had been expected that the impurities, especially those metals readily capable of oxidation, would produce considerable change in the capacity of the cells. However, contrary to this expectation, the tests showed that the discharge capacity was unaffected except in three cases—namely, silver, manganese and platinum—which will be considered in more detail later.

Likewise, observations of the voltage characteristics showed them to be unexpectedly impervious to attacks of impurities. The addition of antimony lowered the charge voltage for a few cycles, after which, however, the cell regained its normal voltage performance. The antimony was probably deposited and plated over on the negative plate. The other impurities, except silver and platinum, were without perceptible influence upon the voltage characteristics.

When, however, we come to the consideration of the self-discharge of the battery and the life of the active material a much more varied behavior becomes apparent, as will be observed in Table I.

The self-discharge or loss of capacity on standing was determined by allowing the cells to stand after charging for intervals of 1 day, 1 week and 4 weeks, respectively, before discharge. They were then discharged at the 5-hour rate. Since the same relative loss in capacity was observed for each of the periods, the loss in capacity for the 4-week period only has been recorded. In the third column of the table this loss is expressed as a percentage of the previously determined capacity of the cell.

TABLE I—EFFECT OF IMPURITIES ON SELF-DISCHARGE AND LIFE OF CELLS

Impurity Per Cent of Electrolyte, Weights	Compound in Which Introduced	Per Cent of Former Capacity After Standing 4 Weeks	Life Tests Performance of Uncontaminated Cells Considered 100 Per Cent
Magnesium....0.05	$MgSO_4.7H_2O$	92.5	85.7
Magnesium....0.5	Sulphuric acid solution.....	87.9	79.5
Manganese....0.005	$KMnO_4$	62.8	80.8
Manganese....0.01	Sulphuric acid solution.....	65.4	42.8
Manganese....0.025		30.1	(1)
Manganese....0.05		56.5	(1)
Manganese....0.05	Water solution....	49.2 (2)	(1)
Manganese....0.5		6.15 (2)	(1)
Zinc.....0.05	$ZnSO_4.7H_2O$	90.0	100.
Zinc.....0.5	Water solution....	95.5	104.5
Cadmium.....0.05	$CdCl_2.2H_2O$	77.2	110.
Cadmium.....0.5	Water solution....	84.1	50.
Iron.....0.01	$FeSO_4.7H_2O$	75.	105.2
Iron.....0.05	Water solution....	77.75	92.5
Iron.....0.1		77.4	80.4
Nickel.....0.05	$NiSO_4.6H_2O$	76.8	109.
Nickel.....0.5	H_2SO_4 solution....	76.8	103.5
Tin.....0.05	Metallic tin dissolved in sulphuric acid.....	85.5	94.95
Tin.....0.5		74.4	92.43
Arsenic.....0.05	As_2O_3 dissolved in HCl, digested with H_2SO_4 to expel Cl.....	76.	86.7
Arsenic.....0.5		59.5	86.2
Antimony.....0.05	$SbCl_3$ in HCl solution.....	71.7	85.5
Antimony.....0.5		47.3	51.1
Mercury.....0.05	$HgSO_4$	93.5	104.
Mercury.....0.5	Water solution...	92.5	67.75
Silver, 1st test..0.005	$AgNO_3$ in water solution.....	74.2	125.6
Silver, 1st test..0.05		83.9	112.9
Silver, 1st test..0.5		59.7	97.5
Silver, 2d test..0.01	$AgNO_3$ sol. digested with H_2SO_4 to expel nitric acid.....	83.	100.
Silver, 2d test..0.05		74.3	100.
Silver, 2d test..0.1		69.6	106.8
Silver, 2d test..0.5		33.5	89.5
Platinum....0.00001	$PtCl_4.5H_2O$	....	48.5 (3)
Platinum....0.01	Water solution....	....	16.4 (3)
Hydrochloric acid.....0.01	HCl.....	(5)	81.28
acid.....0.05	HCl.....	(5)	86.3
acid.....0.1	HCl.....	(5)	96.8
acid.....0.5	HCl.....	(5)	77.25
acid.....1.0	HCl.....	(5)	47.3
acid.....5.0	HCl.....	(5)	20.42
Nitric acid....0.1	HNO_3.....	81.0	100.8
Nitric acid....0.5	HNO_3.....	84.0	98.8
Nitric acid....1.0	HNO_3.....	92.5	100.
Nitric acid....5.0	HNO_3.....	53.7	(4)
Acetic acid....0.1	$HC_2H_3O_2$.....	(5)	101.
Acetic acid....0.5	$HC_2H_3O_2$.....	(5)	101.8
Acetic acid....1.0	$HC_2H_3O_2$.....	(5)	98.
Acetic acid....5.0	$HC_2H_3O_2$.....	(5)	36.6
Acetic acid ..50.(6)	$HC_2H_3O_2$.....		

Compounds were added in some instances in 39 per cent sulphuric acid solution to prevent altering the specific gravity of electrolyte. All metallic impurities were added one-half hour before completion of charge. Foreign acids were added with original electrolyte on assembly of cells.

(1) Other cells too low to put in life test.
(2) After standing one week.
(3) Loss to these figures in six cycles.
(4) Torn down after standing test. No grid disintegration yet apparent.
(5) Not tested.
(6) Immediate complete sulfation..

The life test consisted of consecutive charges and discharges until the capacity fell to a definite fraction of its former value. Rating the performance of the uncontaminated cells at 100 per cent, the relative performance of the contaminated cells is tabulated in column 4.

In order to interpret the results of Table I in terms of practical injury to the battery, certain arbitrary assumptions must be made.

First, with respect to self-discharge, a normal or average depreciation of about 18 per cent was observed in the uncontaminated cells after standing 4 weeks.

Therefore, we have rated at 100 cells which retained at least 82 per cent of their original capacity. Moreover, since normal cells are subject to some variation, we have assumed that no deviation of less than 10 points from the normal thus established can be considered significant.

In like manner, the life of the uncontaminated plates under the experimental conditions was rated at 100, and only a depreciation in excess of 15 per cent of this average has been considered significant. The greater margin required for establishing significant differences in the case of the life tests is due to the greater variability of the latter owing to the large number of factors which influence it. The allowances in each case are sufficient to exclude the maximum variations observed in the control cells.

With these assumptions as to what constitutes practical injury, Table II has been prepared. In the first two columns are indicated the minimum amount of the impurity which proved definitely injurious. In the last two columns are given the maximum percentages of the impurity which produced no pronounced deterioration in the cell.

TABLE II—MAXIMUM AND MINIMUM LIMITS FOR IMPURITIES IN STORAGE BATTERIES

	Minimum Percentage Which Produced Injury		Maximum Percentage Which Produced No Injury	
	Self-Discharge	Life	Self-Discharge	Life
Magnesium	....	0.5	0.5	0.05
Manganese	0.005	0.005	....	....
Zinc	....	....	0.5	0.5
Cadmium	....	0.5	0.5	0.05
Iron	....	0.1	0.1	0.05
Nickel	....	....	0.5	0.5
Tin	....	....	0.5	0.5
Arsenic	0.5	....	0.05	0.5
Antimony	0.5	0.5	0.05	0.05
Mercury	....	0.5	0.5	0.05
Silver	0.1	....	0.05	0.5
Platinum	Not tested	0.00001	....	....
Hydrochloric acid	Not tested	1.0	Not tested	0.5
Nitric acid	5	....	1.0	1.0
Acetic acid	Not tested	5.0	Not tested	1.0

The cells with 0.5 cadmium showed abnormally short life, although the 0.05 cadmium were normal. This is of special interest in connection with the common use of the cadmium electrode in lead battery testing. Further verification is therefore desirable. The effect of the introduction of antimony was also somewhat surprising, but the result may have been due in part to the hydrochloric acid solution in which it was introduced.

Special Effects Caused by Mn, Ag and Pt

The cases of manganese, silver and platinum presented striking characteristics.

Manganese as potassium permanganate in water solution was added in quantities of 0.05 and 0.5 per cent of the electrolyte weight. There was a steady lessening of capacity with successive discharges immediately following charge until in twenty cycles after the addition of the manganese the cells had fallen to 83 and 52 per cent of their original values for the 0.05 per cent and 0.5 per cent additions, respectively. After a week's standing, the capacity had fallen so low that the cells were torn down and a new series of tests started to confirm the result. Potassium permanganate was then added to correspond to 0.005, 0.01, 0.025 and 0.05 per cent of manganese in the electrolyte. All showed an abnormal loss of capacity on standing, and after 4 weeks those contaminated with 0.025 and 0.05 per cent refused to "take charge." The two lower percentages gave short life. The positive plates when examined were expanded, pitted and buckled and the general character of the paste was soft. The negatives were normal.

The addition of silver in water solution of silver nitrate resulted in the immediate precipitation of silver sulphate, shorting the cells and reducing the capacity to 18 per cent normal with the 0.5 per cent contamination. This capacity was regained with succeeding cycles and in six equalled its former value. A repetition of the test in which the silver nitrite solution was previously digested with sulphuric acid gave a less marked, although noticeable, decrease in initial capacity, which was regained as in the former series. It seems probable that the silver was plated over with spongy lead and rendered less harmful on the negative electrode. However, its effect is seen in the loss of capacity on standing.

Platinum gave no room for doubt as to its result. Added even as low as 0.00001 per cent, it caused immediate gassing on discharge, and in five cycles of successive charge and discharge the capacity had fallen to 50 per cent. On examination, the negatives exhibited a soft, pasty character. The cell voltage on charge failed to rise above 2.37 with a positive to cadmium of 2.42 volts, while the normal cell gives 2.60 as a cell voltage and 2.45 of the positive with respect to cadmium.

Methods of Detection

Detection of these impurities by other than chemical analysis of the electrolyte is possible only in the cases of manganese, platinum, hydrochloric and acetic acids. Manganese gives the characteristic permanganate color on charge, and the pitted condition of the positive is also an indication. Platinum is distinguished with certainty by gassing of the cell on discharge. Hydrochloric and acetic acids as well as nitric attack the positive grid, but the first two may usually be detected by the odor on charge. Chlorine is evolved from the hydrochloric acid and the characteristic odor of acetic is attendant on that impurity. However, these are not absolute criteria, for successive cycles of electrolysis decrease the concentration almost to elimination. Hydrochloric bleaches a wood separator, while with acetic acid there is an unusual growth of lead sulphate crystals around the cell posts.

Recent Work on Non-Ferrous Alloys

At a recent conference of the advisory committee on non-ferrous alloys of the Institute of Metals Division of the A.I.M.E., R. J. Anderson, metallurgist of the Bureau of Mines, outlined the results of recent work at the Pittsburgh experiment station in regard to (1) the contraction of aluminum alloys, (2) removal of stress in brass tubing and (3) heat-treatment of cast non-ferrous alloys. He stated that linear contraction experiments had been run in chill molds and sand molds on forty aluminum alloys, and the results showed that in the series of alloys the contraction varied between the limits 0.95 and 1.70 per cent. In the general discussion of the contraction and shrinkage problem, it was felt that the whole situation needed clarifying and that the results of the work should be made available. It was stated that shrinkage is dependent upon structural changes occurring on solidification and that there is not necessarily any relation among shrinkage, hot-shortness and tensile strength. It was stated also that the effect of degasifying and deoxidizing alloys might have considerable effect on shrinkage and hot-shortness. The investigation of the effect of chills, risers and molding practice upon shrinkage was suggested.

Physical Metallurgy at Columbia University

All Engineering Students Are Required to Attend a Course in Metallurgy—Many Chemists Elect the Long Course for Metallurgists—Instruction Continues Through the Summer School for Special Students—Excellent Equipment in Laboratory for Preparation and Examination of Samples

By ERNEST E. THUM

WORK in metallurgy has always been a very important part of that assigned to students at Columbia School of Mines ever since its foundation, in 1864. It would be interesting to trace the variations in the curriculum as they have occurred in the intervening years; such a statement would roughly parallel the history of the metallurgical industries in the United States. However, that is not the present purpose, but rather to describe the equipment now available at Columbia University for the study of metallography.

Although metallography is doubtless a junior branch of the wider science, it may be interesting to know that it has been taught at Columbia for over 20 years by Prof. William Campbell, and to a continually widening circle of engineers. Starting as an advanced study for metallurgical specialists, a brief course is now taught to all men attending the engineering college, while chemical engineers take a continuation course as an adjunct to their work in physical chemistry and phase rule. The mechanical and industrial engineers take the laboratory course and metallurgists also naturally spend extra time on this subject. Interested students can go as far forward as they like.

Courses of Study in Metallography

Several different courses are offered. As mentioned above, all engineering students are required to attend thirty lecture periods of a course on metallurgy of iron and steel. About half the lectures are devoted to a consideration of iron smelting and steel making, while the remainder are devoted to the properties of engineering steels and a few industrial alloys and how they are affected by composition, working and heat-treatment. Of course, it is readily understood that in such a limited time the treatment cannot be exhaustive in any detail. The student, however, is provided with an extended outline, nearly every item of which has one or more references to the literature. In this way he is given a perspective of the subject and a ready means to acquire detailed information on any branch he may later become interested in. Bradley Stoughton's "Metallurgy of Iron and Steel" (McGraw-Hill) and G. H. Gulliver's "Metallic Alloys" (Charles Griffin & Co.) are the textbooks.

In addition to the lectures, the engineering students spend fourteen laboratory afternoons on the subject, mostly engaged in the microscopic examination of a series of prepared samples, typical of alloys used in engineering construction. The equipment, to be described later, is arranged so that each student sketches the structure of each sample in his notebook, records the physical properties of that kind of material and makes explanatory remarks and comments on the notable features called to his attention by a syllabus. A number of useful textbooks are kept in the laboratory and are in constant use clearing up obscurities.

Extended Courses for Chemists and Metallurgists

In addition to the course in metallurgy of iron and steel, chemical and metallurgical engineers are required to continue with another series of lectures on metallography. Many chemists working for A.B. and Ph.D. degrees also elect the course as an adjunct to their work in physical chemistry and phase rule, and evince a surprising interest in the work. This course also follows an exhaustive outline and bibliography of the subject placed in the hands of each student, wherein binary alloys are classified according to chemical compounds which may or may not be formed, whether the mutual solubility in the liquid is complete, partial or lacking, and according to the conditions of solid solubility. In other words, Roozeboom's classification is used, and the actual equilibrium diagrams of the useful alloys are analyzed into their elements. So much stress is laid upon the fact that a thermal diagram is a map of actual occurrences that finally the student believes it and is able to use such diagrams intelligently.

Laboratory work in metallography parallels the lectures. One hundred prepared type specimens are examined, sketched in notebooks and discussed. While the condition of the samples as received by the student is in general very good, several of them must be lightly repolished and etched, giving the students skill in this delicate operation. (One or two samples are prepared from the rough as well.) No formal instruction in photography is given. If the student is interested enough, and many of them are, the method is illustrated to him, and he proceeds to make a few exposures and develop the plates. He is impressed with the fact that it requires skill to make a good photograph, but that it is perfectly possible to acquire that skill as it is needed. A good photographer can be a very poor metallographist—and vice versa (but the chances are the latter will not remain so).

For many years a rather extended series of furnace experiments were conducted, following Prof. Henry M. Howe's laboratory notebook. It became apparent, however, that the results achieved were not as good as could be had by the same expenditure of time and energy in a different channel. Consequently at the present time the regular class instruction is confined to three furnace experiments on steel; first the "Metcalf" test (where a bar, overheated at one end and cold at the other, is broken in pieces and the various fractures noted); Brinell's series of heat-treatments (where the fracture of tool steel is examined after various quenchings, temperings and annealings) and the making, hardening and tempering of a cold chisel. Of course, equipment for

precise heat-treatment is available for students of ability who are able to spend the necessary time on quasi-research work.

The above-described longer course is also repeated in the summer school, when it is compressed into 6 weeks of practically continuous work immediately following July 4. Students registering for summer school and who in fact may not be able to pass all the entrance requirements for the Engineering College or School of Mines—schools which are really for post-graduate instruction—may thus get the complete instruction in metallography in a very short time and for a very small fee. Elementary physics and chemistry, such as taught in high school, are prerequisite for this work; registration may otherwise be made by any student who feels that he can profit by the study.

Metallographical Laboratory

After completion of the present School of Mines Building (donated by Adolph Lewisohn in 1904) the metallographical laboratory was installed in the north wing of the sixth floor, a large room, well lighted by broad windows on three sides and a skylight. Fig. 1 shows a floor plan. One half of the area is devoted to the preparation of samples, while the other half is reserved for microscopic examination.

Samples are cut out of larger specimens in a machine shop, located next door, a shop which contains a shaper, lathe, drill press, saw, emery disk wheel and anvil, in addition to convenient workbenches and tool cabinets.

Finish grinding is done on a series of grinding wheels against the north wall of the main laboratory. These are of a very substantial design for double 8-in. wheels, made by the Norton Co., belt driven from a line shaft above. Tough alloys, especially non-ferrous alloys, are

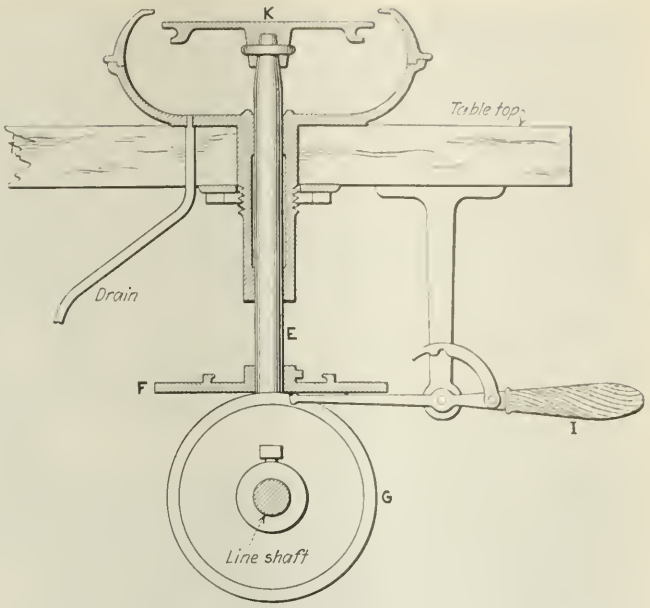

FIG. 2—DIAGRAM OF ZIMMERSHIED POLISHING WHEEL

more readily flattened by "smooth" and "dead smooth" files. Five small swivel vises are provided along the west wall for this purpose—to hold the files, not the specimens. Final polishing is done on polishing disks, a series of which are provided in a machine designed and furnished by Prof. Zimmershied, then of University of Michigan, Ann Arbor. This excellent device is described in detail in the *Journal of the American Chemical Society*, vol. 29, p. 856, and consists of two rotating longitudinal shafts, motor driven, under a long table top. Polishing wheels *K* have a vertical axis of rota-

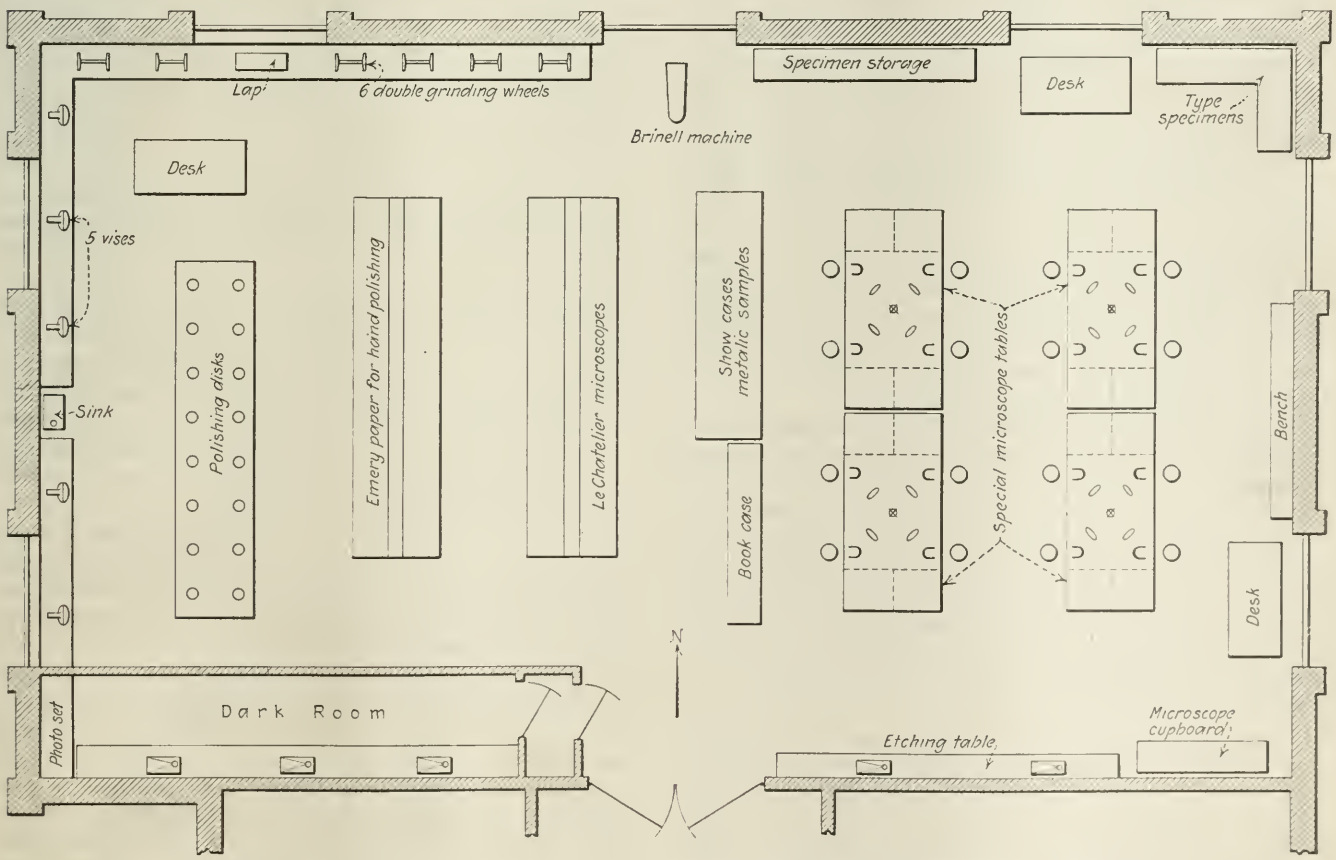

FIG. 1—FLOOR PLAN OF METALLOGRAPHY LABORATORY, COLUMBIA UNIVERSITY

FIG. 3—MICROSCOPE EQUIPMENT FOR STUDENT USE, COLUMBIA UNIVERSITY

tion (*E*, Fig. 2); they are driven by friction disks *G* and *F*, and when not in use are raised up clear by a lever *I*. About 18 in. above the working table has been fixed a series of small cabinets, containing spare disks and bottled abrasives.

Extremely brittle material, especially mattes, will not stand the emery wheel and is taken down on a lap, or by rubbing on a flat glass plate charged with FFF carborundum powder. Alongside the Zimmershied machine is a pair of stone-topped tables from the old chemical laboratory. These are kept clear for sheets of emery paper for use when polishing specimens by hand.

Experience with this layout indicates that it could be improved by locating the rough-grinding machinery near together, and inclosing them in a tight partition. This would prevent coarser particles of grit being blown on the cloth disks. These in turn should be covered with a hinged hood when not in use.

A second table from the old chemical laboratory is utilized for a series of LeChatelier microscopes when necessary to handle an overflow of students, but ordinarily there is enough room at the four special microscope tables at the east end of the room, illustrated in Fig. 3. These are 4 ft. x 8 ft. in area, with a flat top set 29 in. from the floor. Under each end can be seen a small cupboard, and three flat drawers (2 in. deep x 1 ft. 9 in. square). Four students work at each table simultaneously, sitting on stools placed as indicated in the plan, Fig. 1.

Each microscope on these tables has been simplified to its bare essentials. Leitz instruments with fixed stages are used; an objective with a plane glass reflector is attached to the lower end of the tube. Magnifications of from 150 to 175 diameters are available by choice of different eyepieces. Fine details of structure may be studied at magnifications of 500 diameters or more, on a high-power microscope at an instructor's desk. There are three such instruments.

In order that up-and-down movement of the objective may be confined to small adjustments on the slow motion screw, it is essential that the specimen be always mounted a fixed distance above the stage. This is done in a simple manner, as indicated in Fig. 4. A spun brass cup, about 2¼ in. diameter and 1 in. deep, with upper edge milled parallel to the base, contains a lump of plasticene, into which the specimen is pressed by a square of plate glass. Plasticene is better than shot, since it cannot be spilled. The cup rim is also very useful to prevent dislodging the specimen by an accidental touch.

In such a layout as shown in Figs. 1 and 3, four microscopes are very conveniently illuminated by a single Welsbach mantle; the lamp is heavily shaded above to prevent glare. A simple condensing lens projects a beam into the reflector.

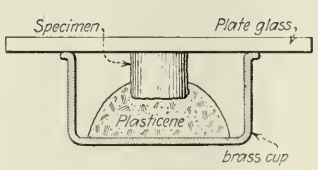

FIG. 4—MOUNTING CUP

Etching is done at a long table made of chemically resistant stone set against the wall. Convenient reagent shelves, sinks, water and gas lines are installed here, as is shown clearly in Fig. 3.

A dark room has been partitioned off for student use. It is somewhat too narrow for comfort. A micrographic set is placed on a bench at one end, and along the wall are three complete sets of light-tight cupboards, developing tanks, sinks and printing frames. Entrance is through a double door with pilot lights.

Specimens for study are stored in a cabinet in one corner. As noted above, each student is provided with

a partitioned tray (Fig. 3) containing a full set of the samples assigned for his particular course. Therefore there are several thousand specimens ready for use. In addition the laboratory possesses many thousand prepared and catalogued specimens of mattes, slags, ores and steels available for the special study of various metallurgical processes, such as steel making, carburizing, annealing and other thermal operations. Several glass exhibition cases contain large samples of defective materials. A very large number of metallic specimens of almost every commercial alloy are also available from accumulation during the past, only a part of which have been studied in detail.

The Production of Metallic Magnesium*

By S. T. Allen
Chief Engineer and General Manager,
Wolverhampton Electricity Department

THE IMPORTANCE of magnesium metal has greatly increased during the last few years, because of its present value and future possibilities in connection with the alloying of other non-ferrous metals, where extreme lightness and high strength are required, such as in the building of airships and airplanes, and also because of its properties as a deoxidizer of other metals.

Magnesium is 40 per cent lighter than aluminum, and when pure is no more susceptible to atmospheric corrosion than is aluminum. Thus, given production as cheap as aluminum, which the Magnesium Co. states is a possibility, and provided that there is a corresponding demand, the uses in the future of this beautiful metal will certainly multiply. Its production will therefore be watched with considerable interest.

The intention of this article is more especially to describe the new electrolytic process developed in Wolverhampton by the Magnesium Co., which is already creating a considerable amount of interest throughout the world.

Raw Materials

The only two compounds of magnesium which occur abundantly in nature are the carbonate and chloride; the choice of the raw material for the production of the metal is accordingly limited to one or other of these compounds. Magnesite, the carbonate, is found in varying states of purity in all parts of the world. There are no deposits of pure magnesite in the United Kingdom, but large quantities occur as dolomite, the double carbonate of magnesium and calcium, from which pure carbonate of magnesium can be separated by simple processes. Magnesium chloride occurs in nature as one of the constituents of the German salt deposits. The separation of potassium chloride from these deposits involves the production of huge quantities of magnesium chloride. Magnesium chloride also occurs in sea water, and is a product of its evaporation for the production of salt. Either of these two compounds can be used as raw material, the choice being influenced by the cost of freight and the means available to the manufacturer for the disposal of his byproducts.

Suggested Processes

The processes which have been proposed or used for the production of magnesium may be placed under three headings: (1) Thermal processes; (2) substitution processes; and (3) direct electrolytic processes. In the first the oxide of magnesium is reduced by carbon at a temperature well within the range of the electric furnace. The metal is produced as vapor, which may be condensed. This process has been tried on a considerable scale, but great difficulties were encountered in attempts to produce coherent metal from the finely divided material (magnesium powder) which resulted from the condensation.

In the second process magnesium has been produced experimentally by the reduction of magnesium oxide with aluminum. Unlike the well-known "thermit" reactions, the reaction between magnesium oxide and aluminum is endothermic, and heat must be supplied. In the second process magnesium chloride is also readily reduced by metallic sodium, and at first sight this might appear to be an economic method of manufacture. To obtain satisfactory yields the magnesium chloride must be anhydrous, and as anhydrous magnesium chloride can be electrolyzed for the direct production of magnesium, reduction with sodium can be economical only if the sodium electrolytic cell shows a higher current efficiency than the magnesium electrolytic cell.

The choice of the electrolyte for the production of the metal by direct electrolysis is for practical purposes limited to the chloride and the fluoride, although claims have been made for the electrolysis of magnesium oxide in a bath of fused magnesium fluoride following the lines of the ordinary aluminum process. Electrolysis of the fused sulphide has also been proposed, but it is safe to say that all the magnesium for the market is produced by electrolysis of the chloride in a state of fusion with or without the admixture of potassium and sodium chlorides.

Preparation of Anhydrous Magnesium Chloride

The Magnesium Co. is interested in two processes for the production of anhydrous magnesium chloride, in one of which the chloride is produced by the action of chlorine on magnesium oxide, and in the other water is removed from magnesium chloride crystals.

In the presence of carbon, chlorine reacts with magnesium oxide, producing magnesium chloride and carbon monoxide. With pure materials the temperature at which this reaction is complete is uncommercially high. Compounds of iron act as chlorine carriers or catalysts of this reaction, and enable it to proceed to completion at a reasonable temperature. During the war large quantities of anhydrous magnesium chloride were made by this process and subsequently reduced to the metal. The complete dehydration of magnesium chloride crystals is not a simple matter, and has been made the subject of a large number of patents.

The following is a brief description of the process employed by the Magnesium Co.:

The crystals of magnesium chloride, after passing through a hydro extractor to remove adhering water, are exposed for several hours to a current of dry air at a temperature of about 150 deg. C. Half the combined water is thus removed with a small decomposition of the magnesium chloride, the product having the composition: $MgCl_2$, 73.0 per cent; MgO, 4.0 per cent; and H_2O, 23.0 per cent.

The partly dried material is now exposed to a current of dry hydrochloric acid gas at a temperature of about 300 deg. C. The remainder of the water is removed,

*From the *Electrician*, Jan. 27, 1922, p. 92.

the magnesium oxide is converted into magnesium chloride, and a product showing over 99 per cent of magnesium chloride results. As the temperature of fusion is never reached during the drying process, the crystals retain their original form, and in consequence the product is very easy to handle. The hydrochloric acid gas used in the drying process is produced by direct combination of hydrogen and chlorine, resulting from the electrolysis of brine.

Electrolytic Arrangements

As the melting point of anhydrous magnesium chloride, 750 deg. C., is above the economical temperature for electrolysis, sodium or potassium chloride, or both, are added to the anhydrous magnesium chloride to produce the electrolyte. Molten magnesium floats on the surface of this electrolyte, and consequently a simple cell of the form used in the manufacture of aluminum cannot be employed. Such a cell would have to be fitted with permeable diaphragms in order to keep the chlorine out of contact with the magnesium. These diaphragms are a constant source of trouble and expense, and, further, they tend to reduce the energy efficiency of the cell. This difficulty has been got over by the Magnesium Co. by conducting the electrolysis in two stages.

Stage 1.—The cell, which is of cast steel lined with firebrick, is fitted with a gas-tight cast-iron cover which carries the graphite anodes. These have suitable openings for the discharge of the chlorine gas and the removal of the electrolyte. The cell is charged to the depth of a few inches with molten lead, which forms the cathode. On the surface of the lead cathode floats a 1-in. layer of the electrolyte, into which dip the ends of the graphite anodes. The gap between anodes and cathode surface is about $\frac{3}{4}$ in.

Circulation of Electrolyte

Means are provided for the circulation both of the electrolyte and the liquid lead cathode. The cell has a capacity of 5,000 amp., at a cathode current density of about 1,500 amp. per sq.ft., and a terminal voltage drop of about 5 volts. Under these conditions the cell is self-heating, and produces about 100 lb. of Mg per 24 hours in the form of an alloy with lead, with an ampere efficiency of approximately 85 per cent.

Stage 2.—The cell used in this stage is similar to that used in stage 1, except that the magnesium lead alloy produced in stage 1 forms the molten anode, while the cathode consists of a large number of small diameter steel rods immersed to a small depth in the electrolyte, which has the same composition as that used in stage 1. Suitable means are provided for the removal of the molten magnesium as fast as it is produced.

It will be realized that this part of the process really consists in the electrolytic refining of impure magnesium. Means are provided to circulate the magnesium lead alloy, which, as it becomes depleted of magnesium, is returned to stage 1 to be enriched. The secondary cell, which is worked in series with the primary, operates on 5,000 amp. at 2 volts. It will be seen that the total energy consumption for 100 lb. of magnesium per 24 hours amounts to 8.5 kw.-hr. per lb. of metal produced, giving an energy efficiency approaching 40 per cent. Given pure magnesium chloride, such as is produced by the processes already described, the cells operate with remarkable smoothness and require little attention, save for the changing of the electrolyte and the removal of the metal.

Chlorine Disposal

The disposal of the chlorine from processes of this type, especially when worked on a comparatively small scale, is always a matter of some trouble. The process adopted by the Magnesium Co. overcomes this difficulty in a neat and economical manner. The chlorine is aspirated from the cells and is brought into contact in a series of scrubbing towers with milk of magnesium, produced by suspending the ordinary calcined magnesia of commerce in water. The chlorine is absorbed by the magnesia, and a solution is produced containing magnesium chloride and magnesium chlorate in the proportion of 5 molecules to 1.

This solution is concentrated to such a strength that, on cooling, half the contents of magnesium chloride separates as crystals. Potassium chloride is added to the mother liquors in quantity equivalent to the magnesium chlorate present. Potassium chlorate crystallizes out practically quantitatively; it is washed and recrystallized, and is then ready for the market. The mother liquors from the potassium chlorate crystallization are returned to the system, and are concentrated so as eventually to yield all their magnesium chloride as crystals. The potassium chlorate forms a valuable byproduct; but if for any reason it is undesirable to produce it, advantage may be taken of the well-known reaction whereby, when chlorine is passed into milk of magnesia in the presence of a catalyst, such, for example, as nickel oxide, magnesium chloride only is produced and oxygen liberated.

A Cyclic Operation

It will be realized from the above description that the process forms a complete cycle, and really consists in the indirect separation of magnesium and oxygen, in that, apart from the production of the byproduct, potassium chloride, the only raw material is magnesite. The chlorine is being continually separated from the magnesium in the electrolysis, and the same chlorine continually used for the production of more magnesium chloride from magnesite.

The magnesium produced is, as would be expected, of remarkable purity (over 99.5 per cent), and it is interesting in this connection to note that metal of this purity may be melted in open vessels without risk of burning.

Properties of Magnesium

To repeat what has been previously stated, there is no doubt that magnesium, either alone or in alloys, has big possibilities. It is 40 per cent lighter than aluminum, and, when pure, is no more susceptible to atmospheric corrosion than is aluminum. It can be rolled and extruded. As a deoxidizer of other metals it is unrivaled, and its use in this direction is continually extending. It is a minor constituent of many valuable alloys. Alloys in which magnesium is the major constituent are already in use in cases where combined lightness and strength are desirable. Given a corresponding demand, there is nothing to prevent magnesium being put upon the market at the same price as aluminum.

The writer is indebted to the Magnesium Co. for the details describing the process and the many interesting interactions connected therewith.

Graphic Analysis of Sublimed White Lead

By Burton Paxton

WITH the increased use of sublimed white lead as a paint pigment has come a demand for a rapid method of analysis.

Early methods of analysis of this pigment required determination of ZnO, Pb and SO_3; calculation of SO_3 to $PbSO_4$ and residual lead to PbO. This was shortened by Schaeffer's method as given in Scott, "Standard Methods of Chemical Analysis." In this method the Pb and ZnO are determined and by means of formulas calculated to $PbSO_4$ and PbO.

Explanation of the Chart

In order to escape the determination of SO_3 and at the same time eliminate the calculations, the accompanying chart was devised. The left-hand scale of the chart is graduated from 5 to 10, representing percentage of zinc oxide in the pigment. Right-hand scale is graduated from 65 to 70, representing total lead in the pigment. The two center scales are graduated in terms of lead sulphate and lead oxide. A line drawn across the chart connecting any point (*a*) on the ZnO scale with any point (*b*) on the Pb scale will intersect the center scales at percentages of lead sulphate and lead oxide contained in pigment having *a* per cent of ZnO and *b* per cent of Pb.

How to Use the Chart

To use the chart it is necessary to have percentages of Pb and ZnO in the pigment. These may be determined quite rapidly by volumetric methods as follows:

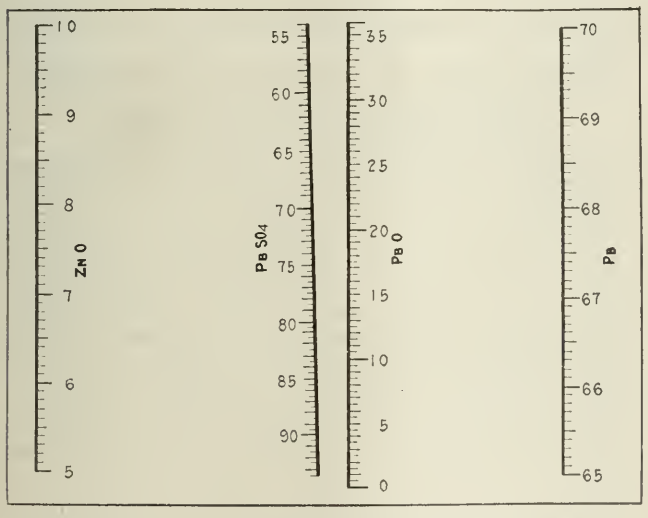

CHART FOR GRAPHIC ANALYSIS OF SUBLIMED WHITE LEAD

For ZnO.—Boil 1 gram of pigment in 6 c.c. HCl, 30 c.c. H_2O and 5 grams NH_4Cl. Pigment will not all dissolve, but this has no effect on result. Dilute to 250 c.c. with hot water, add a few drops of 10 per cent sodium sulphite solution and titrate with a standard solution of potassium ferrocyanide, using ammonium molybdate as an outside indicator. Ferrocyanide solution should equal 0.01 gram ZnO per c.c.

For Pb.—Dissolve 1 gram of pigment in acid ammonium acetate and dilute to 200 c.c. Heat to boiling and titrate hot with a standard solution of ammonium molybdate, using tannic acid as an outside indicator. Molybdate solution should equal 0.01 gram of Pb per c.c.

Now lay straightedge across chart connecting percentage of ZnO on left-hand scale with percentage of Pb on right-hand scale. Intersection of this line with center scales will give percentages of $PbSO_4$ and PbO. The sum of percentages of ZnO, $PbSO_4$ and PbO is, for all practical purposes, a constant, 99.7 per cent.

Using this chart, it is possible to make analysis of pigment in 10 or 15 minutes.

Danville, Ill.

Legal Notes

By Wellington Gustin

Suggestion for Stopping Demurrage Held Not Authority to Deliver Shipment

A telegram was held not to be authority to a carrier of goods to deliver same in a suit brought by the receiver of Rogers, Brown & Co. against the Chicago, Milwaukee & St. Paul R.R. for the wrongful conversion of a car of soya bean oil, K.T.X. No. 561, and valued at $9,251.75. The oil was purchased by Rogers, Brown & Co. of the Koster Co., which had shipped the oil to its own order to Winnipeg over the named railway, with instructions to notify Royal Crown Soap, Ltd., under an "order bill of lading." Rogers, Brown & Co. purchased the oil, and the bill of lading was indorsed to it, and in due course came into the possession of the receiver.

The complaint alleged that the railroad company delivered the oil without the surrender of the bill of lading to person other than the receiver, or his order. The railway admitted the delivery by it to the Royal Crown Soap, Ltd., and alleged as a defense that upon arrival of the oil at destination it notified the Royal Crown Soap, Ltd., and requested disposition of the car and production and the surrender of the bill of lading. Koster & Co. in turn were notified, who advised that Rogers, Brown & Co. had purchased the draft and bill of lading and were the owners who had been requested to forward the documents. Thereafter the receiver wired the soap company that he was doing all possible to locate documents in order to stop demurrage and suggested that the soap company establish a bond to produce the documents and unload the car. It then further alleged that the soap company advised the railway company of the telegram and the railway company, acting and relying upon such telegraphic instructions, permitted the Royal Crown Soap, Ltd., to unload the car and released the same.

The United States District Court for Washington, Northern District, held that the telegram can in no sense be construed into an order to deliver. It was merely a suggestion as to how the possession of the oil might be obtained before the receiver was able to locate the necessary documents. Nothing in the telegram changed the status of right or obligation of the parties. The loss was occasioned not by anything the receiver did or omitted to do, but rather because the railway company delivered the car without the surrender of the bill of lading, or in lieu of the bill of lading a bond holding the railway company harmless, if the bill of lading is not produced.

Oil Tank Protected From Fire by Cork Insulation

An interesting example of how a material installed for one purpose may render valuable service in a quite unexpected way occurred last summer at the plant of the Island Petroleum Co., Neville Island, Pittsburgh, Pa.

The company had recently completed three steel cold settling tanks, 20 ft. in diameter by 25 ft. high, for bright stock. Being operated part of the time at low temperature produced by brine refrigeration, these tanks were insulated with 3 in. of Nonpareil corkboard. At the time of this incident they were practically filled with oil.

On Aug. 25, 1921, during a violent electrical storm, accompanied by unusually heavy rain, lightning struck one of the crude oil tanks. The resulting explosion released a large quantity of burning oil, which spread out over the partly flooded yard and practically surrounded the nearest settling tank. Hastily constructed dikes shut it off from immediate contact with the others.

For nearly 3 hours the fire raged around this tank, and for almost an hour the flames were leaping directly against its sides, while officials and employees, striving to stop the spread of the fire, momentarily expected the big tank to "let go," with consequent disaster to the entire plant. Three times the hatch on the roof lifted to permit the escape of accumulated gas, but the heat-retarding quality of the corkboard insulation kept the

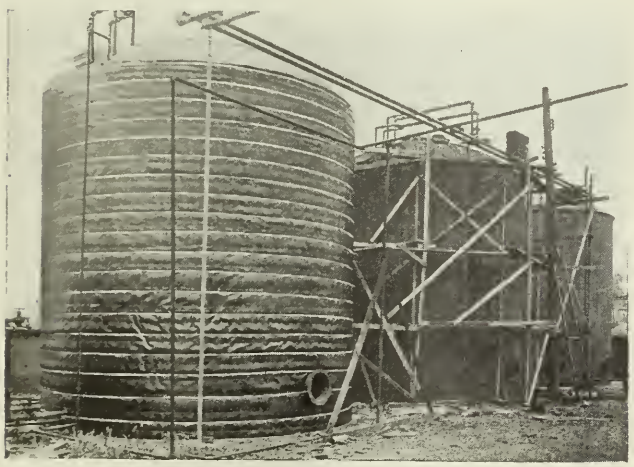

FIG. 1—THE INSULATED SETTLING TANKS OF THE ISLAND PETROLEUM CO., PITTSBURGH, PA.

The tank in the foreground is completed. On the next, the corkboard is in place ready for the jacket of roofing paper. The insulation of the last tank has not been started.

temperature below the danger point, and the fire finally burned itself out with no further loss of property or damage to the insulated tank beyond a slight charring of the outer surface of the corkboard insulation.

The Island Petroleum Co. officials are unanimous in the opinion that the protection afforded by the insulation prevented the destruction of all three tanks and the heavy loss such an explosion would have entailed.

Though insulation may seldom be called upon to withstand so severe a test, the record of this performance is convincing proof of the non-conducting property and fire resistance of corkboard. The same properties have brought the material into favor for the insulation of settling tanks, wax-extraction plants, low-temperature lines, etc. On storage tanks and car tanks for the more volatile oils, insulation, by excluding outside heat,

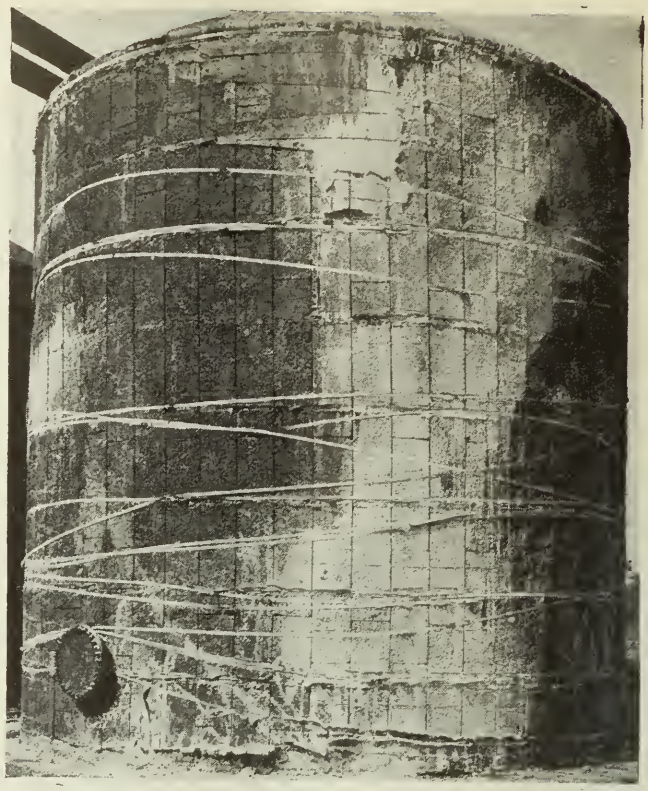

FIG. 2.—AFTER THE FIRE

The jacket has been burned off but the cork, though somewhat charred, is substantially undamaged.

prevents excessive evaporation and reduces the outage to an inconsiderable amount in comparison with the heavy loss sustained when there is no such protection.

Synopsis of Recent Chemical & Metallurgical Literature

Detonation in Internal Combustion Engine.—For a number of years the Bureau of Standards has co-operated closely with the National Advisory Committee for Aëronautics in investigating the performance of airplane and other types of internal combustion engines. This work has included a study of the phenomenon of detonation, and a paper has recently been prepared on this subject which will appear as Technical Note 93 of the National Advisory Committee for Aëronautics, 2722 Navy Building, Washington.

The paper is entitled "The Background of Detonation," and has for its object the discussion of a phase of this question which so far has received but little attention. The effect of the temperature and pressure of the charge before combustion is especially considered, as it is believed that a careful study of this "background" can throw considerable light on results that have been obtained in investigations of detonation both at the bureau and elsewhere.

It is shown that compression and explosion pressures, scavenging and the operation of the ignition system all play a prominent part in the phenomenon of detonation. The influence of changes in fuel characteristics, however, is believed to lie outside the province of this paper and is not taken up in any detail.

Pre-ignition and detonation are conceded to be entirely independent phenomena, and it is shown that overheating troubles are more likely to be from pre-ignition than from detonation. Curves and diagrams showing various phases of the subject are presented, and the whole forms a valuable contribution to the study of the internal combustion engine.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Preparation of Borneol.—Borneol is prepared from oil of turpentine by heating the latter in an autoclave with an ester and then saponifying the bornyl ester produced. The following are given by way of example of the esters employed: Butyl chloride, amyl chloride, camphyl chloride, dimethylethylmethyl acetate and isobornyl acetate; other esters that may be used are salicylates, formates and benzoates. The ester employed is regenerated by combining the acid liberated by the saponification process with the hydrocarbon formed during the ester treatment of the oil of turpentine. (Br. Pat. 174,032. Not yet accepted. L. Peufaillit, Lille, France. March 8, 1922.)

Decolorizing Liquids.—In the process for decolorizing sugar juices and other liquids by means of adsorbents and reducing agents described in the parent specification, formaldehyde-sulphoxylic acid or its salts, such as sodium formaldehyde-sulphoxylate, is used as the reducing agent. (Br. Pat. 174,027. Not yet accepted. J. F. Straatman, Haaksbergerstraat, Holland. March 8, 1922.)

Synthetic Tanning Agents.—Naphthalene, anthracene, phenanthrene or other hydrocarbon at least bicyclic or carbazo, or a halogen or sulphonic acid substitution product, is condensed with a carbohydrate, such as cellulose, starch or their conversion products down to glucose, or with other sugars, in such a way that sulphonic acid groups are contained in the final product—that is to say, sulphuric acid is used as a condensing agent when a sulphonic acid is not employed as a reaction material. According to the example, naphthalene is condensed with cellulose in the presence of concentrated sulphuric acid; the product is neutralized with lime, filtered, the soluble calcium salt decomposed with sodium carbonate and the filtrate evaporated to dryness. The resulting soluble compound can be used as a tanning agent or for the production of lakes from basic dyestuffs, particularly in the presence of metallic salts such as aluminum sulphate. The provisional specification states that any derivative, except hydroxy derivatives, of the above-mentioned hydrocarbons may be used. (Br. Pat. 173,881. Badische Anilin & Soda Fabrik, Ludwigshafen. March 8, 1922.)

Red Iron Oxide.—Red oxide of iron, in a form suitable for use as a pigment, is obtained by roasting in air a mixture of ferrous chloride with excess of barium carbonate. A solution of ferrous chloride, for example galvanizer's waste pickle, neutralized, is mixed with witherite, which is ground so that it passes through a 30-mesh sieve, but is retained by one of 150-mesh. The witherite is present in an excess of from 50 to 100 per cent over the theoretical quantity. The solution is evaporated to dryness and the product roasted at 300 deg. C. until the reaction is complete. The mass is treated with water, which dissolves the barium choride, and forms a suspension of iron oxide, from which the unchanged witherite quickly settles. The oxide is filtered, washed and dried, and barium chloride obtained from the filtrate by evaporation. The process may be modified by adding to the original mixture a finely divided iron compound, which is decomposed under the conditions of the process. Hydrated ferric oxide, ferrous carbonate and iron pyrites are suitable compounds. Two examples of the working of the process are given. (Br. Pat. 174,306. D. Tyrer, Stoneleigh, England. March 15, 1922.)

Extraction of Sulphur From Gas Purification Mass.—Sulphur is extracted from charcoal which has been employed as a contact mass for removing sulphuretted hydrogen from gases by oxidation with air, by means of ammonium sulphide solution. The solution is boiled in a still, the vapors passing to a condenser and the condensed ammonium sulphide runs through a vessel containing the spent charcoal; the solution, saturated with sulphur, flows back to the still, in which sulphur accumulates. On continuing the distillation the condensate eventually becomes practically free from ammonium sulphide and serves for finally washing the charcoal, after which it is diverted into a receiver. The precipitation of the sulphur in the still may be facilitated by adding an electrolyte—for example, salt. The parts of the apparatus which are exposed to the ammonium sulphide solution are preferably made of or coated with aluminum or its alloys. Specifications 13,383 (1911) and 1415 (1914) are referred to. The provisional specification refers to the extraction of sulphur from exhausted gas-purification masses in general. (Br. Pat. 174,143. Badische Anilin & Soda Fabrik, Ludwigshafen. March 15, 1922.)

Chlorinating Acetylene.—The chlorination of acetylene is rendered controllable and does not result in polymerized products by conducting it in the presence of water vapor at high temperatures—for example, 400 to 500 deg. C.—with or without the aid of catalysts such as chlorides of copper, iron or calcium. By an adjustment of proportions, temperature and gas velocity the reaction is made to proceed in any desired direction. The products can easily be separated by fractionation. According to an example, acetylene, chlorine and superheated steam in the proportions by volume of 1:2:12 are passed at the rate of 15 liters per hour through a pipe containing refractory clay at 500 deg. C. and the product consists of dichlorethylene, trichlorethylene, tetrachlorethane and higher chlorination products in the proportions 1:6:6:1. (Br. Pat. 174,635. Not yet accepted. Holzverkohlungs-Industrie Akt. Ges., Baden, Germany. March 29, 1922.)

Fatty Acids.—Fatty acids are obtained by the oxidation of liquid hydrocarbons by means of air or oxygen in the presence of a base with or without other catalysts, provided the liquid hydrocarbons are first freed, say by treatment with fuming sulphuric acid, from constituents which tend to form resinous or asphaltic bodies. The preliminary refining may, however, be dispensed with wholly or in part, if the reaction-promoting agents formed by blowing the liquid hydrocarbons in an acid medium are added to the hydrocarbons before the treatment in the presence of a base, or if the liquid hydrocarbons are first blown in the presence of acid and the oxidizing treatment then continued in the presence of a base. Specification 148,358 is referred to.

In a second patent by the same patentees, the base referred to above is specified as an alkaline earth or magnesia, preferably dry slaked slime, and the oxidation is carried out step by step, the detrimental reaction products being removed between the steps, say by filtration. (Br. Pat. 174,642 and 174,643. Not yet accepted. H. Winternitz, T. Bullinger and G. Teichner, Vienna. March 29, 1922.)

Alcohols.—Alcohols are prepared by passing a mixture of the vapor of the corresponding aldehyde and hydrogen over finely divided copper obtained by the reduction, preferably at a low temperature, of copper compounds which have not been prepared by precipitation and whose preparation has not involved temperature of glowing heat and above. Activators may be added to the catalysts. The following examples are given of the preparation of catalysts for the production of ethyl alcohol from acetaldehyde, methanol from formaldehyde and benzyl alcohol from benzaldehyde: (1) Pumice is coated with copper powder and water glass solution or colloidal silica; the copper is then oxidized at 200 deg. C. and finally reduced at 200 to 250 deg C.; (2) copper formate is brought on to pumice and then treated with hydrogen; (3) lumps of malachite are reduced at 200 to 250 deg. C. The catalysts described in the parent specification may also be employed for the production of other alcohols than ethyl alcohol. (Br. Pat. 175,238. Not yet accepted. Badische Anilin & Soda Fabrik, Ludwigshafen. April 5, 1922.)

Removal of Phenols From Waste Liquors.—Phenols are removed from waste waters by extraction with benzene after acidifying, preferably by treating with acid resins obtained in benzene purification; for further use, the benzene is freed from phenol by means of caustic soda solution. A process and apparatus are described for removing phenol from alkaline waste waters from ammonia works. The waters are freed from solid matter by settling, acidified, preferably by passing part of them through acid resins, and agitated with benzene or "another organic liquid produced by the pyrogenic decomposition of coal or brown coal"; the waste liquid is run off and the benzene agitated with caustic soda solution to remove phenol; fresh waste liquid is then run into the benzene and so on. The caustic soda solution is used repeatedly. The residue from the acid resins used in the neutralizing process may be used as fuel or as insulating material. (Br. Pat. 175,285. Not yet accepted. Posseyer Abwasser- und Wasser-reinigungs Ges., Essen. April 5, 1922.)

Tanning.—Hides are soaked in slightly acidulated water before treatment with lime in the hair-removing process, so that the hair or wool, which retains a relatively large amount of the acidulated water by capillarity, is not attacked by the lime, which nevertheless easily traverses the skin after neutralizing the acid held therein. The soaked hides are piled in pairs with their skin sides together, each pair being separated by a waterproof fabric to protect the hair from the lime in the adjacent skin, and are treated in the usual manner with a somewhat larger amount of lime. (Br. Pat. 175,620. Not yet accepted. Soc. de Feutre, Paris. April 12, 1922.)

Potassium Chloride.—Rocks containing potash, such as leucite, are treated in counter-current in a furnace with gaseous hydrochloric acid, the temperature being about 600 deg. C. at the outlet and 300 deg. C. at the inlet end. The chlorides other than alkali chlorides are decomposed by the time the material reaches the outlet end, and the chlorides are leached out from the product. The hydrochloric acid may be produced by the Hargreaves process, using the potassium chloride produced by the main process, the hydrochloric acid being used directly in the hot state. (Br. Pat. 175,348. G. A. Blanc and F. Jourdan, Rome. April 12, 1922.)

Hydrogen.—In the iron-steam method of manufacturing hydrogen, producer gas is used to reduce the iron oxide, the spent producer gas being utilized in a gas engine. The exhaust gases from the engine are employed to heat the iron-oxide retorts and to raise steam. To produce mixtures of nitrogen and hydrogen, a portion of the spent producer gas is mixed with steam and passed over a catalyst, and the carbon monoxide and carbon dioxide are removed in any well-known way. (Br. Pat. 175,501. J. Harger and Woodcroft Manufacturing Co., Ltd., Liverpool, April 12, 1922.)

Dyeing Cellulose Acetate.—The partial or superficial saponification of cellulose acetate threads or fabrics by alkaline agents prior to or during dyeing is regulated or controlled by the addition of sodium chloride or sulphate or other alkali salts of strong mineral acids in concentrations up to 5 per cent. These salts may be partly replaced by sodium acetate described in specification 176,034 or by the salts specified in specification 175,486. Specification 169,741 also is referred to. According to the provisional specification, the invention is not confined to the above-mentioned salts or concentrations.

A second specification by the same patentee covers the regulation of the partial or superficial saponification of cellulose acetate threads or fabrics by alkaline agents prior to or during dyeing by the use of alkali silicates, aluminates or borates, used either alone or with added alkali. Water-glass is preferred; when used alone it should be employed in such quantity that after the saponification the residual alkali retains the silicic acid in solution. Sodium acetate may be added as described in specification 176,034. Specification 169,741 also is referred to. (Br. Pat. 175,485 and 175,486. British Cellulose & Chemical Manufacturing Co., London. April 12, 1922.

Book Reviews

AMERICA'S POWER RESOURCES. By *Chester G. Gilbert* and *Joseph E. Pogue*. New York: The Century Co. 325 pp. 37 figures. Price, $2.50.

It does a technical man good once in a while to get a broad economic picture of important national problems. This volume gives a splendid portrayal and interpretation of the energy resources—coal, oil, natural gas and water power—in their relation to industry. The presentation is simple and straightforward, clearly intended to make a popular and very general appeal to non-technical readers; but this only makes the work the more readable for the technical man.

The sound reasoning which the authors apply to the problem will furnish the chemical engineer interested in fuels and fuels processing a splendid foundation on which to stand in his consideration of new energy supply questions. The work is based upon the extended study made of the same subject by the two authors while they were connected with the Smithsonian Institution. Many readers after consideration of this brief volume will wish to get the more detailed studies which were prepared on some phases of the general topic and issued as bulletins of the National Museum.

It is to be hoped that a large number will read the book and profit by its arguments. A general appreciation that the maintenance of higher standards of living for the American people can be based only upon a more efficient utilization of energy resources and application of machine power cannot help but be beneficial to the community as a whole. The authors have clearly and convincingly demonstated this thesis. R. S. McBride.

* * *

ZIRCONIUM AND ITS COMPOUNDS. By *Francis P. Venable*. American Chemical Society Monograph Series, 173 pp. 23x15 cm. New York: The Chemical Catalog Company, Inc., 1922. Price $2.50.

The author takes cognizance of the growing technical and commercial importance of zirconium in the prefatory statement, "My purpose has been to give a systematic, clear and sufficiently full account of the chemistry of zirconium which should prove useful in connection with the increasing interest attaching to this element."

The first chapter on the history of the element opens with the pertinent statement, "While this element is widely distributed and fairly abundant, its similarity in general properties to other so-called earths, especially alumina, the difficulty of separation from them and the absence of any easy characteristic test caused it to escape the notice of the earlier chemists." There is an interesting account of the occurrence of zirconium, showing its remarkably wide distribution, together with the fact that although the element as such is comparatively new, mention is to be found of jacinth, the natural silicate, in the writings of the ancients.

A succinct statement of the properties of the element which conduced to the failure of the earlier investigators in their attempts to prepare it introduces the reader to the chapter on the element and its properties. There follows an account of the work of several workers in which the difficulties of the task are quite obvious. The work shows the need of careful and exact determinations of many of the physical constants, the present values being uncertain and sadly lacking in agreement.

In the form of the oxide ZrO_2 this element exhibits properties tending to mislead the investigator. On page 40 we read, "When zirconia is ignited, it becomes practically insoluble in all acids except hydrofluoric. The discrepancies in the statements as to its solubility in other acids seem to be due to differences in the degree of ignition."

One finds on reading the account of the qualitative methods of separation and detection that with one exception all the reactions recommended as being distinctive with zirconium salts and therefore adapted to their identification, are given by some others. The exception is notable and

described by the author as follows on page 121: "Biltz and Mecklenburg recommended a most delicate and useful qualitative test. The solution supposed to contain zirconium is strongly acidified with nitric or hydrochloric acid. A few drops of sodium phosphate are added and the solution warmed. A white, gelatinous precipitate is given when as little as 0.0005 per cent of zirconia is present. No other element known to the authors gave such a precipitate in strongly acid solution. Iron, aluminum, the rare earths, beryllium, titanium, thorium and silicon gave no reaction. When a mineral is to be examined, it can be fused in a soda bead in the oxidizing flame, the bead dissolved in excess of hydrochloric acid, boiled, filtered, and a drop of the phosphate solution added. The test is not applicable if phosphoric acid is present in the mineral."

"Zirconium in combination with a volatile or organic acid is usually determined by direct ignition and weighing as ZrO_2." Causes of error in this method are given, one being retention of a small quantity of the volatile acid radical by the oxide formed and the other being losses due to carrying away of light particles of oxide by gas currents. Errors in the quantitative determination result from adsorption of soluble salts by precipitated hydroxides, explosion of hydroxide on ignition, and hydrolysis and consequent loss of weight of certain precipitates on washing.

Most of the methods of separation from other elements are disposed of by referring the reader directly to the original literature on the subject. The cupferron method is discussed in some detail. Being accurate, simple and quick, the selenious acid method of Smith and James might well have been included in this chapter.

As one would expect from the presentation of the properties of the various zirconium compounds found in former chapters of this volume, the chapter upon technical applications comprehends a great variety of uses, many of which are the subject of patents. Precious stones, oxy-hydrogen light, gas mantles, incandescent filaments, reduction of metals, alloys, furnace applications, refractories, enamels, glass, textile applications, colloidal applications, medicinal, abrasive and chlorinating agent comprise the list.

Under the heading alloys there is discussed the possibility of using certain zirconium alloys as incandescent lamp filaments. "Such filaments are claimed to have the power of selective radiations—in other words, emit more light than corresponds to the temperature to which they are heated by the electric current. This implies a considerably lower wattage per candle power than is now required by the average metal filament lamp."

The volume includes an interesting, useful patent list, with a short abstract of each patent, also a comprehensive bibliography which includes all the patents given and to which reference is constantly made in the text.

From the nature of the element there is undoubtedly more than the usual amount of conflicting data and discrepancies to be found in the literature, from which in each case the most reliable work has been selected with a discrimination which evidences an accurate comprehensive, experimental knowledge of the subject.

F. C. NONAMAKER.

* * *

PHYSICAL CHEMISTRY FOR COLLEGES. A Course of Instruction Based Upon the Fundamental Laws of Chemistry. First Edition. By *E. B. Millard*, Assistant Professor of Physical Chemistry, Massachusetts Institute of Technology. International Chemical Series, H. P. Talbot, Ph.D., Consulting Editor. New York: McGraw-Hill Book Co., Inc., 370 Seventh Ave.; London: 6 and 8 Bouverie St., E.C., 4. 1921. vii + 411 pp. 61 figures. Price $3.50.

"This book has been prepared to bring before college students certain of the more important aspects of physical chemistry, together with accurate modern data which illustrate the applicability of its laws to the phenomena observed in the laboratory. It has been assumed that the student is familiar with inorganic and analytical chemistry, that he has had an adequate course in college physics and that the simple processes of calculus are familiar to him.

"No attempt has been made to cover the whole of physical chemistry in a single volume; its most important topics have been treated at such length as the size of the volume allows, and numerous references to recent periodical literature are included for those who would pursue any given topic further.

"The limitations of the orthodox laws of physical chemistry have been emphasized more than is commonly done in beginning courses of physical chemistry. To this end the illustrative data have been carefully chosen from modern experimental work, in order to minimize the 'experimental errors' which are so often used to conceal real deviations of a law from the facts it is intended to express. A trusting belief in inadequate physical laws will only retard the scientific progress of a student, and weaken his faith in adequate laws; whereas a wholesome appreciation that physical chemistry is an unfinished and growing science may stimulate thoughtfulness and research. The proper time to encourage a research attitude is in the very beginning of a student's chemical career."

With the above sentiments all modern physical chemists will be perfectly in accord, and in the hands of a capable and conscientious teacher Prof. Millard's book will undoubtedly be an admirable and inspiring text for college students. The various topics are presented in simple and entertaining style, and a sincere effort has been made throughout to enable the thoughtful worker to obtain an exact idea of the present status of our knowledge on each point.

The most serious criticism that can be raised is that the text assumes too much on the part of the teacher, and it is to be feared that a student forced to make his way through the volume without more than the average available amount of direction would be likely to emerge with a very confused idea of the fundamentals of the science. In the attempt to include minor details of recent advances, the early development and the intimate correlation of the different branches of the subject are often totally neglected. Important relationships, such as the ideal osmotic pressure equation on page 142, the van't Hoff equation for the change of equilibrium point with temperature on page 251 and the Gibbs-Helmholtz equation on page 399, are introduced quite casually without any hint as to their derivation. Unless the groundwork in each case is added by the instructor, the knowledge gained must evidently be merely empirical.

The best chapters are those on Radioactivity and Atomic Structure. The exercises at the end of each chapter are carefully selected, and cannot fail to be of great value to the student.

JAMES KENDALL.

* * *

GAS CHEMISTS HANDBOOK. Compiled by the Chemical Committee Technical Section of the American Gas Association. New York: Second edition. 608 pp., 113 illustrations. Price $6.

This volume should be in every gas works and coke-oven laboratory, for most of the methods in it can be recognized as standard for these industries. Others who have any problems of testing or analysis in connection with gas works raw materials, products of gas manufacturing or impurities in gas will also do well to study these methods carefully.

The committee in the second edition of the handbook has followed its earlier policy of using methods which have been approved by the A.S.T.M., the American Chemical Society, Bureau of Standards and Bureau of Mines. This policy of following standard procedures adopted by associations or government institutions adds greatly to the value of the work. This plan should certainly be encouraged and followed in future editions as they may become necessary.

As in any volume which is a composite of the work of numerous authors, the text lacks somewhat that finish of style and that uniformity of presentation which makes a book most attractive. However, as this is largely a reference work for use of laboratory men, the defect is not really serious. It would have been desirable, however, if a greater uniformity in illustrations had been found possible. Many of these illustrations are excellent, certainly a great improvement over the earlier edition; but there is still room for improvement, as many of the drawings are by no means as carefully made as the value of the work would justify.

R. S. MCBRIDE.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

American Institute of Chemical Engineers Holds Conference on Chemical Engineering Education

At the invitation of the American Institute of Chemical Engineers, representatives of a score of colleges, together with a number of prominent chemical engineers, met at the Brooklyn Polytechnic Institute, Tuesday, May 16. The meeting was called to consider the reports of the Institute's committee on chemical engineering education. This report was based upon an extensive questionnaire on the curriculum of chemical engineering courses offered at seventy-three institutions in this country. These results were tabulated, and on a basis of these tabulations, fourteen recommendations were made. The report is a thorough and admirable work.

The meeting was called to order by President Henry Howard of the American Institute of Chemical Engineers. He introduced President Atkinson of the Brooklyn Polytechnic Institute, who made a short address of welcome to the conference. Dr. Atkinson said that he felt that some of the evils apparent in chemical engineering education were due to the fact that quantity production was the primary aim. He urged upon the conference the desirability of having the students undertake actual industrial work as a part of their technical courses.

Secretary Olsen called the roll of the conference and the following men were present:

Educators—F. W. Atkinson and J. C. Olsen of the Brooklyn Polytechnic Institute; S. T. Arnold, Brown University; Edward Bartow, State University of Iowa; R. M. Bird, University of Virginia; F. E. Breithut, College of the City of New York; C. W. Crockett, University of Maine; John Frazier, University of Pennsylvania; T. B. Freas and D. D. Jackson, Columbia University; R. T. Haslam and W. K. Lewis, Massachusetts Institute of Technology; J. H. James, Carnegie Tech.; R. R. Renshaw and Henry Masson, New York University; Allen Rogers, Pratt Institute; R. L. Sackett, Pennsylvania State College; R. S. Tour, University of Cincinnati; H. M. Ullmann, Lehigh University; A. H. White, University of Michigan; James Withrow, Ohio State University.

Chemical Engineers—A. D. Little, of A. D. Little, Inc.; Henry Howard of the Grasselli Chemical Co.; J. B. F. Herreshoff, General Chemical Co.; F. W. Frerichs, Herf & Frerichs; Charles L. Reese, du Pont company; T. B. Wagner, U. S. Food Products Corporation; G. E. Walker, Dorr Co.; Charles D. Allen and W. C. Bainbridge, H. Kohnstamm & Co.; A. Trowbridge, National Industrial Conference Board; R. T. Stokes, of the *Journal of Industrial and Engineering Chemistry*, and H. C. Parmelee, Ellwood Hendrick, S. D. Kirkpatrick and Charles Wadsworth, 3d, of Chemical & Metallurgical Engineering.

The secretary then read a number of letters from institutions too far away to be represented, all expressing great interest in the conference.

Engineers Express Views on Education

Arthur D. Little of Boston, chairman of the Institute committee, was asked by President Howard to take the chair. Dr. Little began by reading one by one the recommendations which the committee had made, and calling for objections to the recommendations as they stood. In this preliminary discussion ten of the recommendations were approved without change and four were reserved for discussion at the afternoon session. Dr. Little then called on a number of chemical engineers to express their views with regard to the products which the educational institutions are turning out under the name of "chemical engineer."

Henry Howard of the Grasselli Chemical Co. said that he felt that most of the chemical engineers lacked initiative and originality. He did not know whether these attributes could be supplied by education, but felt that the problem should be considered. The young chemical engineer seems to him to lack a knowledge of how to undertake problems, and his suggestion was to train not specialists, but engineers who have breadth of point of view. Charles L. Reese, chemical director of the du Pont company, made a very strong plea for training in English and said that he believed this to be the greatest lack in chemical engineers at the present time. He would prefer a man who had been well trained in chemical theory rather than the ordinary chemical engineer, but admitted that the demands of the du Pont company differ from those of smaller organizations. J. B. F. Herreshoff of the General Chemical Co. felt that perhaps the greatest lack in chemical engineering training was that men were not able to think methodically. What is needed in industry is men who can talk well, think well and write well, he said. Able criticisms of present chemical engineering education were also made by T. B. Wagner, F. W. Frerichs and R. S. Tour.

Dr. Little closed the morning session with a few extracts from the Mann report on engineering education. The conference then adjourned to the Brooklyn Chamber of Commerce, where informal luncheon was served.

Educators Express Views

In the afternoon session the educators, who may be considered the producers of the chemical engineer, were given an opportunity to express their views on chemical engineering education and to suggest changes which would be beneficial. Discussions centered around some of the moot points of the Little report. Prof. James of Carnegie Tech. contended that business training for chemical engineers was highly desirable, especially for those who went into smaller companies. Companies such as the du Pont organization might not find such training necessary, but subjects such as commercial engineering should, in his opinion, be included in the training of a chemical engineer. Another point raised by Prof. James was that engineering subjects, such as mechanical engineering, applied mechanics, strength of materials and such courses, should be given to chemical engineers in somewhat condensed form, as minor subjects, much as chemistry is given in condensed form to medical students.

Dean Sackett of Pennsylvania State College Engineering School felt that it would be distinctly unwise to omit subjects such as might be included under industrial engineering and plant management from the curriculum of the chemical engineer. He further made a plea for the 4-year course in chemical engineering, stating that such a course should be a general course and that special subjects should be taken up as graduate subjects, preferably in institutions specializing in such subjects. This, he said, would make for economy in educational institutions. He was somewhat opposed to special courses in English, economics, etc., because he felt that good English and fundamental principles of economics could be taught through courses in engineering. The writing of reports could be just as efficacious in teaching the students good English writing as random subjects in English composition. It would be much easier for the student to recognize economic principles employed in connection with engineering problems in the courses which he had to take. Dean Sackett stated in clos-

ing that courses in chemical engineering should do their best to increase the interest of the student in the human side of his profession.

A reading knowledge of a modern language was considered very desirable, and both French and German were felt to be necessary, although many of those present believed that high school preparation would eliminate the necessity of taking up either or both of the languages in a technical course already crowded with subjects. Prof. Lewis of the Massachusetts Institute of Technology made a strong plea against overcrowding the curriculum of the chemical engineer. Four years were in his opinion nearly filled with mathematics, physics, chemistry and chemical engineering. It should be urged on the students that four years cannot possibly turn out a finished chemical engineer and that professional success can come only with continued study after graduation. The technical school then should confine itself to subjects which it is difficult to study away from the institution. Such subjects as chemistry very properly should be majored in institutions, whereas subjects such as industrial engineering, in Prof. Lewis' opinion, should be postponed until the student has graduated, for such a subject he could well undertake himself.

The M.I.T. System

Dr. Haslam of the Massachusetts Institute of Technology described the Technology system and told how it worked. In brief, there are three stations to each of which fifth year students in chemical engineering are sent for two months. Each one of these stations is in charge of a director and an assistant director, both of whom are members of the faculty of the Institute. Each station is connected with two manufacturing plants and the students spend one month in each of the plants. The program in each plant is somewhat similar. During the first week a flow sheet or description of the manufacturing process is made out by the student, after which investigative tests are organized. These tests are designed by the director of the station and are carried out by the students. They are not intended to study the operation of the plant as such. In other words, the fact that the men are working in a sugar refinery is not the significant fact. Primarily, they are studying filtration in the sugar refinery and they concentrate on "unit studies," such as grinding, filtration, evaporation, heat transfer, etc.

The students thus are given a six months' course in plant research. Specific problems in industry are being studied from the point of view of the chemical engineer. The students solve these problems themselves under competent guidance. They organize the tests, decide what data are necessary, make sure that the data are taken accurately, and record the data themselves. Considerable interest was evidenced on the part of the conference in this new and apparently successful experiment.

Dr. Allen Rogers of the Pratt Institute told something of the work which is done at his institution in training, not chemical engineers, but chemical foremen. This work also was followed with great interest.

Recommendations Adopted

The recommendations of the Institute committee as finally adopted by the conference were as follows:

1. An undesirable multiplicity of subjects is now included in courses in chemical engineering.
2. Wherever possible it is desirable to avoid splitting major courses into a number of minor courses.
3. Any course in chemical engineering should provide, as the background for specific instruction in chemical engineering as such, strong courses in chemistry, physics, mathematics and the fundamentals of engineering.
4. As preliminary to the desirable reorganization of chemical engineering courses, steps should be taken to secure agreement on the nomenclature concerned with the subjects involved.
5. A much closer agreement in the weighting of the various courses as to clock and credit hours is urgently needed in those institutions giving courses in chemical engineering.
6. The committee would omit from chemical engineering curricula courses in civil engineering, sanitary engineering, mining engineering (except geology), and electrical engineering beyond its fundamentals, which should include the instruction required for the erection and operation of motors and generators.
7. It is desirable to avoid specialization by industries in the 4-year course in chemical engineering. When specialized training is offered, the specialized subjects should preferably be segregated as post-graduate work. This applies to such subjects as petroleum technology, sugar, cellulose technology, fuel and oil, and refrigeration.
8. The committee considers a thorough grounding in English, a reading knowledge of some foreign language and a reasonable familiarity with English literature essential to the adequate training of the chemical engineer, and regards English as one of his most effective working tools. It recommends a special course in report writing and the oral presentation of projects.
9. The committee recommends that a "source of information" course or its equivalent be provided as a part of the chemical engineering course. This specialized course should familiarize the student with patent literature, governmental reports, bibliographies, trade journals and catalogs, abstract journals, publications of societies and other technical literature, the resources of libraries and the activities of scientific and technical organizations throughout the world.
10. The committee recommends that wherever possible, engineering studies should be preceded by 3 years of general college training, in which special emphasis be given to mathematics, physics, chemistry, English history and economics, with the idea of obtaining a broad foundation for their professional study and of entering upon this study at a greater maturity and with presumable reduction of time required for their professional courses.
11. The committee wishes to emphasize the fact that the chemical engineering profession is a difficult one and that, accordingly, a thorough and broad preparation for entrance should be insisted upon by institutions offering courses in chemical engineering.
12. The committee recommends that technical schools and professional schools of universities arrange their courses so that properly qualified college graduates may secure a professional degree at the end of a two-year course.
13. The committee deprecates the use of undergraduate or even graduate students as major instructors (instructors of laboratory sections or quiz sections) in charge of classes of chemical engineering, even in the freshman year.

The conference voted that the chairman appoint a committee to carry on the work and to call a second conference at some future time. Dr. Little urged the members of the conference to suggest the names of members of the committee to him. A vote of thanks was passed to the Brooklyn Polytechnic Institute for its courtesy in housing the conference.

Modern Trend of Engineering in Public Service Indorsed by Heating and Ventilating Engineers

Eulogizing the report of the committee on elimination of waste in industry of the Federated American Engineering Societies as a "notable and outstanding" achievement in the public interest, a report of the committee on industrial reconstruction of the American Society of Heating and Ventilating Engineers urges active engineering participation in the national effort to solve the pressing problems of industry. The committee was appointed to study some of the questions of industrial reconstruction and to seek to co-operate with the committees of other engineering societies to ascertain avenues for public service by engineers.

It is the intention of the Society of Heating and Ventilating Engineers to associate with the Federated Societies as soon as its finances permit.

Lime Association to Meet in Cleveland

The annual convention of the National Lime Association will be held June 14 to 16, at the Hotel Statler, Cleveland, Ohio. The activities of this convention will deal with the technology of the uses of lime and the industrial problems of manufacturing and marketing lime.

Differences Between Importers and Alliance Aired Before Dye Investigation

Additional testimony relating to the importers' view of the dye situation was presented before the Senate investigating committee by Paul Pickhardt, of Kuttroff, Pickhardt & Co., in the dye hearings last week. In addition to Senator Moses' complaints against the administration of the licensing system which Mr. Pickhardt voiced at his first appearance, the latter presented a lengthy recital of his own activities and those of his firm in connection with the importation of German dyes. His testimony was designed to show that all of the activities of himself and of his company were proper and did not merit the condemnation and criticism that he said previous witnesses before the committee had expressed. Mr. Pickhardt read quotations from communications between his firm and the German cartel, and between various officials in the United States and American representatives in Paris dealing with the dye situation. These showed, he said, that statements and inferences made against the activities of his firm were not justified and that his company had acted within its rights at all times.

Again Attacks Textile Alliance

Mr.Pickhardt again emphasized his contention that the German manufacturers desired to have all dyes wanted by the United States, other than those controlled by the Reparation Commission, imported through the firm of Kuttroff, Pickhardt & Co., and he again attacked the prominence of the Textile Alliance in importing German dyes for consumers. The intention of the Germans, he said, was that Kuttroff, Pickhardt & Co., be the sole importing agency of all other than reparation dyes.

His company had returned 188 import licenses to the consumers for whom they had obtained them, he said, because the Textile Alliance was able to secure the dyes at a cheaper price. These licenses were the property of the consumers and should be turned back to them, he felt, rather than turned over to the Textile Alliance, although the consumers themselves gave the licenses to the Alliance to fill.

Derides German Bugaboo

Efforts have been made, continued Mr. Pickhardt, to impress upon the country the great power of the German chemical cartel and the danger of the cartel securing a hold on this market through importers. "As a matter of fact," he said, "any hold that may be obtained will be through the quality of their goods or their prices, and whether that hold comes through importing agencies or an official agency makes little difference."

"Reference has been made to the danger of German dumping," he continued. "It must be remembered that the Germans are in a commercial business. Before the war $11,000,000 would cover the entire market in the United States. The consumption of German dyes in the United States was not over 15 per cent of the total world consumption. It is scarcely probable that the Germans would disturb prices all over the world, including all other markets where they now can make a profit, in order to dump dyes in the United States. They would be throwing a world market away for a comparatively small part of it. The statement that the German cartel would be willing to spend $50,000,000 dumping dyes in the United States in order to destroy the American industry is absurd."

Textile Alliance Offers Defence

W. B. Denton, treasurer of the Textile Alliance, presented a statement from A. M. Patterson, president of the Alliance, replying to Mr. Pickhardt's charges against that organization. The statement declared that the Textile Alliance has had only the same sources of information that are open to Kuttroff, Pickhardt & Co. He added that the delays in receipt of reparations dyes charged to the administrators of the system by Mr. Pickhardt were caused by the efforts of importers, present or former agents of the cartel, to delay and block the deliveries of reparation and "Herty option" dyes to consumers in the United States.

Mr. Patterson replied to a number of other charges by Mr. Pickhardt and stated in conclusion that the rights to the reparation dyes guaranteed and safeguarded by the treaty with Germany can be maintained only through a government agency or a nominee acting for the American public and the consuming trades.

Howe Explains C.W.S. Exhibit

The importance of chemistry to national defense, as well as to medicine and to industry and science, was emphasized by H. E. Howe, formerly of the National Research Council, in his testimony on May 20 before a special session of the committee. Dr. Howe explained the chemical exhibit which was prepared under the auspices of the National Research Council with the co-operation of the Chemical Warfare Service of the United States Army. The exhibit was prepared, he said, to educate the public to the vitally important part in our national existence played by chemistry. The exhibit now is permanently installed at the Smithsonian Institution in Washington.

New Proposal for Government Operation of Muscle Shoals in Senate

Senator Norris of Nebraska has introduced a bill for the operation of the Muscle Shoals nitrate plants by a government corporation to be known as the Federal Chemical Corporation. The bill was prepared by ex-Representative Lloyd of Missouri.

The proposed corporation would continue for 50 years and would have seven directors, of whom three would represent the government by selection of the Secretaries of Treasury, War and Agriculture. These three directors would have the same power as the other directors of the corporation and in addition would control the sale and distribution of nitrates and fertilizers produced. The other four members of the board would be selected at the annual meeting of the stockholders of the corporation and hold office for one year.

The offices of the corporation would be established at Muscle Shoals and in Washington. The capital stock would be $5,000,000 divided into 50,000 shares of par value $100.

The bill provides for the lease of the Gorges steam plant and transmission lines with all the plants and dam at Muscle Shoals for a period of 50 years. The corporation would complete the construction projects now under way, including Dam 3 and its proposed power house. Under the provisions of the bill, the corporation would immediately adapt the nitrate plants for the production of fertilizers, the selling price of which would be fixed by the government directors. The bill would also provide that the lessee give to the government, for its protection, a bond in the sum of $1,000,000 to be approved by the Secretary of the Treasury for the faithful performance of the provisions of the lease, which would be renewed every 5 years. In event the bond were not renewed at the expiration of any 5-year period the lease would terminate and the government take possession.

Redmanol Company Consents to Decree and Will Manufacture Under License of Bakelite Co.

The Redmanol Chemical Products Co. has made a settlement of the recent action by the General Bakelite Co. against the General Insulate Co. for infringement in the use of Redmanol by the last named company. This action though brought against its customer was defended by the Redmanol company.

Judge Chatfield rendered a decision sustaining the Baekeland patents, covering broadly, on the one hand, the combination of phenol condensation products with fiber and fibrous materials, and on the other hand the simultaneous use of heat and pressure in the manufacture of articles made from these products.[1] The Redmanol company has now consented to a decree and paid heavy damages in liquidation. Redmanol henceforth will manufacture under license.

The validity of the Baekeland patents is thus confirmed. Previously their validity had been acknowledged by the Condensite Co. of America, a licensee of the General Bakelite Co.

The products of these three companies are well known under trade names of Bakelite, Redmanol and Condensite.

[1] See Chem. & Met. Eng., vol. 25, p. 279, Aug. 17, 1921.

Tariff Discussion in Senate Drags Through 100 of 2,057 Committee Amendments

It took the Senate just a month to consider the less controverted committee amendments to the chemical schedule of the tariff bill. The rates prescribed for coal-tar products, which can be considered only in connection with the administrative provision providing for a continuance of dye and chemical control, are yet to be discussed. With the single exception of American valuation, the dye controversy is the principal storm center of the entire bill.

The chemical schedule contains eighty-eight paragraphs. Some of the more disputed of these have gone over for future consideration. When it is considered that there are 1,690 paragraphs in the bill, in addition to the special provisions and the administrative features, the enormity of the task of putting through tariff legislation under Senate rules, under which it is very difficult to restrict debate, can be realized. The eighty-eight paragraphs in the chemical schedule cover more than 6,000 items. As a consequence, the rate of duty is of concern to a very wide range of industries. Senators anxious to present the viewpoints of constituents are never lacking in material to bring before the Senate regardless of the importance of the item. The bill contains 2,057 committee amendments. During the first month of the consideration of the bill one hundred of that number had been considered.

In this particular bill the special provisions and administrative features represent departures in policy. As a result those provisions will come in for lengthy discussion. They cover 196 of the 438 pages of the bill.

Eyes on the Calendar

Senator Harrison of Mississippi, who is opposed to the passage of the bill, stated on the floor of the Senate May 16 that "the plan of the majority is to allow the consideration of the pending bill to occupy a long time in the Senate—to permit it to drag along for months and months. Then the bill will go to conference. It will stay in conference during the election. Then Congress will adjourn without a tariff bill having been passed."

Five hours and forty minutes was consumed in the discussion of the five-line alcohol paragraph before the committee amendment was voted on. This is typical of the procedure on numerous other items which are by no means storm centers in the bill. "Senators on the other side," said Senator McCumber, who is in charge of the bill, "disclaim any purpose whatever to delay the consideration of this bill. They speak earnestly of their desire to facilitate its progress. They remind me of the poem of Kipling's bear, as they look at us and speak to us like a man in the attitude of prayer, professing their innocence of any intention to filibuster."

Borah Would Postpone Consideration of the Bill

That the Republicans are not a unit in their support of the bill is becoming increasingly evident. Senator Borah boldly stated on the floor of the Senate that the facts at hand are insufficient upon which to base an intelligent tariff bill at this time. "I would vote unhesitatingly," he said, "to postpone consideration of the bill and to take care of the situation by a simple addition to the emergency tariff law. I do not know where we can get facts as to the cost of production abroad. I do not see how it is possible to secure them. The facts available today will be swept away utterly tomorrow, so that there are no facts upon which we can base an intelligent opinion. I do not believe it is possible to make a tariff law of permanent worth under such conditions."

While it is known that certain Republican Senators are not enthusiastic about the bill, there can be no denying that the majority leaders are doing all in their power to expedite its consideration.

Ammonium Nitrate Off Free List

At the last minute the committee changed its mind with with regard to the action it would take on ammonium nitrate. This commodity had been placed on the free list, but on reconsideration the committee decided to recommend that it be made dutiable at one cent per pound. It was contended that the byproduct coke industry must be encouraged, and since such a duty would not be in the interest of a monopoly but in the interest of a very large number of separate concerns, the committee finally determined to give it protection to the extent of 1 cent a pound. It was admitted that the Republicans on the Finance Committee were closely divided on the matter, but the Senate supported the 1-cent duty by a vote of 35 to 24.

By a vote of 32 to 24 the rate of 50 per cent ad valorem on trichlorethylene was reduced to 35 per cent. It was pointed out by Senator Willis of Ohio that it is important to use this chemical in the decaffeinization of coffee in that it does not explode like benzene. This permits the carrying on of this operation within city limits where it otherwise would be barred by fire regulations.

The duty on dry, ground, bolted or precipitated chalk was reduced from 35 per cent to 20 per cent ad valorem. The rate on putty was increased from ½ to ¾ cent per pound, while the manufactures of chalk not specially provided for were put back to the House rate of 25 per cent ad valorem. The committee also receded from its proposal to make ethers and esters not specially provided for dutiable at 30 per cent ad valorem. The House rate of 25 per cent was restored.

King Would Reduce Barium Rates

As fast as he could offer them the Senate rejected amendments of Senator King to reduce the duties on barium products. By a vote of 41 to 15 it rejected his amendment to reduce the duty on barium carbonate from 1 to ¼ cent a pound, and the committee duty of 1 cent a pound was adopted, 38 to 15. By a vote of 36 to 13 the Senate rejected King's amendment to reduce the duty on barium chloride from 1¾ cents to ¼ cent a pound, and adopted the committee duty without division. An amendment by the Senator reducing the duty on barium hydroxide from 1¾ cents to ¾ cent a pound was defeated, 40 to 12, and another amendment reducing the duty on barium nitrate from 2½ to 1½ cents a pound was defeated, 39 to 13.

This brought up the matter of a proposed duty on manganese, which product the Finance Committee had placed on the free list. Senator Smoot of Utah said the controlling factor which induced the committee to place manganese on the free list was a report of the Geological Survey to the effect that there were no deposits in this country of sufficient content to enable them to be worked profitably.

New Jersey Chemical Society Enjoys Annual Outing at Princeton

A more beautiful day for an outing could not have been desired than Saturday, May 20, when the members of the New Jersey Chemical Society journeyed to Princeton for their annual ladies' day, as guests of the Chemical Society of Princeton University. The Princeton campus, with its shaded walks, expansive lawns and well-kept gardens, was at its best. Campus and buildings were thrown open to the visitors, and little groups of chemists wandered through the grounds as their fancy led them. Many of the members found their way to the athletic field and saw Princeton triumph over Harvard in the dual track meet. Late in the afternoon light refreshments were served in Murray Dodge Hall, after which the members gathered at a theater just off the campus, where A. C. Fieldner, of the Pittsburgh Experiment Station of the Bureau of Mines, spoke on the timely subject of the ventilation of vehicular tunnels.

Mr. Fieldner's talk was illustrated with slides and motion pictures showing the experimental mine constructed at Pittsburgh in which were carried out the studies that supplied data for the design of the new Hudson River tunnels. The studies of effect of small concentrations of carbon dioxide on the workers were described, as were the elaborate chemical and physical tests on the rate of flow of air, its optimum humidity and the heat conductivity of the tunnel walls.

Dinner was served in the beautiful graduate school dining room to eighty members and guests. Beyond a brief word of appreciation for Princeton's hospitality there was a refreshing absence of speechmaking, and the guests enjoyed a sociable hour before returning to their homes.

New Merchant Mill Planned by Tennessee Coal, Iron & R.R. Co.

Official announcement is made by George Gordon Crawford, president of the Tennessee Coal, Iron & Railroad Co., that a combination 10- and 12-in. merchant bar mill, two blocks long by 80 ft. wide and having a monthly capacity of 10,000 tons of plain or deformed bars, rounds and squares, is to be built at once at the works of the Tennessee company in Fairfield, a suburb of Birmingham. While the cost of the new mill has not been officially announced, it is stated unofficially that the figure will be approximately a million dollars.

The new merchant mill will be so located as to receive billets from the Fairfield blooming mill, to which tables will be added so that long billets can be delivered to the merchant mill without the necessity of switching cars. It will consist of a roughing train of six strands of 10-in. rolls, an intermediate mill of five strands of 12-in. rolls and a finishing train of two strands of finishing rolls, provided with 11-in. pinions, making it possible to use either 10-in. or 12-in. rolls.

A mechanical hotbed 255 ft. in length will receive the hot bars from the roll trains and, after cooling, the bars will be sheared and stocked in a stores and shipping room specially adapted for the storing of concrete reinforcing bars and with storage capacity for a limited tonnage of merchant bars. The bar mill and stocking building will be 80 ft. wide and 820 ft. long. The capacity of the mills is estimated at 10,000 tons of plain or deformed bars, rounds or squares per month. The mill is to be built to care for the increased demands for bars in the Southern territory and for export. Material for the construction of the mill will be ordered at once and construction will begin as soon as the materials are received.

New Strike Indicates Large Northern Oil Field

The Troy-Sweetgrass Co. has struck oil at a depth of 1,750 ft. in a test-bore that the company was sinking at a point 12 miles southeast of Kevin, Mont. The oil is said to be of the same grade as that found at Kevin about 2 months ago, and would seem to indicate that an important new oilfield has been discovered. When oil was found at Kevin, S. E. Slipper, of the Canadian Geological Survey, after making an examination of the oil, stated emphatically that he believed an important new field had been discovered, and that the geological structure of the country in southern Alberta would lead him to suppose that the field is likely to extend into that province nearly as far as the Saskatchewan River. The recent discovery of very "wet" gas near Medicine Hat would seem to bear out Mr. Slipper's prediction. The Troy-Sweetgrass Co. will enlarge the bore, so that oil may be pumped from the well.

Tile Manufacturers Exhibit Varied Products

The Associated Tile Manufacturers, co-operating with the American Institute of Architects, held an exhibit of tiles and tile work and presented a series of illustrated addresses at the Cosmos Club, Washington, D. C., May 12 to 15, inclusive. The exhibit was largely of samples of tiles for house and building finish or decoration. The possibilities of utilizing colored and figured tiles for both exterior and interior was particularly emphasized. Among the speakers were Frank Upman, Albert Kelsey, D. Knickerbocker Boyd and A. L. Harris, architects, and F. W. Walker, secretary of the Associated Tile Manufacturers.

Carnegie Tech Students Join Industrial Engineers

A chapter of the Society of Industrial Engineers was recently organized among students at Carnegie Institute of Technology, Pittsburgh, to be known as the Carnegie Industrial Engineers Society. This is the third chapter to be organized in the country.

The department of machine construction, under Prof. Charles C. Leeds, organized the chapter, which includes 108 members. Sophomore, junior and senior students taking 4-year degree courses in the colleges of engineering and industries are eligible, but a satisfactory scholastic standing must be maintained to hold membership.

Fellowships Offered at Washington and Alabama

The College of Mines of the University of Washington offers five fellowships for research in mining, metallurgy and ceramics in co-operative work with the Bureau of Mines. The fellowships are open to graduates of universities and technical schools who are properly qualified to undertake research investigations. The value of each fellowship is $780 per year of 12 months, beginning July 1. Fellowship holders are required to register as graduate students and to become candidates for the degree of master of science in mining engineering, or metallurgy, or ceramics, unless an equivalent degree has previously been earned.

The School of Mines of the College of Engineering of the University of Alabama also offers five fellowships in mining and metallurgical research in co-operation with the Bureau of Mines. The fellowships are open to graduates of universities and engineering schools who have proper qualifications to undertake research investigation. Conditions are the same as mentioned above.

The Co-operative Department of Mining Engineering of Carnegie Institute of Technology, Pittsburgh, announces the offer of two fellowships in mining research and two in teaching and research, in co-operation with the Pittsburgh Experiment Station of the United States Bureau of Mines. Fellowships are open to graduates of universities and technical schools who are properly qualified to undertake research investigations. The value of each fellowship is $750 per year of 10 months beginning July 1 for the position of research fellow and Aug. 1 for teaching fellow.

International Chamber of Commerce to Hold General Meeting in Rome

The next general meeting of the International Chamber of Commerce will be held in Rome, Italy, the week of March 19, 1923. In arriving at this decision the board of directors of the International Chamber, which just met in Paris, was influenced to a great extent by the possibilities of the Genoa Conference.

Before this meeting the International Chamber committees, consisting of experts in financial and commercial problems, will be able to consider the results from the Genoa Conference in so far as they affect industry and commerce. Based on the views of these committees, constructive plans will be made at that time as to such further steps which should be taken in restoring the trade of the world.

The Congress planned for next spring will be the first meeting of the International Chamber to be held in Italy. As it is to be held early in the year, it is expected that large delegations of business men from the twenty or more countries connected with the International body will attend.

New Fertilizer Plant in Florida

Work has begun on the factory of the Non-Acid Fertilizer & Chemical Co., which will manufacture finished fertilizer from phosphate taken from its own mines in Polk county, Fla. The plant will be completed in time to begin filling orders by Aug. 1, according to backers of the enterprise.

The plant, which will have a capacity of 40,000 tons a month, is located on the main line of the Atlantic Coast Line R.R., 1½ miles south of Lakeland. When completed it will have a complete mixing plant capable of converting the raw phosphate into finished commercial fertilizer. The company owns several tracts of phosphate lands in the Lakeland and Mulberry district and will mine its own raw material. The main building will be 80x300 ft. and 150 men will be employed.

Says Freight Rates Keep Up Fertilizer Prices

Fertilizer prices are discussed by Chairman Anderson of the Joint Agricultural Commission in a report on the effect of railroad rates on agriculture and basic commodities. "Fertilizer prices are now close to the pre-war basis except for the higher freight costs now prevailing," he said. "Material prices and costs of manufacture are almost back to normal, leaving the present freight costs almost entirely responsible for the difference between present cost of fertilizer and that which prevailed prior to the war."

American Section, Society of Chemical Industry, Holds Symposium on Activated Carbon

Of rather unusual interest, partly because of the comparatively recent development of the subject and partly because of its wide industrial application, was the conference on activated carbon held by the American Section of the Society of Chemical Industry in New York, May 19. Two papers on different phases of the subject were presented and the discussion which followed was general and animated.

Activated Carbon and Its Uses

Dr. A B. Ray, of the National Carbide & Carbon Co., took as his subject "Activated Carbon and Its Uses." Although handicapped considerably by lack of facilities for projecting his carefully prepared stereopticon slides, Dr. Ray went into the theory of activated carbon and its application in industry in a lucid and interesting manner. Activated carbon apparently has a distinct physical form. Amorphous carbon, aside from its occurrence as diamond and as graphite, occurs in two forms, one of which is active, while the other is not. The active form is prepared by the carbonization of nut shells or lignite at low temperatures, giving a product which is known as primary carbon. This is not absorptive, since it is apparently already saturated with stabilized hydrocarbons. The process of activation consists in breaking down this complex of stabilized hydrocarbons by treatment with saturated steam, by differential oxidation or by a chemical treatment with lime or zinc chloride. Active and inactive carbon differ in the temperature of formation, the active modification being formed at temperatures between 500 and 600 deg. C.

The absorptive power of the carbon depends upon two characteristics of the substance, its specific absorptive capacity and its capillary absorptive capacity. Dr. Ray described tests developed during the war for the determination of these two quantities by saturating and then evacuating a sample of carbon. By far the largest part of the absorbent power of the carbon is due to its specific absorption power, and this portion is also most readily recovered. He also described the iodine test for determining the capacity of the substance for absorbing complex substances from solution. For this phase of selective absorption, porosity is a requisite of the material as well as activity. The porosity is determined by measuring the apparent density in a specially designed apparatus.

Application of Activated Carbon in Industry

Activated carbon is finding application in industry in three main fields, for absorbing gases, absorbing substances from solution and as a catalyst. For the first purpose, the carbon must have a high retentivity and be structurally strong. It is being used for removing toxic vapors from air, in solvent recovery, extracting gasoline from natural gas, sulphur compounds from coal gas, purifying hydrogen, separating mixed gases, manufacturing helium, obtaining high vacuums and in purifying carbon dioxide and ammonia. As an absorbent for substances in solution it is used in refining sugar, organic acids, glycerine, gelatine and glue, pharmaceuticals, mineral acids, alkaloids and decolorizing waxes.

G. A. Burrell described in greater detail the application of activated carbon to the extraction of gasoline from natural gas, a process which seems to promise relief for the motor fuel situation of the future. Dr. Burrell pointed out how the tremendous demand for motor gasoline has forced the refiners to cut deeper and deeper into the petroleum to produce lighter fractions for this purpose. The product so obtained is low grade and has to be mixed with natural gasoline to make it fit for use as a fuel.

Both of the ordinary processes of removing gasoline from natural gas have their disadvantages, the compression process involving high losses due to the liquefaction of butane, which then absorbs hexane, and the oil absorption process demanding considerable handling of solvent oil. There are three plants in commercial operation at the present time, according to Dr. Burrell. A unit consists of three absorbers, one of which is absorbing while one is being evacuated and the other is cooling. By this process it is said that a very superior grade of gasoline is produced, averaging 7 to 8 lb. vapor pressure.

Expect Good Representation at Annual Exposition of Chemical Industries

The Eighth National Exposition of Chemical Industries will be held this year in the Grand Central Palace, New York, Sept. 11 to 16. It will follow immediately upon the fall meeting of the American Chemical Society.

The managers report that three full floors and part of the fourth of the Grand Central Palace are already taken for the exposition. There are this time 350 exhibitors who have contracted for their space locations. In the exposition there are two special sections, one upon the subject of fuel economy, where exhibits intended for the more efficient use of fuel, its combustion, distribution or control will be made; another where the subject of shipping containers will be given considerable attention and will have to do with the container itself, whether of metal, wood, fiber, paper or the cooperage of slack or tight barrels, tanks and towers with machinery for packaging, labeling, handling and conveying the packaged material and lastly making it ready for final shipment. This section will furnish the complete ideal for any industrial plant. There will be groups of exhibits of glass and ceramic products. Laboratory equipment will be thoroughly represented. There will be a group of Canadian exhibits where the natural resources of the adjoining dominion will be made and there will also be a Southern section where not only the resources of our South but of the manufactured products coming from that section will be made.

The program of the exposition has been outlined and work is now in progress upon it, and it may be expected to compare fully with the high standards of the preceding expositions. As has been the custom, there will be exhibits of motion pictures covering all phases of the chemical industries and the exposition will hold much of interest for every visitor.

New Chamber of Commerce Building Dedicated

In the presence of representative business men from all parts of the country, the cornerstone of the new home of the Chamber of Commerce of the United States was laid May 17, on the site of Daniel Webster's old home, facing the White House.

As expressed by Joseph H. Defrees, president of the National Chamber, the proposed new building was dedicated to industry and commerce on the basis that "if it is not for the common good it is not good for business."

The speakers were Secretary of Commerce Hoover, former Secretary of Commerce and Labor Charles Nagel, L. S. Gillette of St. Paul, chairman of the building committee, and Harry A. Wheeler, Chicago banker, the first president of the Chamber.

Safety Institute Extends Activities

The Safety Institute of America has recently announced the appointment of Dr. C.-E. A. Winslow as health supervisor. It is planned to broaden the program of the organization to include, in addition to the prevention of accidents, the general problems of factory sanitation, personal hygiene of workers and treatment of injuries and disease. One section of the Institute's permanent museum of safety will be devoted to industrial hygiene and will include exhibits dealing with lighting, ventilation, dust removal, factory seating, etc.

International Commercial Exposition in Mexico

An invitation to attend the Second International Commercial Exposition in Mexico City, Aug. 15 to Sept. 15, 1922, has been extended to American manufacturers, exporters and business men through the Mexican Chamber of Commerce of the United States. Sept. 16 is the national independence celebration day in Mexico. Mexico City has the largest number of visitors during the two or three weeks previous to that date. A great percentage of the merchants throughout the republic and the well-to-to people go to Mexico City to do their purchasing and make their connections at this time.

Civil Service Openings for Chemists

The U. S. Civil Service Commission announces open competitive examinations for the following positions:

Laboratory assistant, senior grade, at salary of $1,200 to $1,380 per year. Examinations will be held June 7 and 8 and July 19 and 20, 1922.

Laboratory assistant, junior grade, $1,000 a year. Senior aid, $900 a year. Examinations June 7 and July 19, 1922.

Application for the above should be made at once on form 1312.

New Soda Factory in Indo-China

The large factory for the manufacture of soda and by products by the Société Industrielle de Chimie d'Extrême-Orient, is practically completed. The factory is on a deep-water site near Haiphong, and is considered to be the most important and modern plant in the Orient. It represents an expenditure of 11,250,000 francs. The company expects to supply a large number of paper, glass, soap and spinning factories in the Orient with caustic soda and other chemicals.

Paper Mill Operates Largest Electric Boiler

An electric steam boiler, said to be the largest ever built, was recently put in operation by the Laurentide Paper Co. The boiler is designed for 25,000 kw. and is being run at 34,000 kw., producing 100,000 lb. of steam per hour at 125 lb. pressure. The boiler was constructed and installed by the Dominion Engineering Works, Montreal.

Personal

Dr. Edward Bartow, head of the department of chemistry, State University of Iowa, intends to sail for Liverpool on June 3. He also intends to visit a number of places on the Continent and will attend the International Union of Pure and Applied Chemistry, at Lyons, France.

Dr. William Blum, of the Bureau of Standards, who has been suffering severely through difficulty with his eyes, is recovering slowly from this trouble as a result of a recent operation. His friends will be pleased to know that the doctors give great encouragement regarding complete recovery, though he will still be compelled to refrain from much active work for some time to come.

John V. N. Dorr, president of the Dorr Co., of New York, is on a 2 months' business trip and expects to visit the principal European countries. He will make his headquarters at the offices of the Dorr Co. at 16 South St., London, E. C., and expects to return to New York in July.

H. C. Fuller addressed a joint meeting of the Chemical Society of Washington and the American Pharmaceutical Association, Washington branch, on May 11, on the subject "The Chemist and the Druggist." A series of motion pictures was shown descriptive of the manufacture of industrial alcohol and several other related topics.

W. H. Fulweiler, of Philadelphia, has been selected to serve on the new executive committee of the Division of Research Extension of the National Research Council.

Captain D. P. Gaillard, who has for several years been in the Nitrate Division of the Army, has been permanently transferred from Washington. He is now Ordnance representative at the Old Hickory Ordnance Reserve Depot, Jacksonville, Tenn. At that station he will be the representative of the army in matters relating to the sale of property which was formerly the Old Hickory powder plant, located near Nashville, which is being disposed of by the National Industrial Corporation, under a contract with the government.

H. W. Hardinge has left for a tour throughout the West to make a general survey of conditions in both the mining and industrial fields.

Kotaro Honda, professor of metallurgy at the Imperial Japanese University, Sendai, was presented with the Bessemer Medal of the British Iron and Steel Institute in recognition of his researches into the magnetic properties of iron and steel. He has established the theory of molecular magnetism, based on the measurement of the amount of change of the volume in the steel when magnetized, and his researches led to the discovery of one of the best materials for the manufacture of permanent magnets.

Milton Kutz, for the past 25 years with the Roessler & Hasslacher Chemical Co. and during the last 12 years manager of the Philadelphia office, is now located in New York as manager of sales.

Dr. C. E. Kenneth Mees gave a lecture on May 12 on "A Photographic Research Laboratory" before the Northeastern Section of the American Chemical Society at Rochester, N. Y.

Dr. G. A. Menge, formerly with Libby, McNeill & Libby, has opened an office as consulting chemist at 111 West Monroe St., Chicago, Ill.

Dr. R. B. Moore, chief chemist of the Bureau of Mines, is en route to Europe on an official visit to study developments in radium, rare metals and rare gases. In addition he will make observations as to the potash and dye industries. Dr. Moore also will carry credentials from the Chemical Warfare Service and will look into certain matters of chemical development in which that Service is much interested. His itinerary includes London, Paris, Berlin, Prague, Vienna and Leyden. He has accepted an invitation to deliver several lectures while in Prague.

Prof. W. Nernst on April 1 took over the duties of director of the Physikalisch-Technische Reichsanstalt, but will continue to act as rector of the University of Berlin until Oct. 15.

H. C. Parmelee, editor of Chemical & Metallurgical Engineering, addressed the Chemical Society of the Massachusetts Institute of Technology on "The Chemist in Public Life" on May 11.

L. D. Perry, treasurer of the Central Iron & Steel Co., Harrisburg, Pa., has resigned. He has been connected with the company for about 10 years.

Prof. R. S. Tour of the department of chemical engineering, University of Cincinnati, spoke before the Affiliated Technical Societies of Detroit on Friday, May 19. His subject was "Some Technical and Economic Considerations of the Muscle Shoals Development."

E. A. Wilson, director of the pyralin research laboratory of E. I. du Pont de Nemours & Co., is resigning to engage in the practice of chemical engineering.

David Wing, who has been associated prominently with many of the government's activities touching coal, has been designated by Secretary of Commerce Hoover to act as the department's point of contact with trade associations desirous of discussing plans for submitting their statistical data to the department.

Prof. J. R. Withrow of the Ohio State University will sail for Europe June 13 on the Empress of France. He intends to make an extended trip through France, Italy and Switzerland.

At the meeting of the National Academy of Sciences, held in Washington on April 26, members were elected as follows: Edward W. Berry, professor of paleontology, Johns Hopkins University; George K. Burgess, Bureau of Standards; Rufus Cole, director of the hospital of the Rockefeller Institute for Medical Research; Luther P. Eisenhart, professor of mathematics, Princeton University; Joseph Erlanger, professor of physiology, Washington University Medical School; Herbert Hoover, Secretary of Commerce; George A. Hulett, professor of physical chemistry, Princeton University; Charles A. Kofoid, professor of zoology, University of California; George P. Merrill, curator of geology, U. S. National Museum; C. E. Seashore, professor of psychology, State University of Iowa; Charles R. Stockard, professor of anatomy, Cornell Medical College: Ambrose Swasey, president of the Warner & Swasey Co.; W. H. Wright, astronomer, Lick Observatory, University of California. Dr. Albert Einstein, of the University of Berlin, was elected a foreign associate.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Standard Working Hours of Factory Employees

An inquiry regarding standard working hours in New York State, which has recently been completed by the Industrial Commissioner of that state, has brought to light some information of interest to executives in the chemical and allied industries. It is evident from this compilation that over half of the factory employees in New York State work on an 8-hour basis, since the group "45 to 48 hours" shown in the accompanying table accounts for 50.2 per cent of the total and an additional 10 per cent are found in the group "44 hours or less." The chemical industries show even a larger proportion of plants reporting the standard 8-hour day. Leather, glass and lime factories would appear to have longer working hours than the average for all industries. The paper mills, on the other hand, reported the shortest hours of any of the industries considered.

It is interesting to know that in 1913 the 9-hour day was the prevalent working day in New York State, although almost as many wage earners were working 10 hours a day. The longest working hours in 1913 were in the stone, clay and glass industries and in the pulp and paper industry. The latter group reported the greatest reduction in working hours of any industry—from weeks of "over 63 hours" in 1913 to 48 hours in 1921. This reduction is the result of the change in that industry from two-shift to three-shift operation, which changed the working day from 11, 12 or 13 hours in continuous processes to 8 hours.

The chemicals, oils and paints industry is one of the few groups in which working hours in 1921 are shorter up state than in New York City. There are, however, more employees on a 44-hour week in New York City than outside of the city. The low hours in the city are found chiefly in the animal and mineral oil products division. Up state three-quarters of the chemical group and most of its subdivisions work an 8-hour day.

Hours of Labor According to U. S. Census

The returns of the 1919 census of manufactures indicate a general and marked decrease in the prevailing hours of labor throughout the entire country. Of the 9,096,372 wage earners reported by that census, 4,418,693, or 48.6 per cent, were employed in establishments where the prevailing hours of labor per week were 48 or under, while in the previous census, covering the year 1914, the number employed in this class of establishment was only 833,330, representing 11.8 per cent of the total number of wage earners.

The establishments in which the hours of labor were 48 per week in 1919 employed 32.6 per cent, or about one-third of the total number of wage earners, and those in which the hours were less than 48 employed 16 per cent of the total.

In 1914, 74.6 per cent of the total number of wage earn-

NUMBER OF HOURS THAT CONSTITUTE A STANDARD WEEK FOR EMPLOYEES IN REPRESENTATIVE FACTORIES IN NEW YORK STATE

Industry	Number of Firms Reporting	Number of Men						Number of Women					
		Total	44 Hr. or Less	45 to 48 Hr.	49 to 51 Hr.	52 to 54 Hr.	Over 54 Hr.	Total	44 Hr. or Less	45 to 48 Hr.	49 to 51 Hr.	52 to 54 Hr.	Over 54 Hr.
Drugs and chemicals	12	1,308	.....	207	664	207	230	574	16	158	287	113	.....
Paints, dyes and colors	12	2,079	.....	1,248	647	184	.....	255	.....	21	103	131	.....
Animal and mineral oils	16	6,859	324	4,568	780	233	954	1,278	78	874	318	8	.....
Miscellaneous chemical products	11	4,938	.....	3,788	185	346	619	1,947	.....	1,667	81	199	.....
Total chemical oils and paints	51	15,184	324	9,811	2,276	970	1,803	4,054	94	2,720	789	451	.....
In per cent	.....	100	2.1	64.6	15.0	6.4	11.9	100	2.3	67.1	19.5	11.1	.....
Leather	11	1,811	.....	357	680	764	10	99	.....	7	67	25	.....
In per cent	.....	100	.....	19.7	37.5	42.2	0.6	100	.....	7.0	67.7	25.3	.....
Paper	22	5,947	39	4,423	87	951	447	243	3	128	47	69	.....
In per cent	.....	100	0.7	74.4	1.4	16.0	7.5	100	1.2	52.7	17.7	28.4	.....
Glass	10	2,583	171	970	115	1,238	89	286	.....	19	.....	267	.....
In per cent	.....	100	6.6	37.6	4.5	47.9	3.4	100	.....	6.6	.....	93.4	.....
Lime, cement and plaster	14	1,658	572	.....	1,004	.....	82	77	2	.....	75	.....	.....
In per cent	.....	100	34.5	.....	60.6	.....	4.9	100	2.6	.....	97.4	.....	.....
Total for all industries	1,326	225,711	22,598	113,390	38,532	26,870	24,321	84,575	10,889	41,467	20,454	11,765	.....
In per cent	.....	100	10.0	50.2	17.1	11.9	10.8	100	12.9	49.0	24.2	13.9	.....

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	160.49
Last week	160.20
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

Cottonseed oil was almost entirely responsible for the slight advance over last week's index number. The only other commodity to show an increase was crude potassium carbonate. Slightly lower prices were noted for 66 deg. sulphuric acid, ammonium sulphate and caustic potash. The prices of the other chemicals included in this index number remained unchanged.

WAGE EARNERS IN MANUFACTURING INDUSTRIES OF U. S.

	1919 Number	1919 Per Cent of Total	1914 Number	1914 Per Cent of Total
Prevailing hours of labor per week:				
48 and under	4,418,693	48 6	833,330	11.8
44 and under	1,111,107	12.2	(a)	....
Between 44 and 48	346,179	3 8	(a)	...
48	2,961,407	32.6	(a)	....
Between 48 and 54	1,496,177	16.4	945,735	13.4
54	828,353	9.1	1,818,390	25.8
Between 54 and 60	1,248,854	13.7	1,543,018	21.9
60	827,745	9.1	1,487,801	21.1
Over 60	276,550	3.0	407,973	5.8
Total	9,096,372	100 0	7,036,247	100.00

(a) Figures not available for 1914.

ers were employed in establishments where the prevailing hours of labor per week were not less than 54, and 26.9 per cent in establishments operating not less than 60 hours per week. In contrast with this the census of 1919 reported 34.9 per cent employed in the former class of establishments (working not less than 54 hours) and 12.1 per cent in the latter (working not less than 60 hours).

Financial Notes

Virginia-Carolina Bond Issue. A group of New York bankers has underwritten a total of $35,000,000 in bonds of the Virginia-Carolina Chemical Co. Of this amount, one issue of $22,500,000 is of 7 per cent sinking fund gold bonds based on a 25-yr. first mortgage due June 1, 1947. These bonds are offered at 98¾, to yield about 7.12 per cent. The other issue is of $12,500,000 15-yr., 7½ per cent convertible sinking fund gold bonds. It is said that the new financing will provide for the purchase or retirement at or before maturity of all the company's existing funded obligations and will provide additional working capital.

Mathieson Alkali Now Operating at a Profit. The first 3 months of 1922 showed a net profit of $151,667 on the books of the Mathieson Alkali Works, as compared with a loss of $61,571 during the first quarter of 1921. The value of sales for the first 3 months of the current year was $1,418,291, as against $683,858 for the first quarter of last year.

Du Pont Company Applies for Listing. Application has been made for the listing on the New York Stock Exchange of the $63,378,300 outstanding common stock of E. I. du Pont de Nemours & Co. of Wilmington, Del. According to the public announcement made in connection with the application, the company's average annual income for the past 11 years as applied to its common stock has amounted to 54.33 per cent. Commercial business as distinguished from military has accounted for an average of 12 per cent of the net earnings on the common stock during this period. The du Pont company now owns 36.95 per cent or 7,628,137 shares of the common stock of the General Motors Corporation.

Wholesale Prices in April

Both chemical and metallurgical products advanced in price during April, according to the index numbers of the U. S. Bureau of Labor Statistics. The index figure for the group "chemicals and drugs" had remained stationary at 159 for the previous 3 months, but in April it advanced to 160. "Metals and metal products" had been falling off continually since October, 1920, and had reached a low of 114 in March, 1922. The April figure, however, showed an increase to 117. These index numbers are based on a par of 100 for the year 1913.

The general index for all commodities did not change during April, remaining at 152. Of the 327 price series on which this index is based, increases were found to have occurred for 91 commodities and decreases for 100. In the case of 136 commodities no change was reported.

The New York Market

NEW YORK, May 22, 1922.

The chemical market during the past week was somewhat irregular and activity was limited to a few important items. The export interest in solid caustic soda continued along the same firm lines as during the previous week. Inquiries for large tonnages were received from leading European and South American countries and May allotments for standard brands have been well absorbed. The tendency of this market is toward much higher prices. The soda ash market has shown no price changes, but leading dealers believe that this item is about set for a sharp advance. Prussiates have featured the week's trading. Both the potash and soda salts have reached new high levels for the year and considerable consuming interest has been noticed. Supplies of both products have been greatly reduced and buyers are finding extreme difficulty in locating any round quantities. Oxalic acid has shown additional price advances and the market closed in a very firm condition. Salt cake buyers are complaining about the difficulty of procuring any spot supplies. Producers are heavily sold ahead and the market has shown every sign of reaching higher levels. Citric and tartaric acids have continued along steady lines, with trading a trifle under expectations. Copper sulphate has maintained its strong position and agricultural interests have continued to purchase largely. Producers are well sold up for future delivery. Barium chloride was exceedingly scarce during the latter part of the week. Caustic potash has shown some traces of weakness on spot, but several large holders reported a moderate inquiry, with moderate sales at former levels.

General Chemicals

Barium Chloride—Spot goods have been very limited and sellers were enabled to maintain prices at $105 per ton. Only a few odd lots are obtainable in first-hand directions. Shipment material is quoted at $95 per ton, duty paid, with domestic producers holding the same prices, f.o.b. works.

Bichromate of Soda—Trading was along quiet lines, with sales recorded at 7½c. per lb. for small quantities. For carload lots 7¼c. per lb. was quoted. The consuming industries seem to be well supplied by regular standing contracts.

Caustic Potash—General conditions in this product have slightly changed, with the tendency rather downward. The range for the 88-92 per cent imported is 6c. per lb. on spot, although in several directions 5¾c. per lb. was quoted.

Caustic Soda—The foreign inquiry continues along very strong lines and the market retains its former firm position. May shipments of standard brands are quoted nominally at $3.90@$3.95 per 100 lb., with practically no material available. Leading factors report a steady demand for contract deliveries and report the market at 2½c. per lb., basis 60 per cent works. Ground and flake caustic are quoted at $3.65 per 100 lb. in drums and $3.85 in barrels, f.o.b. works, carload lots.

Chlorate of Potash—Imported material was quoted at 7c. per lb. among some of the more important traders, while in other directions it was stated that several odd lots could still be had down to 6½c. per lb. Domestic makers still quote 8c. per lb. works.

Prussiate of Potash—The yellow material is very scarce on spot. In some prominent quarters as high as 32c. per lb. is being asked for limited lots. The red variety remains at 75c. per lb.

Prussiate of Soda—Higher prices have been reported for spot material and the market was in a very firm position during the latter part of the week, with offerings rather scarce. Sales were recorded up to 20c. per lb. and some leading sellers refused to accept business under 21c. per lb.

Salt Cake—Producers of this material are heavily sold up and the market is much stronger than at any time during the past year. The lowest figures heard were $18 per ton, f.o.b. works, and $20@$25 per ton for spot goods.

Soda Ash—Prices are holding quite steady, with leading dealers taking on business in carload lots at $1.90 per 100 lb. in single bags on spot. Barrels are quoted at 2c. per lb. Leading producers offer contracts at $1.20 per 100 lb. for single bags in carload lots and $1.40 for barrels, f.o.b. works.

Coal-Tar Products

The market in the coal-tar products industry during the past week was irregular. Specialties were about the only feature to trading and in most instances the transactions were small and limited only to actual requirements. The phenol market was the outstanding feature, with spot goods exceedingly scarce. A good inquiry for this product was noted for both home consumption and export. Toluene and benzene are well sold ahead and the market remains quite steady. Cresylic acid is maintaining its recent advance and offerings are somewhat limited. Dimethylaniline and dinitrotoluene are a shade easier. Betanaphthol is moving along quietly.

Anthracene—The consuming inquiry for this product has not shown very much activity of late, but leading factors are maintaining former prices. Several sales of the 80-85 per cent were reported at 75c. per lb.

Benzoates—First-hand sales of benzoate of soda were reported at 50@55c. per lb. Benzoic acid prices were heard around 60@65c. per lb. The demand for these products has shown seasonable improvement.

H Acid—Producers quote this product at 85c. per lb., with smaller lots running up to $1. Business is irregular.

Phenol—Former levels are fully sustained by leading dealers and the market is quoted firm at 14@15c. per lb. for prime white, U.S.P. crystals. Offerings are very limited and a good inquiry is reported.

The Chicago Market

CHICAGO, ILL., May 18, 1922.

The tone of the general chemical market showed signs of improvement during the past week, and while no large transactions were reported, business was fairly active in a small way. It is reported that stocks of many items are very low and any unusual demand will cause prices to advance sharply. Foreign material is not very plentiful and what is available is offered at a figure so close to the domestic price that consumers are not interested. Prices in general were quite firm and but few reductions were to be noted. This was particularly true in the fine chemical market, where several sharp advances took place.

General Chemicals

The alkali market was in a very firm position, although the expected advance in prices did not occur. No large stocks of *caustic soda* could be located on spot and small lots were quoted at $3.87 per 100 lb. for the solid and $4.35 for the ground or flake, basis 76 per cent. *Caustic potash* was reported to be moving very well at 6¾c. per lb. for the 88-92 per cent material in drums. This was foreign material and domestic producers were apparently making no effort to sell this market. *Soda ash* was also very firm, with small or moderate lots in cooperage quoted at $2.20@$2.30 per 100 lb.

Alums lacked quotable change and continued to move in a routine way. *Potash alum* was quoted at 4½c. per lb. for the lumps and 5½c. for the U. S. P. powdered. *Barium salts* continued scarce with prices higher. Small lots of *barium chloride* could be had at $130 per ton. *Sal ammoniac* was firm and was reported to be moving fairly well at 7¾c. per lb. for the white granular in cask lots. *Carbon tetrachloride* was slow and resale material was available at 10c. per lb. *Blue vitriol* was in active demand and could be had in one direction at $5.75 per 100 lb. It was reported that in some quarters this material was getting quite scarce. *Furfural* is still quoted at 50c. per lb. in 100-lb. lots. *White arsenic* was firmer at 8@8½c. per lb. for small lots. *Formaldehyde* continued quiet, with consumers interested only in small quantities. This material was offered at 10c. per lb. in single-barrel lots, but it is quite possible that this could have been shaded a trifle. *Glycerine* was dull and c.p. material in drums could be had at 15c. per lb.

Bichromates attracted but little attention and dealers maintained their schedules. *Potassium bichromate* in single-cask lots was quoted at 11¾c. per lb. and similar quantities of *sodium bichromate* at 9c. *Permanganate of potash* was dull and easy at 16c. per lb. for the imported U.S.P. crystals. *Red prussiate of potash* was available in broken lots at 70@75c. per lb. The *yellow prussiate* was in a very strong position at 33@36c. per lb. *Hypo* moved in a routine way to the consuming trade at $3.95 per 100 lb. for the pea crystals in single-barrel lots.

Linseed Oil

A prominent factor in this field reports that *linseed oil* is getting scarce in this market and that higher prices may be expected very soon. The oil is moving very well to the trade and today's market on the boiled oil in 5-drum lots was 97c. per gal., with the usual reduction for raw.

Naval Stores

Turpentine, like linseed oil, is scarce in this market, one factor reporting that he could sell all that he could get. The movement is very good and no one is complaining. Today's price on 5-drum lots was $1 per gal., and an advance was expected. *Rosin* is not so scarce and is moving in a satisfactory volume. The tendency is without a doubt upward, with nearly all factors predicting the advance to take place soon. The G grade was offered today in carlots at $5.85 per keg of 280 lb.

The Iron and Steel Market

PITTSBURGH, May 19, 1922.

Apart from steel involved in freight car and fabricated steel orders there has been a relatively light turnover in finished steel products in the past week, the market having been fairly well sold up into July in the activity that characterized March and April. Producers seem to have the edge—i.e., it is a sellers' market rather than a buyers' market. The tonnage involved, however, is not large.

Activity is restricted because the mills, in general, are unwilling to enter third-quarter contracts, as they are not certain as to the tonnage they will be able to turn out then, on account of the coal strike.

Orders for freight cars reported in the past week total about 9,000, representing an increased rate of buying. About 60,000 cars were ordered in the first 4 months of the year, more than double the number in the entire year 1921. Car buying has been equal to the average in the 10 years before the war, when, however, steel-making capacity was only one-half to two-thirds as great as at present.

Fabricated steel lettings are running heavier than formerly, the average in the past few weeks being 30,000 or 35,000 tons a week. The lettings now approximate the fabricating capacity, while lettings last year represented only 35 per cent of capacity.

Finished Steel Prices

Finished steel prices continue to show a stiffening tendency. Bars, shapes and plates are quotable at 1.60c. on ordinary orders, but on particularly attractive lots shapes and plates would probably go at 1.50c. At the low point in February all three products were quotable at 1.35c. even on small lots. Independents have advanced their price on bands, hoops, and hot rolled strips from 2c. to 2.25c., while the Steel Corporation does not seem to have any regular price. Regular prices on sheets, as advanced $3 a ton early in April, are 2.40c. for blue annealed, 3.15c. for black, 4.15c. for galvanized and 4.50c. for automobile sheets. Six or seven mills are quoting $5 to $7 a ton above these prices, while, on the other hand, the bimonthly wage scale adjustment showed shipments in March and April invoiced at an average of 2.80c. for 26, 27 and 28 gage, the same level as shown by the two preceding adjustments. Tin plate is steady at $4.75.

Steel Production

The Carnegie Steel Co. resumed making ingots at the Mingo plant at the beginning of this week, the two Mingo furnaces that were banked early in April having resumed last week, while the banked Farrell stack is again in operation and the Farrell works, scheduled for resumption early in April, is about to operate. Both plants make sheet bars, the supply of which was beginning to grow scant.

The industry as a whole is producing ingots at a trifle above 37,000,000 tons a year, against rates of about 35,000,000 tons March 31 and 30,000,000 tons Feb. 28. The Carnegie Steel Co., at first affected by the Connellsville strikes, has made various arrangements for fuel supply and is now operating thirty-five blast furnaces, against thirty-four on April 1.

Coal, Coke and Pig Iron

Connellsville coal has advanced sharply in the week, steam grade being now $4.25@4.50. The advance was caused chiefly by continued heavy buying by Eastern consumers, who require some high-volatile coal, not obtainable farther east than the Connellsville region. Coke is a shade easier, with furnace at 6.25@$6.50, foundry remaining quotable at $6.75. There is no regular demand from furnaces. Offerings are very limited.

In coal circles the steel industry is regarded as particularly well stocked with coal. In some quarters it is estimated that the industry has drawn but little upon stocks, having bought coal and coke freely where it could be had, and being very conservative in preparing for a long strike.

The pig iron market has been altogether stagnant. The market is quotable at prices that are more or less nominal: Bessemer, $26; basic, $25; foundry, $24, f.o.b. valley furnaces, freight to Pittsburgh being $1.96.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0.38 – $0.40
Acetone	lb.	$0 08 – $0 09	09¼ – .10
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 25 – 9 50	9 75 – 10 25
Boric, crystals	lb.	.11 – 11½	11¾ – .12
Boric, powder	lb.	.11 – 11½	11½ – 12½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1 10 – 1 20	1.25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – 11½	11 – 12
Lactic, 44 per cent tech	lb.	.09½ – .10	10½ – 12
Lactic, 22 per cent tech	lb.	04 – 04½	04½ – 05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	06 – 06½	06¾ – 07
Nitric, 42 deg.	lb.	06½ – 06¾	07 – 07¼
Oxalic, crystals	lb.	13½ – 13¾	14 – 14½
Phosphoric, 50 per cent solution	lb.	08 – 08½	08¾ – 09¼
Picric	lb.	22 – 24	24½ – 30
Pyrogallic, resublimed	lb.	..... –	1 65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	15 00 – 16 00	..... – .....
Sulphuric, 66 deg., drums	ton	19 00 – 20.00	20 50 – 21 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20 00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33 00 – 34 00
Tannic, U. S. P.	lb.	..... –	60 – 75
Tannic (tech.)	lb.	40 – 45	46 – 50
Tartaric, imported crystals	lb.	..... –	27 – 28
Tartaric acid, imported, powdered	lb.	..... –	28 – 30
Tartaric acid, domestic	lb.	..... –	..... – 30
Tungstic, per lb. of WO	lb.	..... –	1 00 – 1 10
Alcohol, ethyl	gal.	..... –	4.75 – 4 95
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – 34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – 34
Alum, ammonia, lump	lb.	03½ – 03¾	04 – 04¼
Alum, potash, lump	lb.	03¾ – 04	04¼ – 05
Alum, chrome lump	lb.	07½ – 08	08¼ – 08½
Aluminum sulphate, commercial	100 lb.	1 50 – 1 65	1 70 – 2 25
Aluminum sulphate, iron free	lb.	02½ – 02¾	03 – 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ – 07¾	08 – 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – 30½	31 – 33
Ammonium carbonate, powder	lb.	07 – 07½	07½ – 08
Ammonium nitrate	lb.	06 – 06½	06¾ – 07½
Amylacetate tech	gal.	..... –	2 00 – 2 25
Arsenic, white, powdered	lb.	07 – 07¼	07½ – 08
Arsenic, red, powdered	lb.	12 – 12½	12½ – 13
Barium chloride	ton	103 00 – 105 00	106 00 – 110 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	06½ – 07	07½ – 08½
Barium sulphate (precip.) (blanc fixe)	lb.	03½ – 0	04½ – 04
Blanc fixe, dry	lb.	04 – 04½	..... – .....
Blanc fixe, pulp	ton	45 00 – 55.00	..... – .....
Bleaching powder	100 lb.	1 60 – 1 75	1.80 – 2.75
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	05½ – 05¾	06 – 06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	27 – 28	28½ – .35
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	04½ – 04¾	05 – 05½
Calcium chloride, fused, lump	ton	24.00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .01¾	02 – 02½
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	15 – 16
Camphor	lb.	..... –	.79 – .81
Carbon bisulphide	lb.	06½ – 06¾	07 – 07½
Carbon tetrachloride, drums	lb.	09½ – .10	10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	04¼ – 04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	03½ – 03¾	..... – .....
Chalk, precip.—imported, light	lb.	04½ – 05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	05 – 05½	05¾ – 06
Chloroform	lb.	..... –	35 – 37
Cobalt oxide	lb.	..... –	2.00 – 2 10
Copperas	ton	20.00 – 22 00	23.00 – 30 00
Copper carbonate, green precipitate	lb.	.19 – 20	.20½ – .21
Copper cyanide	lb.	..... –	58 – .60
Copper sulphate, crystals	100 lb.	5.50 – 5 60	5 65 – 6.15
Cream of tartar	lb.	..... –	25 – 26
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	90 – .95
Formaldehyde, 40 per cent	lb.	08½ – .09	09¼ – .10
Fullers earth, f.o.b. mines	net ton	16.00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30.00 – 32.00	..... – .....
Fusel oil, ref.	gal.	..... –	2 15 – 2.50
Fusel oil, crude	gal.	..... –	1 30 – 1 50
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	15 – 15½
Iodine, resublimed	lb.	..... –	4 20 – 4 25
Iron oxide, red	lb.	..... –	12 – 18
Lead acetate	lb.	..... –	09⅝ – 12
Lead arsenate, powd	lb.	.14 – 14½	14¼ – 15½
Lead nitrate	lb	..... –	15 – 20
Litharge	lb.	07¾ – 08	08¾ – 09
Magnesium carbonate, technical	lb.	08 – 08½	08¾ – 09
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1 00 – 1 80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – 60
Nickel salt, double	lb.	..... –	.11 – 11½
Nickel salt, single	lb.	..... –	.11 – 11½
Phogene (see carbol chloride)		..... –	..... – .....
Phosphorus, red	lb.	45 – 46	47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	09¾ – .10	10¼ – 10½
Potassium bromide, granular	lb.	..... –	.17 – .20
Potassium carbonate, U. S. P.	lb.	.12 – 12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – 05¼	05½ – .06
Potassium chlorate, powdered and crystals	lb.	.07 – 07¼	07½ – 08¼
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6.25 – 7.00
Potassium iodide	lb.	..... –	3.30 – 3.40
Potassium nitrate	lb.	07¾ – 07½	08 – .09
Potassium permanganate	lb.	14¾ – .15	15¼ – .20
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	31½ – .32	32¼ – 32½
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – 07¼	07½ – 08
Salammoniac, gray, granular	lb.	07½ – 07½	07¾ – 08
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	20.00 – 25.00	..... – .....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.90 – 2.00	2.10 – 2.50
Soda ash, dense	100 lb.	1.95 – 2.05	2.10 – 2.60
Sodium acetate	lb.	.05 – 05¼	05½ – .06
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	07¼ – 07½	07¾ – 08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	04¼ – 04½	04¾ – 05¼
Sodium chlorate	lb.	.06 – 06½	06¾ – .07
Sodium chloride	long ton	12 00 – 13 00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09 – 09½	09¾ – .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.90 – 3.95	4.00 – 4.25
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.03 – 03¼	03½ – 03¾
Sodium nitrite	lb.	08¾ – .09	09¼ – 09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	03¾ – .04	04¼ – 04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.20½ – .21	21¼ – 21½
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.25
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.85 – 1.00	1.10 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	04¾ – 04⅝	04¾ – 05½
Sodium sulphite, crystals	lb.	03¾ – 03⅝	03¾ – 04¼
Strontium nitrate, powdered	lb.	09½ – .10	10½ – .12
Sulphur chloride, yellow	lb.	04½ – .05	05¼ – .06
Sulphur, crude	ton	18.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – 08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 – 40 00	..... – .....
Talc—domestic powdered	ton	18 00 – 25 00	..... – .....
Tin bichloride	lb.	.09 – 09¼	09½ – .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – 14½	14¾ – 15½
Zinc chloride, gran	lb.	.05½ – .06	06¼ – 06¾
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	07½ – .08	08¼ – 08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.15 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.50 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.25 — .27
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	2.40 — 2.50
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	12 —	.15
Ortho-toluidine	lb.	.14 —	.18
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.13 —	16
Paranitroaniline	lb.	.75 —	.77
Para-nitrotoluene	lb.	.60 —	.70
Para-phenylenediamine	lb.	1.55 —	1.60
Para-toluidine	lb.	1.0 —	1.10
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, purc	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls	lb.	25 —	25½
Salicylic acid, U. S. P	lb.	26 —	26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	25 —	28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	10 —	12
Sulphanilic acid, crude	lb.	24 —	26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	30 —	....

Waxes

Quotations same as previous report.

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.30 —	$5.45
Rosin E-I	280 lb.	5.60 —	5.80
Rosin K-N	280 lb.	5.90 —	6.50
Rosin W. G.-W. W	280 lb.	7.25 —	7.75
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	97 —	97½
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	.... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y	100 lb.	3.60 —	3.65
Blood, dried, f.o.b., N. Y	unit	3.55 —	3.65
Bone, 3 and 50, ground, raw	ton	27.00 —	28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.70 —	2.80
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	3.75
Tennessee, 78-80%	ton	7.00 —	7.50
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0.18¼ —	.18½
Upriver coarse	lb.	.12¼ —	.13
Upriver caucho ball	lb.	.13¼ —	.13½
Plantation—First latex crepe	lb.	.15 —	.15¼
Ribbed smoked sheets	lb.	.15 —	.15¼
Brown crepe, thin, clean	lb.	.13½ —	....
Amber crepe No. 1	lb.	.15 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.10½ —	$0.10¾
Castor oil, AA, in bbls	lb.	.12 —	.12¼
China wood oil, in bbls	lb.	.14 —	.14¼
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.09¼ —	.09½
Corn oil, crude, in bbls	lb.	.11½ —	.11¾
Cottonseed oil, crude (f. o. b. mill)	lb.	.10½ —	.10½
Cottonseed oil, summer yellow	lb.	.12½ —	.12¾
Cottonseed oil, winter yellow	lb.	.13½ —	.13¾
Linseed oil, raw, car lots (domestic)	gal.	.90 —	.91
Linseed oil, raw, tank cars (domestic)	gal.	.86 —	.87
Linseed oil, in 5-bbl lots (domestic)	gal.	.93 —	.94
Olive oil, denatured	gal.	1.15 —	1.17
Palm, Lagos	lb.	.07½ —	.07½
Palm, Niger	lb.	.06½ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10¼
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.84 —	.85
Rapeseed oil, blown, in bbls	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	....

FISH

Light pressed menhaden	gal.	$0.54 —	.
Yellow bleached menhaden	gal.	.57 —	..
White bleached menhaden	gal.	.56 —	..
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York, Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$750.00	$900.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	60.00 —	110.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	14.00 —	17.50
Barytes, ground, white, f.o.b. mills	net ton	17.00 —	23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00 —	21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00 —	24.00
Barytes, crude f.o.b. mines	net ton	8.00	8.00
Casein	lb.	10½ —	12
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00 —	8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00 —	9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin)ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	14.00 —	20.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, No. 1 pottery grade	long ton	6.40 —	6.75
Feldspar, No. 2 pottery grade	long ton	5.75 —	5.90
Feldspar, No. 1 soap grade	long ton	7.00 —	7.50
Feldspar, No. 1 Canadian, for mill	long ton	21.00 —	22.00
Graphite, Ceylon lump, first quality	lb.	.06 —	.07
Graphite, Ceylon chip	lb.	.04½ —	.05½
Graphite, high grade amorphous crude	ton	15.00 —	30.00
Kieselguhr, f.o.b. mines, Cal	per ton	40.00 —	
Kieselguhr, f.o.b. N. Y	per ton	55.00 —	60.00
Magnesite, calcined (crude)	per ton	8.00 —	12.00
Pumice stone, imported	lb.	.03 —	.05
Pumice stone, domestic, lump	lb.	.05 —	.05½
Pumice stone, domestic, ground	lb.	.06 —	.07
Shellac, orange fine	lb.	.76 —	.77
Shellac, orange superfine	lb.	.78 —	.79
Shellac, A. C. garnet	lb.	.62 —	.63
Shellac, T. N	lb.	.74 —	.75
Silica, glass sand, f.o.b. Indiana	per ton	1.25 —	2.25
Silica, sand blast material, f.o.b. Indiana	per ton	2.25 —	4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16.00 —	16.00
Silica, building sand, f.o.b. Pa	per ton	2.00 —	2.75
Soapstone	ton	12.00 —	15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00 —	12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50 —	12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00 —	20.00

Refractories

All prices remain quotably unchanged

Ferro-Alloys

Ferromanganese—76-78 per cent Mn. German Gross ton, $66. Other quotations same as previous report

Ores and Semi-finished Products

Molybdenite—85 per cent, MoS_2 Per lb.....40-45c

Tungsten Ore—Scheelite & Wolframite, 60 per cent WO_3—Unit .....$3.00-$3.50

All other prices remain unchanged

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.25
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	5.40–5.50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00–33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	30.75
Lead, New York, spot	5.35–5.50
Lead, E. St. Louis, spot	5.25–5.35
Zinc, spot, New York	5.35–5.40
Zinc, spot, E. St. Louis	5.125

OTHER METALS

Silver (commercial)	oz.	$0.73¼
Cadmium	lb.	1.15–1.20
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.05
Platinum	oz.	85.00
Iridium	oz.	150.00@170.00
Palladium	oz.	50.00@ 55.00
Mercury	75 lb.	54 — .55

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

GLASS—The Thatcher Mfg. Co. has resumed operations at its Clarksburg, W. Va., plant, following a suspension for more than 12 months. The works will operate for the manufacture of bottles, giving employment to close to 100 men.

The F. C. Wheaton Co., Millville, N. J., manufacturer of druggists' glassware, has resumed operations at its North Millville plant. The main Millville works is running full, and it is said that orders on hand insure this basis of operation for some time to come.

The Mississippi Glass Co. is reported to be planning for the resumption of production at its Morgantown W. Va., plant as soon as alteration and improvement work, now under way, has been completed. The factory recently curtailed operations for this purpose.

RUBBER—The Firestone Tire & Rubber Co., Akron, O., has made another advance in production, from 22,000 to 24,000 tires per day.

The Miller Rubber Co., Akron, O., manufacturer of automobile tires, has increased its working schedule to 6,500 tires per day.

The Goodyear Tire & Rubber Co., Akron, O., has made further additions to its working force, and production is now scheduled on a basis of 25,000 tires a day.

Practically all of the rubber-manufacturing plants at Canton, O., have adopted an overtime working schedule. Increases are being made in the number of employees.

IRON AND STEEL—The United Alloy Steel Corp., Canton, O., has increased production at its plant, and is now working on a basis of close to 90 per cent of maximum capacity.

The United States Steel Corp., New York, N. Y., has increased production to an average of about 80 per cent of capacity at its different mills.

The Bethlehem Steel Co., Bethlehem, Pa., has blown in a second blast furnace at its Steelton, Pa., plant; this is the first time that two units have been in service at the mills for a number of months past. The company has resumed operations at another finishing mill at its Lebanon, Pa., plant, giving employment to close to 100 men. Work has also been resumed in the bessemer steel department at the company's plant at Sparrows Point, near Baltimore, which has been idle for a number of months past. About 200 men will be added to the working force at once, and further additions will be made at an early date. It is said that the company is now running at more than 80 per cent of capacity at its different plants.

The Replogle Steel Co., New York, N. Y., is perfecting arrangements for the immediate blowing in of one of the new blast furnaces at its Wharton, N. J., plant. A second unit will be placed in operation at an early date.

The Carnegie Steel Co. has blown in another stack at its Mingo, O., plant, making 30 furnaces in operation at this works. It is planned to resume operations at 5 additional stacks in this district at an early date.

The Central Iron & Coal Co., Tuscaloosa, Ala., has resumed operations at its No. 3 foundry, following a suspension for many months past. About 125 workers have been added to the force and further additions will soon be made.

The Rogers-Brown Ore Co. a subsidiary of the Rogers-Brown Iron Co., Buffalo, N. Y., has resumed operations at its Kennedy properties at Duluth, Minn., which have been closed down since last July.

The Republic Iron & Steel Co., Youngstown, O., will resume operations at once at its iron ore properties at Ironwood, Mich., on a full-time basis.

The LaBelle Iron Works, Steubenville, O., has advanced production to close to 90 per cent of normal capacity.

The Wheeling Steel Corp., Wheeling, W. Va., is increasing production at all of its plants with the exception of the furnace at Martins Ferry, O., and the local steel plant of the Whitaker-Glessner division. It is expected to make advances at the latter works at an early date.

METALS—The Vanadium Steel Alloys Corp. is running full at its Latrobe, Pa., works, with night shift operation in various departments, in addition to regular day production.

The Vanadium Corp. is perfecting arrangements for the early resumption of operations at its plant at Bridgeville, near Pittsburgh, Pa., which has been idle for about a year past.

The East Butte Copper Mining Co., Butte, Mont., will increase production at once at its ore-treating plant. The company has secured a 24-month contract from the Davis-Daly Copper Co., for the treatment of ores from its mines.

The Ray Consolidated Copper Co., Ray, Ariz., is increasing production at its plant, following operations on a curtailed basis since the properties were reopened on April 1.

MISCELLANEOUS—The Santa Cecilia Sugar Co., 115 Broad St., New York, N. Y., is running under increased production at its mills. Up to the present time about 70,000 bags of raw sugar have been made as compared with 59,500 bags for all of last season.

The Wilmington Fibre Specialty Co., Wilmington, Del., has increased the working hours at its plant, with schedule from 7:30 a.m. until 5:30 p.m. Production is being advanced.

Construction and Operation

Arizona

YUMA—The Yuma Valley Cane Sugar Corp. has plans under way for the construction of a new refining plant on local site, estimated to cost in excess of $200,000. Dr. F. Thatcher is president.

AJO—The New Cornelia Mining Co. is having plans prepared for the construction of a new flotation plant at its properties, with capacity of about 10,000 tons. W. R. Weymouth, C. C. Moore Construction Co., Kansas City, Mo., will be in charge of erection.

California

SAN FRANCISCO—W. P. Fuller & Co., 301 Mission St., manufacturer of paints, varnishes, etc., has awarded a contract to R. McLeran & Co., Hearst Bldg., for the construction of a new 5-story addition, estimated to cost about $315,000.

Connecticut

HARTFORD—The Capitol City Glass Co., Chapel St., will soon break ground for the construction of a 2-story addition to its plant, 40x150 ft. F. C. Walz, Hartford, is architect.

STAMFORD—The Charles H. Harris Co., Main St., manufacturer of glass products, has awarded a contract to the Hewlett Co., Bridgeport, Conn., for the construction of a new addition 90x100 ft. Work will be commenced at once.

Illinois

CHICAGO—The National Oxygen Co., 12 East Harrison St., manufacturer of commercial oxygen, has acquired a tract of about one-half acre of land in the Clearing Industrial district for a consideration of approximately $15,000. It will be used for plant expansion.

CHICAGO—The Chicago By-Products Coke Co., 122 South Michigan Ave., has filed plans for the construction of a new building at Crawford Ave. and 35th St., to be used for general service work. The Koppers Co., Pittsburgh, Pa., has the contract for the work.

Indiana

KOKOMO—The Kokomo Gas & Fuel Co. is having plans prepared for the erection of a new artificial gas-manufacturing plant to cost about $500,000, with equipment. The company is affiliated with the Peoples Gas Light & Coke Co., 122 South Michigan Blvd., Chicago, Ill., C. A. Monroe, president. The Koppers Co., Union Arcade Bldg., Pittsburgh, Pa., is engineer for the work.

Kentucky

CATLETTSBURG—The Great Eastern Refining Corp., recently organized, has commenced the construction of its proposed new oil refinery at Leach, near Catlettsburg. The plant will have an initial capacity for handling about 1,000 bbl. of crude oil per day, and it is planned to double this output at a later date. A lubricating oil- and wax-manufacturing plant will also be erected. A. J. Dalton is president.

ASHLAND—The Pittsburgh Brick & Tile Co., Pittsburgh, Pa., represented by Samuel DeBord, Ashland, has acquired a local tract of land and plans for the construction of a new plant for the manufacture of brick, hollow tile and other burned clay products. The initial works will cost in excess of $500,000, including machinery.

Maine

SKOWHEGAN—The Skowhegan Paper Co., Bangor, Me., recently organized with a capital of $200,000, will take over the plant of the Maine Pulp & Paper Co., and plans to resume production at an early date. A number of extensions and improvements will be made. Harold Hinckley is president; and James D. Rice, treasurer.

RUMFORD—The Oxford Paper Co. has awarded a contract to J. W. Kerr, Rumford, for the construction of an addition to its local paper mill, estimated to cost about $40,000. Headquarters of the company are at 200 5th Ave., New York.

Maryland

BALTIMORE—The American Sugar Refining Co., Woodall and Clement Sts., has filed plans for the construction of a 1-story building at its new local plant 107x154 ft. Stone & Webster, Inc., 120 Broadway, New York, is engineer and contractor.

HANCOCK—The Maryland Glass Sand Co. has acquired the plant and business of the Round Top Glass Sand Co., operating in this same district, and will consolidate the works under its present name. Plans are under way for the construction of a number of new additions, and considerable equipment will be installed. The company has increased its capital from $75,000 to $150,000, to provide for the expansion.

Massachusetts

TUFTS COLLEGE—The Board of Trustees, Tufts College, has filed plans for the construction of a new 3-story chemical laboratory, 78x165 ft., on Talbot Ave., estimated to cost about $200,000. The W. H. Whitcomb Construction Co., 6 Beacon St., Boston, is the general contractor.

HOLYOKE—The Palmer Steel Co., recently organized with a capital of $100,000, has acquired property comprising about 14 acres of land at Meadow St. and McKinstry Ave., as a site for its proposed new plant. Plans are under way for the initial buildings, to cost in excess of $500,000. Wayne F. Palmer, 7 Montgomery Ave. is treasurer.

Minnesota

ST. PAUL—The St. Paul Brass Foundry Co., 288 Minnesota St., is considering plans for the construction of a new 1-story plant addition, 36x50 ft., to be equipped for the manufacture of brass and bronze castings, etc. Frederick Oshrlein, president, is in charge.

Missouri

TRENTON—The City Council is having plans prepared for the construction of a new filtration plant, in connection with extensions and improvements in the waterworks system, estimated to cost about $180,000. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., are engineers.

CEDAR CITY—The Standard Crate & Filler Co., Jefferson City, Mo., is perfecting arrangements for the erection of its proposed new local mill for the manufacture of strawboard products. The company recently purchased a site. The new plant will cost close to $350,000, and will have an initial daily capacity of about 150 tons. A. W. Happy is president.

New Jersey

MAURER—Fire, May 16, destroyed a portion of the plant of the United Lead Co.,

111 Broadway, New York, N. Y., at Maurer, near Perth Amboy, with loss estimated in excess of $1,200,000, including stacks, buildings, machinery, etc.

BAYONNE—The Standard Oil Co. of New Jersey, 25 Broadway, N. Y., has plans nearing completion for the construction of a new 1-story oil separating plant, 60x200 ft., at its Constable Hook refining works. Tucker & Lewis, 103 Park Ave., New York, are engineers.

NEWARK—Fire, May 11, destroyed two buildings at the plant of the Alcohol Products Co., Blanchard St. and the Passaic River, with loss estimated at about $200,000, including equipment. Henry W. Miner is president.

NEWARK—The Magna Metal Corp., Doremus Ave., Port Newark district, manufacturer of special metals, operating at the former plant of the Atlantic Smelting & Refining Co., has tentative plans under consideration for the erection of an addition.

PERTH AMBOY—The Perth Amboy Gas Light Co., 196 Smith St., has plans under way for extensions and improvements in its artificial gas plant, including the erection of a new holder with capacity of about 1,000,000 cu.ft.

BAYONNE—Fire, May 16, destroyed a portion of the plant of the Tidewater Oil Co., 11 Broadway, New York, N. Y., with loss totaling close to $700,000, in tanks and other equipment, stock, etc.

GLASSBORO—The New Jersey Corp. has been organized by bondholders of the former New Jersey Gas Co., and has taken over the artificial gas plant and system of the latter company. Improvements will be made and the plant continued in operation. The new company is capitalized at $1,690,000. Norman Grey is president.

New York

SILVER SPRINGS—The Worcester Salt Co., 71 Murray St., New York, has commenced the erection of a new local manufacturing plant, to be 2-story, 42x148 ft. The John W. Ferguson Co., United Bank Bldg., Paterson, N. J., is the contractor.

COHOES—The Frank Gilbert Paper Co., 135 Broadway, New York, a division of the Hercules Paper Corp., same address, is reported to be planning for the erection of an addition to its local mill to cost approximately $50,000. Fire, May 5, destroyed the old pulp mill of the company, with loss estimated in excess of $25,000, including machinery, etc.

PORT HENRY—Witherbee, Sherman & Co., 2 Rector St., New York, have plans under way for the construction of a new blast furnace, in the vicinity of their present furnace, with daily capacity of 500 tons of pig iron. The works will include a sintering plant with daily output of 400 tons; electrically operated pumping plant; laboratory, warehouse and other structures. The installation will comprise two blowing engines, rated at 45,000 cu.ft. capacity each, 65,000-hp., boilers, and other equipment. The plant is estimated to cost about $2,000,000. To provide for the construction, the company has disposed of a bond issue of $4,000,000. Lewis W. Francis is president.

NEW YORK—The Corn Products Refining Co., 17 Battery Place, has organized a subsidiary company with capital of $1,000,000, to operate in Germany. Three refining plants now established in that country will be acquired and plans are being considered for the erection of a fourth refinery on site to be selected. G. M. Moffet, vice-president of the parent company and official of the new organization, has left for Germany to perfect the plans for the project. J. W. Fisher and George Mahana, directors of the Corn Products Company, will be active in the German subsidiary.

NEW YORK—The Crystal Chemical Co., 130-34 Willis Ave., has filed plans for improvements and alterations in its plant to cost about $10,000.

North Carolina

MARION—The Clinchfield Pottery Works is planning for enlargements in its plant for increased output. A. W. Hilton is president.

Ohio

BELLAIRE—The Standard Slag Co., 707 Wick Bldg., Youngstown, O., will build a new 4-story plant at Bellaire, 40x75 ft., with crushing, grinding and other producing departments.

WOOSTER—The Weldless Tube Co., recently organized with a capital of $300,000, has acquired a site of about 100 acres of land near the city, and has preliminary plans under way for the construction of a new tube mill, estimated to cost in excess of $100,000.

Oklahoma

WAYNOKA—The Oklahoma Pure Salt Co. has preliminary plans under way for the construction of a new plant, to utilize salt deposits in Harper and Woodward counties.

MANGUM—The Chamber of Commerce is developing plans for the establishment of a local gas plant. It is proposed to organize a company to operate the works.

VINITA—The City Council has plans under way for the installation of a new filtration plant in connection with extensions and improvements in the water works. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., are engineers.

Pennsylvania

ROCHESTER—The American Borax Co. has acquired a portion of the former Keystone plant of the National Glass Co., and will remodel the structure for a new works. Plans are under way for the construction of a new 3-story plant, estimated to cost about $150,000, including machinery.

READING—The Reading Casting Co., 1432 Mulberry St., manufacturer of iron and steel castings, is said to have preliminary plans under way for the rebuilding of the portion of its plant destroyed by fire May 12, with loss estimated at about $50,000, including machinery.

PHILADELPHIA—The Shingle Leather Co., 315 Vine St., has awarded a contract to the Bowden Construction Co., 1713 Sansom St., for the construction of its proposed 1-story plant at 54th St. and Grays Ferry Ave., to be 120x195 ft., and estimated to cost about $50,000. Carson & Carson, Franklin Trust Bldg., are engineers.

PHILADELPHIA—The Henry Bower Chemical Mfg. Co., 29th St. and Grays Ferry Ave., has had plans prepared for the construction of an addition to its plant. Bissell & Sinkler, Otis Bldg., are architects.

PITTSBURGH—The Pittsburgh Steel Co., Union Arcade Bldg., has tentative plans under way for the construction of an addition to its plant at Wireton, Pa. Willis F. M. Cook is president.

Tennessee

COPPERHILL—The Tennessee Copper Co., 61 Broadway, New York, N. Y., is reported to be planning for extensions and improvements in its local plant, to cost about $200,000, including equipment. It is proposed to construct a new flotation plant at a later date.

Texas

PASADENA—The Great Lakes Western Refining Co. has acquired the local plant of the Port Houston Refining Co., with capacity of about 325 bbl. of oil per day. The company will operate the refinery and has plans under way for the construction of additional units to provide an output close to 1,500 bbl. per day. J. C. Carrington is head.

ODESSA—The Farmers Oil Co., Inc., Woolworth Bldg., Lancaster, Pa., has acquired property aggregating about 75,000 acres in the Odessa field, with oil, gas and potash deposits, and plans for extensive operations on the tract. Plans are said to be under way for the early erection of a large potash plant. H. A. Hartzell is president.

Virginia

WEST POINT—The Chesapeake Corp. has plans in preparation for the construction of an addition to its plant for the manufacture of paper products and pulp board, etc. It will cost about $250,000, of which amount approximately $100,000 will be expended for equipment. W. C. Gouldman is secretary.

PETERSBURG—The Southern Chemical Co. is having plans prepared for the construction of a new plant on local site. Work will be commenced at an early date.

Washington

BEVERLY PARK—The Orient Rubber Co., recently organized with a capital of $500,000, will soon break ground for the construction of a plant for the manufacture of rubber goods, under a special reclaiming process. The company is headed by H. H. Hazelton and J. H. Brokow.

West Virginia

HUNTINGTON—The Huntington Products Co. has acquired the local plant of the Glass Brick Co., manufacturer of slag brick and kindred products, and will place the plant in service at once, to develop an output of about 50,000 bricks per day. Plans are said to be under way for plant expansion. H. B. Jackson is president and general manager.

Wyoming

CASPER—The Texas Co., 17 Battery Place, New York, N. Y., has preliminary plans under way for the construction of a new oil refinery on local site, with initial capacity to handle about 5,000 bbl. of crude oil per day from the Salt Creek field. It is proposed to commence the work early in the summer.

New Companies

THE QUALITY BRANDS CO., New York, N. Y., has been incorporated with a capital of $75,000, to manufacture paints, greases, oils and kindred products. The incorporators are A. and E. Lehman, and R. Whitney. The company is represented by Harry Kutscher, 50 Broad St., New York.

THE MERRIMACK CLAY PRODUCTS CO., Boston, Mass., has been incorporated with a capital of $400,000, to manufacture brick, tile and other burned clay products. M. Kimball Wentworth is president; and M. A. McGrath, 38 Newbury St., Newton Centre, Mass., treasurer.

THE LYNCHBURG PIGMENTS CORP., Lynchburg, Va., has been incorporated with a capital of $25,000, to manufacture paints and kindred products. John A. Weinman is president; and William A. Robertson, secretary, both of Lynchburg.

THE NITRO POWDER CORP., Jersey City, N. J., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are George V. Reilly, Harry C. Hand and A. Roy Myers. The company is represented by the United States Corporation Co., 15 Exchange Place, Jersey City.

THE ENNIS PETROLEUM PRODUCTS CO., 208 South La Salle St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture oil specialties. The incorporators are Edward C. Ennis, Charles A. Dunn and Edward R. Tiedebohl.

THE GORDEE PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of $200,000, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington.

THE RELIANCE FOUNDRY CO., Cincinnati, O., has been incorporated with a capital of $50,000, to manufacture iron, steel and other metal castings. The incorporators are Charles Radley and Edwin D. Brooks, both of Cincinnati.

THE JERSEY CITY ENAMELING & REFINING CO., 307 Ocean Ave., Jersey City, N. J., has filed notice of organization to manufacture enamels and kindred products. The company is headed by William Lehndorff and Peter Connin, 197 Linden Ave. Jersey City.

THE BYBEE POTTERY CO., Frankfort, Ky., has been incorporated with a capital of $15,000, to manufacture pottery goods of various kinds. The company has plans under way for the establishment of a local plant. The incorporators are William J. Jillison, Joseph W. Porter and Bullitt McCoun, all of Lexington, Ky.

THE UNITED MAGMA COPPER CO., Wilmington, Del., has been incorporated with a capital of $3,500,000, under state laws, to manufacture refined copper and other metals. The company is represented by the Delaware Corporation Co., Ford Bldg., Wilmington.

THE UNITED STATES FIBER LATH & PLASTER BOARD CO., 4425 Filmore Ave., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture fiber composition products. The incorporators are C. Earnest Guyton, Noble E. Snyder and William R. T. Ewen.

THE MILLER-LISZKA CORP., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are O. W. Swift, J. C. Williams and F. W. Kristeller. The company is represented by Watson, Kristeller & Swift, 68 William St., New York.

THE STANDARD OIL CO. OF FLORIDA, St. Petersburg, Fla., has been incorporated with a capital of $1,000,000, to manufacture petroleum products. The incorporators are C. W. Beck, St. Louis, Mo.; R. F. Beck, Webster Grove, Mo.; and R. V. Sellers, St. Petersburg.

THE ENTOMOLOGICAL LABORATORIES OF NORTH AMERICA, INC., Jersey City, N. J., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts, insect destroyers, etc. The incorporators are Albert H. Mitschele and Albert Stehling, 71-A Poplar St., Jersey City.

THE BELMENBY CO., Wilmington, Del., has been incorporated with a capital of $200,000, under state laws, to manufacture cottonseed oil products. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington.

THE PECOS PETROLEUM CO., 30 North La Salle St., Chicago, Ill., has been incorporated with a capital of $300,000, to manufacture petroleum products. The incorporators are E. M. Nadel, Kenneth M. Rogan and William E. Bell.

THE SUPERIOR CHEMICAL CORP., St. Louis, Mo., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are William Ross, Carr L. Glasgow and H. G. Bristow, all of St. Louis.

THE PUNCTURE SEAL MFG. CO., Seattle, Wash., has been incorporated with a capital of $50,000, to manufacture liquid compounds, chemicals, etc. The incorporators are William M. Orthan, A. E. Shrimpf and G. M. Watson, all of Seattle.

THE SUPERIOR TANNING CO., 1254 West Division St., Chicago, Ill., has been incorporated with a capital of $150,000, to manufacture leather products. The incorporators are Samuel, Henry and Mayer Katz.

THE REPUBLIC METAL ALLOYS CORP., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture metal alloys. The incorporators are M. J. Brownstein, E. Friedman and D. Wachstock. The company is represented by M. M. Helfgot, 35 Nassau St., New York.

THE IDEAL COLORINE CO., 17 Seymour Ave., Newark, N. J., has filed notice of organization to manufacture coloring specialties, chemicals and chemical byproducts, etc. The company is represented by Samuel Granet.

THE CHELSEA REFINING CO., Tulsa, Okla., has been incorporated with a capital of $1,000,000, to manufacture refined oil products. The incorporators are W. M. Welch, W. L. Walker and D. W. Bell, all of Tulsa.

THE GRIBURN CO., Philadelphia, Pa., has been incorporated under Delaware laws with a capital of $100,000, to manufacture chemical products, disinfectants, etc. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

THE CEASAR RESILIENT TIRE CORP., New York, N. Y., has been incorporated with a capital of $200,000, to manufacture automobile tires and other rubber products. The incorporators are P. Di Ceasar and C Capria. The company is represented by F. J. Rinaldi, 167 East 121st St., New York.

THE PINE PRODUCTS CORP., Camden, N. J., has been incorporated with a capital of $100,000, to manufacture pine tar products and affiliated specialties. The incorporators are Henry W. A. Hanson, Norman H. Schich and Hamilton Turner. The company is represented by Oscar B. Redrow, 428 Market St., Camden.

THE RUSSELL PAINT CORP., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of $100,000, to manufacture paints, varnishes, etc. The incorporators are George J. Young, H. T. Germann and Charles L. King, all of Pittsburgh. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE SUPERIOR LEATHER CO., 2610 North Western Ave., Chicago, Ill., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture leather products. The incorporators are W. S. Shaw, E. F. Shaw and R. C. Tallcott.

THE MAR-VEL-O MFG. CORP., New York, N. Y., has been incorporated under Delaware laws with capital of $250,000, to manufacture chemical products, washing fluids, etc. The incorporators are John T. McGovern, M. E. Nolan and M. E. Brause, all of New York. The company is represented by the Delaware Registration & Incorporators Co., Ford Bldg., Wilmington, Del.

L. DE LONG & BROTHER, INC., Newark, N. J., has been incorporated with a capital of $100,000, to operate a metal smelting and refining plant. The incorporators are G. Lawrence Feldman, Jr., Albert A. Schmidt and Louis De Long, 345 Halsey St., Newark.

THE CONSOLIDATED INK CO., New York, N. Y., has been incorporated with a capital of $40,000, to manufacture inks and kindred products. The incorporators are C. A. Johnson, J. R. Norwood and H. Fixler. The company is represented by Barnes, Chilvers & Halsted, 2 Rector St., New York.

Capital Increases, etc.

THE BEACH CHEMICAL CO., St. Louis, Mo., has filed notice of increase in capital from $100,000 to $200,000.

THE ROGERS-BROWN IRON CO., Buffalo, N. Y., producer of pig iron, coke, ferromanganese, etc., has filed notice of increase in capital from $7,000,000 to $8,000,000.

THE VALVOLINE OIL CO., 60 Broadway, New York, N. Y., has arranged for a bond issue of $2,000,000, to be used for general operations, additions to working capital, etc. The company is operating oil refineries at Warren and East Butler, Pa., and Edgewater, N. J.

THE PORTSMOUTH GAS CO., Portsmouth, Va., has arranged for an increase in capital from $500,000 to $1,000,000, a portion of the proceeds to be used for extensions and improvements in its artificial gas plant. B. B. Ferguson is president.

THE BLACK SILK STOVE POLISH WORKS, Sterling, Ill., manufacturer of polishes, etc., has filed notice of increase in capital from $25,000 to $150,000.

THE FRANCISCO SUGAR CO., 112 Wall St., New York, N. Y., operating a refinery in the Province of Camaguey, eastern part of the Island of Cuba, is disposing of a bond issue of $5,000,000, a portion of the proceeds to be used for general expansion, operations, etc. Manuel Rionda is president.

THE BEACON OIL CO., 111 Devonshire St., Boston, Mass., has disposed of a preferred stock issue of $1,500,000, the proceeds to be used for expansion.

THE VITREOUS ENAMELING & STAMPING CO., 1381 Sedgwick Ave., New York, N. Y., has filed a petition in bankruptcy, showing liabilities of $212,588 and assets of $137,350.

THE AMALGAMATED SUGAR CO., Ogden, Utah, is arranging for a bond issue of $4,000,000, the proceeds to be used for general expansion, operations, etc.

THE PENTEX OIL CO., Philadelphia, Pa., John E. Cupp, 731 Land Title Bldg., representative, has filed notice of dissolution under state laws.

THE PARAMET CHEMICAL CORP., Lexington Ave. and 131st St., New York, N. Y., manufacturer of chemicals and chemical byproducts, has made an assignment to James F. Gilkinson, 67 Wall St., New York.

THE SAMSON FIREPROOF BLOCK CORP., New York, N. Y., has been incorporated with a capital of $8,000, to manufacture refractory products. The incorporators are V. I. Weedon, W. S. McKay and C. M. O'Neill. The company is represented by S. F. Hartman, 120 Broadway, New York.

THE CELLUFIBRE CORP., New York, N. Y., has been incorporated under Delaware laws, with a capital of $4,100,000, to manufacture celluloid products. The incorporators are Robert A. MacLean and James L. Watson, New York; and F. H. Butehorn, Brooklyn, N. Y. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE OKAMO OIL CORP., Geary, Okla., has been incorporated with a capital of $25,000, to manufacture petroleum products. The incorporators are A. W. Green, W. D. Priddy and H. E. Castleberry, all of Geary.

THE ASSOCIATED FERTILIZER MANUFACTURERS OF AMERICA, INC., Trenton, N. J., has been incorporated with a capital of $250,000, to manufacture fertilizer products. The incorporators are William G. Hopper, Raymond Hutchinson and Kenneth H. Lanning. The company is represented by Wicoff & Lanning, 705 Broad St. Bank Bldg., Trenton.

THE INTERSTATE STEEL PRODUCTS CO., Indianapolis, Ind., has been incorporated with a capital of $100,000, to manufacture steel specialties. The incorporators are Murat Hopkins, Chester H. Ricker and Robert Tafel, all of Indianapolis.

W. A. DOYLE & CO., INC., New York, N. Y., has been incorporated with a capital of $50,000, to manufacture cleaning powders, chemicals, etc. The Incorporators are R. B. and W. A. Doyle, and R. B. Rainder. The company is represented by Campbell & Boland, 342 Madison Avenue, New York.

THE HARRIS PETROLEUM CO., Dover, Del., has been incorporated under state laws, with a capital of $800,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE BARNETT TANNING CO., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture leather products. The incorporators are M. and H. S Barnett. The company is represented by H. E. Cohen, 115 Broadway, New York.

THE MIDLAND SPECIALTIES CO., 2510 Wallace St., Chicago, Ill., has been incorporated with a capital of $15,000, to manufacture sheet steel products. The company is represented by T. P. Grant, Room 1005, 56 West Randolph St., Chicago.

THE NEUCES OIL CO., Tulsa, Okla., has been incorporated with a capital of $25,000, to manufacture petroleum products. The incorporators are O. S. Booth, Rex S. Walker and H. G. Dickenson, all of Tulsa.

THE NELSON MOTOR FUEL & FERTILIZER CO., Tampa, Fla., has been incorporated under Delaware laws, with capital of $100,000, to manufacture refined oils, fertilizers, etc. The incorporators are O. W. Nelson, Herbert M. Banker and Paul S. Maxwell. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet- at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., June 5 and 6.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY FOR STEEL TREATING will hold a sectional meeting at the Bureau of Mines auditorium, Pittsburgh, Pa., on May 25 and 26. The International Steel Exposition and Convention of the society will be held in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

CERAMIC SOCIETY (London) is to have a foreign trip to Sweden and Denmark from May 27 to June 10.

CHEMICAL SALESMEN'S ASSOCIATION, New York Chapter, will hold the next meeting on May 25 at the Advertising Club.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL COAL ASSOCIATION will hold its annual meeting at Congress Hall, Chicago, May 24-25.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NATIONAL LIME ASSOCIATION will hold its annual convention June 14-16 at the Hotel Statler, Cleveland, O.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meeting is scheduled to be held in Rumford Hall, the Chemists' Club, New York: June 9—American Chemical Society, regular meeting.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

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When Does an Employment Contract Terminate?

THE discussion on this subject, which has appeared from time to time in these pages, has been of much interest and value. There can be no doubt that there exists some dissatisfaction over contracts offered technical men and the suspicion seems not ill founded that there may be some injustice in them. It is, therefore, not undesirable perhaps to summarize the situation and endeavor to arrive at some fair and constructive conclusion.

First, from the standpoint of the technical man there appears to be agreement that there is a vagueness about the average contract offered technical men which opens the door to misunderstandings. These misunderstandings apparently are due for the most part to the technical man's ignorance of his own right. He may be considered partly to blame for this, but the system under which he is trained is certainly more to blame than the individual himself. The most important right to him is his right to be recompensed for discoveries made while working on a salary, through his ownership of shop rights in discoveries which he has made. Under present practice he is very apt to sign away these rights in a contract which is perfectly valid. If, now, the knowledge of these inherent rights were a matter of general comprehension, it would be unlikely that an employing corporation would embody in the contract such usurious exactions as a price of employment. That there exists a suspicion on the part of the employee that he is the victim of an unavoidable and unfair condition is a well-established fact. How much better it would be for all concerned if the technical man were promised a fair return for discoveries which he might make while in the employ of the company.

The second cause for considerable dissatisfaction among technical men is the curtailment of their field of usefulness outside of the employer's factory walls. It has been decided legally that such restriction is unenforceable and the knowledge of such decision is fairly widespread among technical men. The insertion of such clauses in an employment contract is usually intended to intimidate the technical man and in so far as they have a deterrent action upon dishonest employees, they have fulfilled their function.

There seems also to be a complete unanimity as to the employer's duty and privilege to protect his property rights. These property rights would seem to include all the knowledge which he possessed up to the time of the employee's engagement and all other knowledge gained during the employee's stay which was not developed by that particular employee himself. The great difficulty seems to be as to how much property right the employer has over uninvented things that the employee may contribute in the future while working under a salary. The consensus seems to be that no man should be asked to sign away an interest in an invention not yet made and that perfect justice would give the employee some personal share in the work of its success.

The whole situation actually rests with the employer. With technical men as a class, it can be said with considerable confidence that in so far as they are trusted and in so far as their own aims and aspirations are made coincident with those of the employer, just so far will the employer enlist their loyalty. No employer has the logical or actual right to demand loyalty from an employee when he demands service which not only does not develop, but actually cramps and hinders the employee's career. We doubt if legislation would be of assistance, for unless the relationship is above any legal plane it ceases to be desirable either to the employer or the employee. We do believe, however, that teachers of chemistry and chemical engineering can make a distinct contribution toward remedying the situation by arranging with competent counsel for one or two lectures a year on the elements of contractual relations.

Discredited Among His Colleagues

SENATOR KING undertook to break down the dye industry of this country by one of the most vitriolic attacks which has ever been made in any Congress upon any young and growing branch of business. He charged monopoly. He charged everything else which might discredit the industry in the eyes of the public. Backed by statistics which contained just sufficient truth to be believable by many, he urged and finally obtained authorization for a Senate investigation. Thanks to Senator FREYLINGHUYSEN, this investigation was made to cover not only the producer but also the importer of dyes. And now the investigation has virtually reached its end.

As a result of the very comprehensive proceedings under the able chairmanship of Senator SHORTRIDGE, it has been conclusively demonstrated that Senator KING'S charge of monopoly is simply bunk. He and the various witnesses from all quarters have conclusively proved that there are in the industry several very large companies. That is all that has even been seriously charged by any one appearing before the committee. Even the most vigorous opponents of an embargo for the domestic dye producers have been forced to deny that there is anything approaching monopoly.

But incidentally the investigation has demonstrated another thing. It has most convincingly set before the members of the Senate the real situation with reference to the organic chemical industries of the United States. The investigation can, in fact, be credited with having convinced the Finance Committee of the Senate that an extension of the embargo on dye importation was desirable. It seems to be unquestioned that it was the

proceedings which started as an attack upon the industry that ultimately proved a tremendous blessing in this particular.

As things now stand, we cannot know for some time what the Shortridge committee has concluded or will recommend to the Senate. The chairman of the committee and the other members of the Senate interested have, however, said enough so that it may be safely forecast that the conclusions and recommendations will be in general favorable and beneficial to the American dye producer.

The industry has come through with a clean, fine record. It is going to be given a slightly extended period of protection against unrestricted import. For at least one year, and more likely two years, after the passage of the pending tariff bill (assuming that that bill ever does pass), a license for imports will be required. What may happen after that no one now can forecast. But there still remains a considerable period in which to set in order the defenses of this industry to meet any mass attack through importation.

The most effective defense against that attack will be the result of research applied as improved technology. If there ever has been a time in any chemical industry when research was needed, it is now in the dye industry. Through research and its application to processes and products, the industry may hope permanently to meet any foreign competitor. American inventive genius, American methods of economical mass production, and clean-cut, vigorous American business methods can well expect this success if they are builded upon sound science and the best possible technology. However, without that foundation none, nor even all of them, can succeed.

Steel Makers Dine With the President

SOME of the commonest things today were quite novel when introduced. The nothing-new-under-the-sun dictum must be adopted with reservations. The first umbrella was a startling innovation and there was even a time when clothes were not worn.

It is a new thing for the President of the United States to invite representative members of the steel industry to dine with him, yet it is not difficult to conceive of such contacts becoming common. Why should not the head of the nation talk frankly with groups of men who have much to do with the course of everyday affairs in the country?

The news dispatches from Washington told of President HARDING having at dinner with him on the 18th twoscore or more of representative steel manufacturers, to discuss informally the subject of the 12-hour day in the iron and steel industry. The dispatches did not bring out the naturalness of the thing, possibly because it is unnatural for newspaper men to seek to minimize the novelty of what they report. But when the head of a large corporation finds in his reports something that he thinks can be improved upon, he is likely to call a conference of those involved. Now the fact is that the Department of Labor has in press at the present time a new report on "Hours of Labor in the Iron and Steel Industry." The report, according to the statement released for the press a week ago, "shows that a considerable change was made in the hours of labor of employees between 1910 and October, 1920, the date of the last figures in the report." It seems like rather a belated report, of course, but probably it was only recently placed before the President. So it is not strange that Mr. HARDING, seeing the report, might conceive the idea of inviting some of the men who have to do with this matter to dine with him and go over the ground. In ten years progress had been made in reducing the proportion of 12-hour employment, why not see if the progress could not be stimulated?

Business men of the United States are anxious to be in real contact with the government. The saying "Less government in business, more business in government" is not contradictory. The difference is between natural contact and the uncomfortable contact that comes from impact. The steel industry itself furnishes a good illustration. The U. S. Steel Corporation was formed in the spring of 1901. In 1908, testifying before the Stanley committee, Judge GARY, chairman of the Steel Corporation from the outset, said plainly and earnestly that he would welcome an arrangement whereby the Steel Corporation would lay all its information before the government and the government would then tell it what it should do and what it should not do. Three years afterward, more than ten years after the corporation had been formed, the government brought suit against it for dissolution. By a Supreme Court decision of four to three the Steel Corporation survived the impact, but it was not the kind of contact that has been found good in the conduct of business.

The Constitution of the United States, by the way, requires the President to inform Congress from time to time as to the state of the Union. Some Presidents have used many thousands of words in telling about government departments rather than the state of the country. In inviting groups of men to dine with him the President is seeking just such information as he ought to have.

Along This Road Lies Profit

HENRY FORD states in his autobiography—now being published in *McClure's Magazine*—that the way to profit in automotive manufacture is first to settle definitely on the design of the motorcar and then devote all possible effort to improving the equipment and methods by which it is produced, rather than to endeavor to change the design and bring out a "new" model from time to time. The success which he has attained by following these methods has been so conspicuous that it would not seem possible to arouse much opposition to the statement. Nevertheless, many do not seem to accept this as true and prefer to look to luck or some other intangible factor as the touchstone of FORD'S success.

If we change the above to fit the chemical industries, it would read something like this: The way to profit from chemical manufacture is to settle definitely on the process to be used and then to devote all possible effort to improving the machinery and methods by which this process is accomplished. This is, unfortunately, even less an accepted maxim of chemical manufacture than it is of automotive industry. The actual method more often followed seems to be, rather, to go on with a manufacturing process in exactly its original form until someone invents a new process or a better product as a substitute and, by the advantage thus gained, eventually forces everyone concerned to adopt the new way.

Our suggestion is in no way to be taken as con-

demnation of scientific research, which is essential to progress in industry. Rather is it a plea that some of the research be directed to developing better equipment for already established processes and finding better ways of operating and managing them. To do this may curtail to some extent the amount available to be spent in research along new lines, but from both the social and business viewpoints we feel that it is perhaps better that the cause of science should suffer temporarily until money is available for full efforts along both lines. This is because the road traveled toward perfection in equipment and method also leads us to far better working conditions for the employee and, for the employer, to the goal of all endeavor—increased profits.

Sulphur and Manganese In Rivet Steel

"HIGH SULPHUR" has long been one of the accepted excuses for baffling defects; sulphur has universally been condemned as an ingredient in steel.

And yet after a careful search in literature we were unable to find any metallurgist placing a definite limit on sulphur for any particular class of steel and giving anything like a clear idea of what would happen if the danger line was overstepped. Steels made before the advent of chemical specifications wore out after long and honorable service before they were discovered to be "dangerously high" in sulphur. In more recent and scientific years chemical specifications for sulphur in steel have varied geographically to a certain extent. The Swedes insist on very low sulphur; the English are much more tolerant; the Americans occupy a middle ground. One almost suspected that a piece of steel if it were honestly and skillfully made would not be spoiled for ordinary uses in rails, shapes or plates by any reasonable amount of sulphur. Perhaps sulphur has been taking the blame all these years because it can be determined chemically, while dissolved gases cannot. Perhaps, too, the excess manganese demanded to "neutralize the sulphur" also did unnoticed yeoman service in neutralizing the oxygen.

But now we have some real information on the subject! An important report on the "Effect of Sulphur on Rivet Steel" has been issued, containing the first data issued since the Joint Committee commenced its work, two years ago. It contains, in graphical form, the results of an exhaustive series of thousands of tests on several selected steels, held as constant in chemical composition as possible except as to sulphur. Apparently here are the data necessary for judging and condemning the culprit—but for reasons of its own, the committee has abstained from any comment on the significance of the tests, leaving each interested engineer to draw his own conclusions. This has been done by one of the editors of CHEM. & MET. for his own edification and perhaps for that of others, as set forth on page 1019 of this issue.

One is tempted to speculate upon the reasons why the committee, which undoubtedly is best qualified to interpret the results, did not state in words the plain indication of the tests. Primarily, the investigation was undertaken to determine whether the war-time specifications permitting high sulphur could be safely retained. Well, can they?

Perhaps the committee declined to say yes or no to such a direct question because it has found that this monumental investigation has tested more than the effect of sulphur in steel. Primarily it has tested our methods of testing—not only their competence but their significance. It has raised such questions as this: What standardized test will give the same indications that can be had from pulling a joint apart, breaking tightly stretched rivets by combined crushing, bending and shear? This question of *competence* of test should seemingly have been decided long ago. Else why spend so much time testing slabs in torsion, for instance? From the published curves, shearing tests on a plain bar are found to parallel strengths of riveted joints admirably, the good old ultimate strength in tension is a close second.

Again, what impact test shall we use? Impact shear on rivet bars in the annealed state are approximately the same as when received from the mill, while Charpy values for annealed bars are cut down 80 per cent. Shall we accept the impact shear, or the Charpy results? Furthermore, it appears to be immaterial whether an unnotched specimen is broken with or across the direction of rolling—the work expended is substantially the same. It may be debatable whether the result of the impact tests on unnotched specimens denotes a uniform material or an insensitive testing method. It might even be that the impact shear is sensitive and accurate, and the material is uniform. Must we then conclude that both the Izod and Charpy are capricious?

Assuming, however, that all these tests are competent and significant, an inspection will show that high sulphur has surprisingly little effect. Twenty of the graphs, if approximated by a median line sketched freely, actually show well-defined maxima or minima at 0.04 to 0.05 per cent sulphur. This might support the contention of certain manufacturers that it is more damaging to "force" open-hearth heat for extremely low sulphur than to leave it in, were it not for the fact that the manganese curve shows a definite minimum in the same region. In fact one or two of the most jagged curves presented by the committee are less baffling if plotted against manganese! While it would be unfair to suggest that the committee has tested the effect of manganese rather than sulphur, these facts, and the rather wide range of manganese contents, make it certain that the results have actually tested the effect of *sulphur plus manganese* on rivet steel.

Some interesting sidelights appear. An unexpected heat containing 0.18 per cent sulphur suggests that the whole art of open-hearth steel melting has been tested. Furthermore, the comparatively innocuous effect of such dangerously high sulphur has tested one of our cherished metallurgical prejudices. Finally, the heat-treatment of low-carbon steel is before the court, for certainly a correct anneal would not be expected to damage the impact properties so greatly.

Perhaps the Joint Committee may be pardoned for not opening this Pandora's box, but it seems that one conclusion will unavoidably be reached from a study of the published tests, and that is this:

In well-made basic open-hearth steel containing less than 0.02 per cent phosphorus, approximately 0.11 per cent carbon and 0.43 per cent manganese, the maximum sulphur now allowed in rivets for structural steel (0.045 per cent) is at least 0.01 per cent below the quantity where sulphur will damage the strength, at least as far as its performance can be predicted by known tests.

Readers' Views and Comments

Radium Production in America*

To the Editor of Chemical & Metallurgical Engineering

SIR:—In two recent papers of this title by H. D. d'Aguiar,[1] the recovery, refining and measurement of radium from carnotite ore were outlined. While Mr. d'Aguiar does not mention the company employing the practice described, the writer is informed that it was that of the former Radium Luminous Materials Corporation, of Orange, N. J.

It is very gratifying that one of the leading radium companies is willing to give its flow sheet and describe its operations. The radium industry in this country has, in some instances, suffered greatly in the past from the lack of proper technical advice and control. This has been particularly true of companies just beginning to operate. In fact, many operations both early and recent have failed from no other cause than this. There is far less excuse today for such a condition prevailing than 10 years ago. The number of technical men familiar with radium measurements and competent to direct plant operations has increased many-fold in that period. The writer, therefore, welcomes information of the character that Mr. d'Aguiar has presented and believes it will be of benefit to the radium industry. Additional value would have been given to Mr. d'Aguiar's paper had he presented more data in regard to recoveries and costs. Any process, chemical or otherwise, must stand or fall on the efficiency and economy of its operation. The writer will take the liberty of making a few comments on some of the points raised by Mr. d'Aguiar, and also of pointing out features of the process described where additional information would be very welcome.

Mr. d'Aguiar makes the statement that the radium-uranium ratio in carnotite may be altered by contact with water, even by such contact as would be brought about by not keeping the ore entirely dry during storage. While it is not intended to challenge this statement flatly, the writer desires to point out that it is not in accordance with the generally accepted results of dry and wet concentration methods as applied to carnotite. Some experiments on both the wet and dry concentration methods, by the Bureau of Mines a number of years ago, indicated that no change is produced in the radium-uranium ratio. Since that time wet mechanical concentration has been much more extensively employed and additional information on this point by the operating companies would be very valuable.

Mr. d'Aguiar describes the application of the alpha ray method in checking the analytical results for U_3O_8. The writer has recently commented at length upon the limitations of this method,[2] and has nothing further to add at present.

The most striking feature in the extraction process described by Mr. d'Aguiar is the use of hydrochloric acid to dissolve the soluble material in the ore, followed immediately, without filtration, by the use of sulphuric acid to precipitate radium and barium as sulphates. From the standpoint of economy this procedure could be justified only if it can be demonstrated that sulphuric acid alone will not give equally good extraction. By the addition of sulphuric acid without previous filtration the radium and barium are thrown out of solution with the tailing and must be recovered by a sliming process, which entails the difficulties of carbonation and the recovery of the radium from the slimes. When hydrochloric acid is used as extractant, it is usually with the purpose of separating the solution from the tailings immediately by filtration and obtaining in a single step a high-grade radium-barium sulphate by precipitation. If this procedure is to be sacrificed (and in some cases it is not applicable), one would naturally expect to use the cheaper acid, sulphuric, for the whole digestion of the core, unless it can be conclusively demonstrated that hydrochloric followed by sulphuric gives a better result.

Mr. d'Aguiar's statement that no radium is found in carbonate liquors can scarcely be entirely correct. Barium carbonate must be present up to its solubility in the liquor in question and radium would be contained corresponding to the radium-barium ratio prevailing. For all practical purposes, however, the amount of radium is too low to represent any material loss. Mr. d'Aguiar does not state at what point of the process, nor how, the lead was removed.

The practice of holding radium tubes, even with forceps, while tubing the salt must be regarded as a very hazardous one. In the work of the Bureau of Mines a very simple arrangement was devised which proved entirely satisfactory. A one-hole rubber stopper was forced into a heavy glass inkwell with a flat base, which prevents the possibility of tipping over. The bottom of the tube to be filled is then inserted for a short distance into the hole in the stopper, which holds it firmly in a vertical position, and at the same time permits all the necessary play for tapping during the tubing operation.

The practice of discarding uranium is very regrettable, but, as Mr. d'Aguiar states, the market conditions have not justified its recovery. Some companies have run the byproduct into sumps from which it could be recovered if a demand ever arises. It is not at all improbable that a use will some time be discovered for this rare metal which will make it extremely valuable.

Regarding the practice described for the measurement by radium of the emanation method, a chamber of 10 liters capacity seems unnecessarily large. Physicists in the past have complained that chemical methods are crude in being able to deal quantitatively with matter only in relatively large quantities. This criticism would appear just if we admit that it is necessary to employ a capacity of 10 liters in measuring a volume of emanation which itself is of the order 5×10^{-3} cu.mm.

The use of such a large volume entails certain disadvantages. The volume of air to be dried is so great that one cannot use conveniently a small system containing concentrated sulphuric acid, but is forced to

*Published with the permission of the Director of the Bureau of Mines.

[1] CHEM. & MET. ENG., vol. 25, pp. 825-28, 877-80 (Nov. 2 and 9, 1921).

[2] *J. Ind. Eng. Chem.*, vol. 12, p. 469 (1920).

resort to the use of solid calcium chloride. On account of the danger of adsorbing radium emanation, it has not been regarded as good practice to pass it over porous solids. The only reason which requires the use of such large volumes is in itself not sound in principle, since the emanation to be measured is removed from the solution by aspiration at ordinary temperature instead of by boiling. It has long been realized that the complete aspiration of radium emanation from water at ordinary temperature is a slow and uncertain process. This point has recently been reiterated by M. Walter Mund[3] in another connection. By far the superior practice consists in boiling the solution; the volume of steam produced sweeps it out completely in a short time and is again condensed so that the volume of air actually introduced is much smaller and an electroscope of ½ liter capacity is sufficient for all purposes.

In connection with the standardization of emanation chambers, the preparation of a standard solution from 1 mg. of radium measured by the gamma ray method would scarcely afford the desired degree of accuracy. It is much better to make up a solution employing a large quantity of salt, which can be more accurately measured, dilute this solution to the desired standard and return the remainder immediately into the form of salt. It is also to be borne in mind that fluctuations in temperature or pressure will produce corresponding errors in the result obtained with a calibrated chamber, unless correction is made. When both of these errors happen to be in the same direction, they can easily amount to 2 or 3 per cent. The ideal system is to have an air bath which can be regulated to correspond to the prevailing barometric pressure on each day so that all emanation chambers can be filled with an air concentration corresponding to that at which they were standardized.

Mr. d'Aguiar's method described for the treatment of sulphates in order to bring the radium into solution for measurement involves a rather difficult operation in duplicate. If the silica content of the sulphates is too high to render the sodium carbonate fusion method applicable,[4] then the bisulphate fusion method of Barker[5] may be used conveniently, or the SiO_2 may be removed by HF before the carbonate fusion.

It is not clear whether Mr. d'Aguiar's statement in a footnote, to the effect that the nitric acid extraction method is needlessly expensive and that only 1 g. of radium has been produced by it, is general, or whether it refers only to the experience of his own company. If he means it as a general statement, it may be of interest to recall that the Bureau of Mines produced between 8½ and 9 g. of radium element by the nitric acid method, which was not only found to be entirely satisfactory but which was above criticism from the cost standpoint, as the following statements will show: The costs published in Bulletin 104 by the Bureau of Mines were $37,500 per gram of radium. These costs were estimated from the production of 1 g. during the course of operation. It has been supposed by some radium producers that the estimate was too low, but, as a matter of fact, it has proved to have been fairly close. When the entire operations of the National Radium Institute were brought to a close, it was found that the net expenditures of the corporation, after deducting for the sale of the plant, byproducts, etc., was a little over $300,000. (No allowance has been made for 30 tons of high-grade black oxide of uranium produced as a byproduct, which has not yet found a market.) Add to this an overhead of $50,000 on the part of the Bureau of Mines, which is a very liberal estimate, divide by 8.9 g., the amount produced, and a cost is shown of $39,325 per gram. It is not meant to imply that this would be a fair figure today under the present cost of chemicals, labor, etc., but it is meant to state that for such ores as are amenable to nitric acid extraction it can compete in cost, when the nitrates are recovered from the tail liquor and the nitric acid is regenerated, with any other method hitherto proposed. In addition it possesses the distinct advantage of furnishing in a single step a high-grade radium-barium sulphate which can be directly converted into soluble form and introduced into the crystallizing system, without the troublesome steps necessary when a less pure sulphate is produced by a sliming method. In the writer's opinion, radium producers who have carnotite ore reasonably free from sulphate, which is, therefore, amenable to nitric acid extraction, make a mistake in overlooking the possibilities of the nitric acid method.

In closing, the writer would like to say that the radium industry is much indebted to Mr. d'Aguiar for the interesting information contained in his two papers and that it is only to be hoped that he will supplement it with statements regarding the relative amounts of radium passing through the different stages of the process described, and give other details and data which would be of the greatest value to those engaged in the radium industry.

S. C. Lind.

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[3] *J. phys. radium*, vol. 2, pp. 381-2 (1921).
[4] *J. Ind. Eng. Chem.*, vol. 7, p. 1024 (1915).
[5] *J. Ind. Eng. Chem.*, vol. 12, p. 525 (July, 1918).

Explosion Hazard in the Darling Process of Electrolyzing Sodium Nitrate

To the Editor of Chemical & Metallurgical Engineering

Sir—In reading the first installment of Mr. Batsford's valuable article on "Metallic Sodium," which appeared in your journal for May 10, I find that, on page 891, following his description of the "Darling Process Using Sodium Nitrate," he says: "Unfortunately the explosion hazard was too great a drawback, and the process was abandoned about the year 1905." As expert special agent in charge of the chemical industries at the census of 1900 I investigated the Darling process, then being operated at the works of Harrison Bros. & Co., Philadelphia, and on pages 50-51 of Bulletin 210 of the Twelfth Census of the United States I have given a description of the process. During my investigation I learned that the quantity of metallic sodium accumulated in storage at the works had become so great the city authorities, fearing accidents, compelled the cessation of operations. It was my understanding that the menace was in the product and not in the process and that this menace will hold for any and all processes for the isolation of sodium. This is a factor of great weight in determining the location of a plant for this industry and in designing the methods for collecting, handling and storing the sodium.

Charles E. Munroe.

Division of Chemistry and Chemical Technology,
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American Iron and Steel Institute

Twenty-first General Meeting at Hotel Commodore, New York City—Judge Gary's Opening Address—Technical Program With Papers on Australian Iron and Steel Industry, Electrification of Steel Mills, Adirondack Iron Ores, Fuel in Open-Hearth Practice, and Gas and Air Valves for Open-Hearth Furnaces

THE twenty-first general meeting and annual spring session of the American Iron and Steel Institute was held on Friday, May 26, 1922, at the Hotel Commodore, New York City. The program consisted of a morning session with an address by President Elbert H. Gary and technical papers, luncheon, an afternoon session of technical papers and discussion, and a banquet in the evening, followed by impromptu speaking in response to the call of President Gary.

There was a large attendance of the members and their guests at both the morning and afternoon sessions and at the banquet. A general tone of good-spirits and optimism was evident and confidence in the return of good conditions to the industry was evidenced on all sides. Field Marshal the Right Honorable Earl French of Ypres was the guest of honor at the banquet and spoke briefly in appreciation of the American iron and steel industry.

Morning Session

The morning session was opened with the customary address by the president of the Institute. Judge Gary opened his remarks with an appreciation of the services to humanity in general and the iron and steel industry in particular rendered by the late Dr. Henry M. Howe, whose memory was honored by a silent standing tribute on the part of the whole assemblage.

President Gary then spoke of the dinner given on May 18 by President Harding, who at that time had forty members of the A.I.S.I. as his guests at the White House. The newspapers were in the main correct in their reports of this meeting, at which President Harding came out frankly and asked the iron and steel industry to do all in its power toward adopting a uniform eight-hour day. The matter was discussed fully among those present and a motion was passed that Judge Gary appoint from the A.I.S.I. a committee whose duty it should be to make a thorough and unbiased investigation as a basis for a report and recommendations upon which the A.I.S.I. might take such action as then seemed appropriate. It was urged on all present that they extend their prompt co-operation to this committee, furnishing all the data pro and con which their industrial connections made available, and always keeping in mind that President Harding's wishes should be fulfilled if such proved to be at all possible.

Judge Gary's Address

President Gary then delivered his address, the subject of which was "Current Legislation." After pointing out the necessity for full and impartial administration of all the laws on the statute books and urging the patriotic duty of all iron and steel men to see that this course was followed, he touched on the legislation now before Congress on the tariff, government regulation and soldiers' bonus, giving his opinion of the course that should be followed that all in the country might derive the most benefit. The sales tax was advocated, whether the bonus legislation passed or not, as being fairer to all concerned and better for the business life of the country than the methods of revenue raising now in vogue. The address closed with a word of optimism and encouragement as to the present and future of the iron and steel industry.

Address by Sir William B. Peat

Following Judge Gary's address, Sir William B. Peat was introduced to the meeting. Sir William has long been influential in iron and steel circles and, an early member of the Iron and Steel Institute of London, was instrumental in the founding of the A.I.S.I. He spoke briefly on the position of the iron and steel industry of the United States in world trade and expressed the opinion that the United States should seek the financing and control of the industries of other countries as England had done a hundred years ago, stating that only in this way could world trade and industry quickly regain their former level.

Iron and Steel in Australia

A paper on "The Development of the Iron and Steel Industry in Australia" was read by David Baker, general manager of the Broken Hill Proprietary Co., Newcastle, New South Wales. The important iron ore resources of Australia are stated to be as follows: Western Australia, 97,500,000 tons; South Australia, 130,000,000 tons; Victoria, 750,000 tons; Tasmania, 41,900,000 tons; Queensland, 500,000 tons, and New South Wales, 53,017,000 tons. There are numerous other rich deposits; but due to their present inaccessibility they were not listed.

The manufacture of iron and steel has made various sporadic starts in the different Australian states; but only in New South Wales, where the industry was commenced in 1852 at the Fitzroy Iron Works, has the development been steady. Following the formation of this company, the Lithgow Iron Works was founded in 1874, becoming the present Hoskins Iron & Steel Co., Ltd., in 1908. The Broken Hill Proprietary Co., founded in the early days of Australian gold mining for the production of gold, silver and lead, originally purchased the iron mines at Iron Monarch and Iron Knob for use in supplying flux for its lead smelters at the Port Pirie Works. In 1911 this company made an investigation of the possibilities of steel manufacture and then commenced this manufacture at Newcastle in 1915. The production of these two last companies is as follows: Hoskins Iron & Steel Co., Ltd., 150,000 tons of pig per annum; Broken Hill Proprietary Co., 600,000 tons of steel per year. There are numerous other companies of less importance for the production of pipe, wire, black and galvanized sheets and other materials.

Afternoon Session

Relation of the Doctor to the Steel Plant

The first paper of the afternoon session was an interesting exposition of the "Relation of the Doctor to the Steel Plant," by Dr. L. A. Shoudy, chief surgeon of the Bethlehem Steel Corporation. Dr. Shoudy pointed out the importance of employing only the highest class of physicians and installing the best of hospital and medical equipment. The important function of the doctor is, by anticipating and removing the causes of ill health in environment and in the human machine, to keep production and efficiency at a high level. In conclusion, he stated that in times of trouble the worker looks on the doctor as a friend who understands and hence the right type of doctor can form a valuable contact between the steel company and the workers.

Electrification of Steel Plants

Wilfred Sykes, of the Steel & Tube Co. of America, read a paper on "The General Effect of Electrification on the Operation of Steel Mills," which stated that it is important that those concerned in steel mill operation should understand the essentials of electrification, as the extension of the steel industry in the future will consist as much of modernization of the old mills as of building new mills, and in this case the main drives will all become electric, as the auxiliary drives now are. The paper then proceeds to give numerous and illuminating examples of operation of electric drives for main rolls and auxiliary mills. An interesting chart shows the progress in use of electric drives on main rolls from 1906 to 1921, the total horsepower in use having increased in that time from about 50,000 hp. to approximately 925,000 hp.

Mr. Sykes gives some interesting figures on the delays resulting from the electrical driving of the reversing drive of a 30-in. universal plate mill at the South Chicago works of the Illinois Steel Co., which was installed in 1907 and was the first to operate. During a total working time of 100,000 hours since that time the mill has had a total delay of 525 hours due to electrical troubles. In 1920, after 13 years' operation, there were no delays, although this mill rolled in this year 20 per cent more than in any of the first 10 years of its life.

Use of Fuel in Open-Hearth Furnaces

Herbert F. Miller, Jr., assistant superintendent of the Lackawanna Steel Co., in a paper on "Methods of Using Fuels in Open-Hearth Furnaces," stated that the field in which ideas for developing power of open-hearth fuels are hidden has barely been scratched. From experiments covering the past ten years on the use of various fuels in open-hearth furnaces he found methods of producing much better flames than are in general use in open-hearth practice. In a producer gas type furnace with a single brick gas port, oil was used for fuel and was introduced through a water-cooled tuyere which projected across the uptake and terminated just short of the nose of the port. This tuyere was pulled back until it terminated over the uptake. The result was such an intensely hot flame that the arch of the port melted and the roof of the furnace burned. However, this flame was used a sufficient time to show that the time of the heats could be reduced from 6½ hours to 4 hours. The reason of the high heat was that the great speed of the oil fuel across the uptake and through the gas port caused it to act as an aspirator for the preheated air in the uptake. Hence the vaporized oil and the air united under pressure and at great speed in a mixing chamber of small cross-section and the condition approached the ideal for perfect combustion. Similar experiments on other fuels and in specially built ports proved that these effects could always be reached. The trouble is that the furnaces now in use cannot stand the heats obtained in this manner. Mr. Miller suggested the construction of open-hearth furnaces along the lines followed to produce the modern high powered blast furnace and that eventually it will be possible to tap heats charged with scrap and cold pig iron in three to four hours after starting to charge, when conditions of high pressure air and gas are developed.

Iron Ores of the Adirondacks

In 1916 F. S. Witherbee, of Witherbee, Sherman & Co., read a paper on this subject. F. L. Nason, the geologist of this company, now presents a paper which supplements and gives further details on this subject and is entitled "The Importance of the Iron Ores of the Adirondack Region." The paper states that there are about 250,000,000 tons of titaniferous ores, and that the total tonnage of both titaniferous and magnetite ores, known and prospective, is 1,736,000,000 tons. Of this amount there is 186,000,000 tons of ore assured. At the present rate of production, about 1,500,000 yearly, the yield to be expected from the rest of the field will be known long before this amount is exhausted.

The paper states also that this region is capable of producing not less than 600,000,000 tons of 61 to 65 per cent concentrates of bessemer grade in phosphorus, of which probably one-half would be "special low phosphorus." Unit for unit, these concentrates can be marketed on even terms, at some point not far east of Buffalo, with the best of the Lake ores.

Gas and Air Valves for Open-Hearth Furnaces

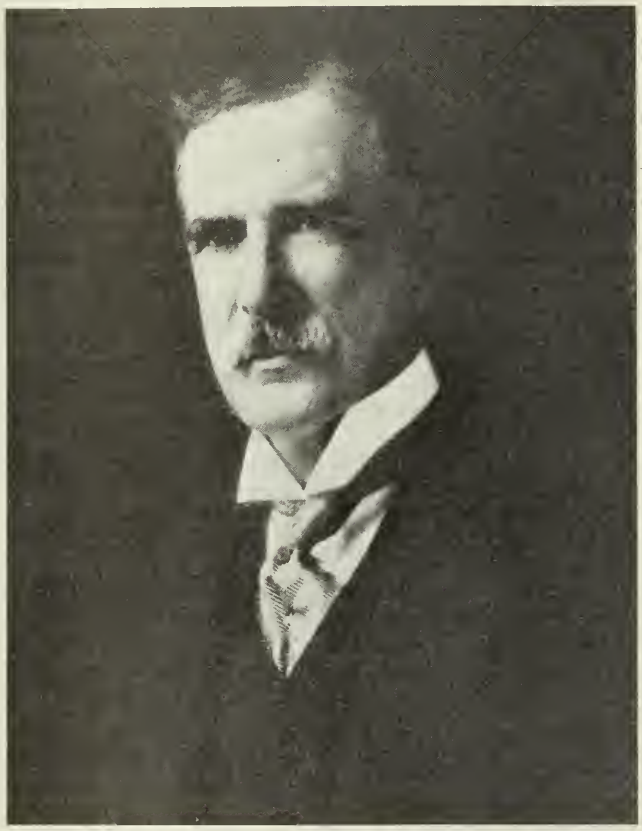
William C. Bulmer, of the Carnegie Steel Co., in a paper on "Gas and Air Valves for Open-Hearth Furnaces," traced the development of these valves from the earliest Siemens furnace down to the types in use today. He stated that the chief requisites of a proper valve are an effective seal and an unrestricted passage. The paper divides valves into three groups—namely, one-way, two-way and four-way, depending upon the number of directions of gas or air passage through them. The one-way group alone offers means of regulating the flow to and from each checker chamber without additional equipment. This valve also permits any desired proportion of the waste gases to be put through either chamber. By regulation of the incoming gases also during periods of shutdown, such as Sundays, a much better temperature can be maintained.

Valve types are classified in this paper as slide, butterfly, mushroom and movable hood—also as dry, refractory-lined, water-cooled and water-sealed. The various advantages and disadvantages of these different qualities are given. From these data the paper concludes that the one-way, water-cooled slide valve with inclined seat comes nearest to perfection in so far as the requisites of effective seal and unrestricted passage can be obtained with good mechanical construction, accessibility for repair, low maintenance cost and various other factors.

Henry Marion Howe

HENRY MARION HOWE died at his home at Bedford Hills, N. Y., on Sunday, May 14, 1922, from a malady which had confined him to his house for more than a year. Living to the ripe age of 74 years, his achievements may be fittingly expressed in the words with which Albert Sauveur conferred the John Fritz Medal:

"Lover of justice and humanity,
"Public servant and public benefactor,
"Master of the English language,
"Loyal and devoted friend,
"Untiring and unselfish worker in an important field of science,
"Stimulating teacher, inspiring investigator and generous collaborator,
"Voyager in realms but dimly perceived by fellow-workers,
"Lone explorer of fields destined to yield rich harvests to future generations,
"Man of genius, honored and loved the world over."



HENRY MARION HOWE

Henry Marion Howe was born March 2, 1848, at Boston, Mass. His father was Dr. Samuel G. Howe, famous for his service to Greece in her war for independence (from 1824 to 1830) and later for his labors in the instruction of the blind. His mother was Julia Ward Howe, author of The Battle Hymn of the Republic," and leader in many reforms.

He was graduated in 1865 from the famous Boston Latin School, and four years later received his degree as Bachelor of Arts from Harvard College. Thus equipped, he entered the Massachusetts Institute of Technology, which gave him in 1871 the degree of "Graduate in the Department of Geology and Mining Engineering"—a cumbrous title for which the institution substituted, a few years later, that of "Bachelor of Science." And Harvard made him Master of Arts in 1872, and Doctor of Laws in 1905.

With the exception of approximately five years devoted to the metallurgy of copper, during which he inaugurated copper smelting in Chile, designed and built the works of the Orford Nickel & Copper Co. at Capelton and Eustis, in the Province of Quebec, Canada, and at Bergen Point, N. J., and managed the Pima Copper Mining & Smelting Co. in Arizona, Dr. Howe's whole professional life had been devoted chiefly to the development of the iron and steel industry, as superintendent of steel works (Joliet, 1872, and Pittsburgh, 1873-4), consulting metallurgist, teacher of metallurgy, investigator, interpreter, writer and presiding officer. While acting as consulting metallurgist he was lecturer on metallurgy at the Massachusetts Institute of Technology from 1883-1897, professor of metallurgy at Columbia University, 1897-1913, and professor emeritus, 1913-1922.

For the last fifteen years he declined as far as practicable all professional business in order to devote himself exclusively to what had clearly become the great scientific mission of his life, a task unfortunately not completed. Dr. Rossiter W. Raymond, in an address in 1917, thus describes it:

"It gives me pleasure to fancy, whether or not the fancy be also fact, that I remember the beginning of that mission, forty-odd years ago. In 1871, the first year of the existence of the American Institute of Mining Engineers, Mr. Howe, then just graduated from the Massachusetts Institute of Technology, became a member of the new organization. His two earliest contributions to its *Transactions*, 'Blast-Furnace Economy,' in volume 3, and 'Thoughts on the Thermic Curves of Blast Furnaces,' in volume 5, indicated already that he was making a scientific study of practice. But between the dates of these papers a famous controversy was inaugurated in the forum of the Institute by the brilliant paper of Alexander L. Holley, *primus inter pares*, entitled 'What Is Steel?' In his controversy eminent metallurgists like Wedding, chemists like Prime, and expert captains of industry like Metcalf vigorously took part; but of all the knights of the tourney, none rode a straighter course or laid in rest a sharper lance than Howe, whose paper on 'The Nomenclature of Iron' ardently advocated a scientific as distinguished from a commercial nomenclature. To tell the truth, the battle had a commercial origin. The real question at issue was not, What is steel? but, What may fairly be called steel at the custom house?

"Well, there was even an international committee on the subject, and the committee made a report. The tariff difficulty was adjusted somehow; the antagonists shook hands; the thunder of the captains of industry and the shoutings died away. But one man continued the inquiry fiercely in his own soul. Henry Marion Howe, before whom the dust of the controversy loomed like a giant Afrite still defying attack, devoted his life thenceforth to the mighty conundrum, What is steel?"

In 1889 appeared in book form his "Metallurgy of Steel" after running serially in *Engineering and Mining Journal*. Let Dr. Howe's associate, Bradley Stoughton, tell of its influence:

"Before Howe wrote his great book, 'The Metallurgy of Steel,' steel making was a practice rather than a science, a series of operations producing material whose quality was sometimes uncertain and whose defects were not understood or explainable. The science of metallography was in its infancy; the use of the microscope in steel laboratories was scarcely heard of. This monumental book, in more ways than one marks an epoch in the history of steel metallurgy; it collected and collated all the valuable information in English, French and German. So thoroughly and so comprehensively had Howe performed the task that the previous literature of steel became of secondary importance, scarcely necessary for reference, because its most important data were included in this one concise volume.

Howe's Leadership Recognized Internationally

"From that time the leadership of Howe in the scientific and literary development of the metallurgy, metallography, heat-treatment and physical properties of iron and steel was recognized internationally. He was possessed of the qualities which eminently fitted him for this leadership. Gifted with a tact, a charm of personality as a presiding officer, an excellent speaking knowledge of French and German, he stimulated his audiences and brought out an active debate in a convention in any language; no one in this field had a command of the English language comparable with his; he developed clarity of expression which enabled him to clothe his thoughts in language that could be readily understood; his devotion to the truth was single minded and predominant; he was not only an able investigator and interpreter but he was an organizer of research to produce the most effective results from the experiments of himself and those working under or with him. He did not waste time with experiments, because he had students available to do the manual work; he did not duplicate work which had already been done, but he preceded each research with careful study of the information already available; he sought to investigate first those problems which stood in the way of progress, which were needed to fill in the gaps of knowledge, or whose solution would most enlarge our field of vision; he planned the work in advance; he did not tolerate a haphazard experimentation; he worked with a desire to reach a definite goal by the shortest possible method; he did not build his bridge without designs and calculations, but rather he prepared in advance in order that each step might count."

His Masterly Work on the Metallography of Steel and Cast Iron

All these labors were to be collected and interpreted in a series of monographs. Only one of them has been completed, "The Metallography of Steel and Cast Iron," appearing in 1916. This book is not a text-book, repeating what is generally accepted already. Covering the field in which others have meritoriously labored, it propounds, suggests and prophesies new truth and new views of truth. It is a product of the two kinds of genius, the genius which consists in an infinite capacity for taking pains, and the genius which with happy intuition surveys, divines, co-ordinates and interprets the cosmos in the chaos. It was hailed by scientists everywhere. Thus Sauveur:

"Prof. Howe, in his masterly book, "The Metallography of Steel and Cast Iron," reviews exhaustively and examines critically, as he alone can do, every view at all worthy of recognition, dealing with the subject he covers. I believe that any responsible author who has ever expressed a reasonable opinion on any subject dealing with the metallography of iron and steel will find his views recorded and discussed in this book. Prof. Howe then proceeds to weigh with great fairness and extraordinary intelligence and lucidity the arguments or evidence supporting the different views, and draws his conclusions accordingly. His method is that of a mathematician solving a problem in which each factor is given its proper value. In this way Howe has rendered to metallurgists an inestimable service; and he alone could render it. Where most of us could see only chaos and obscurity, he is able to bring order, and to discover the light that, under his skillful manipulation, soon illuminates the darkest corners. . . .

"This, I think, is his greatest achievement—the marvelous co-ordination which he has brought into the science of metallography through his genius and his labor, tremendous in quantity, marvelous in lucidity. To him more than to any one else we owe the quick rejection of weak or ill-supported theories, in favor of the survival of the fittest—a process so necessary to the advance of any branch of human knowledge."

Completion of a series of such great works was undoubtedly prevented by the fact that during the Great War Dr. Howe acted as chairman of the Engineering Division of the National Research Council, giving his entire time and energy to the many problems in its charge. One of the many problems successfully solved was curing "haircracks" in airplane engine crankshafts. In this instance Dr. Howe applied the results of a study made by the Army and Navy Ordnance Departments on wastage in the manufacture of nickel steels of high transverse strength.

His Service as President A.S.T.M.

Dr. George K. Burgess also dwells upon the services rendered by Dr. Howe, during the four terms he acted as president of the American Society for Testing Materials:

"Dr. Howe always illuminated any subject which he considered and also took very active part in the discussion of any subject of interest to him and had a wonderful ability of expressing vividly and tritely the major facts as well as the details of any metallurgical problem, however recondite. His very logical mind and comprehensive grasp of the theoretical as well as the practical sides of questions relating to properties and testing of materials made him an exceedingly valuable leader in A.S.T.M. activities. He was always most frank and fearless, at the same time courteous and considerate, in expressing and maintaining his ideas in verbal discussion and in writings. I am certain that his balance, foresight and ability must have had a predominating and far-reaching influence in framing not only questions of Society policy but also in the development of technical and scientific problems. He with Professors Lanza and Merriman held each in his own field of engineering a unique place of dominance for many years in the A.S.T.M. councils. All three were professors, and each of them put the imprint of his personality into the formulation of its ideals. As far as metallurgy is concerned, the late Dr. Dudley and Professor Howe, one representing the practical use of specifications and the other more interested in development of correct concepts and securing progress by research, were easily the leading minds in the early days of the A.S.T.M."

Prof. William Campbell of Columbia University, who

was associated with Dr. Howe for many years, pays his tribute:

"In the death of Professor Howe this country has lost one of the great teachers. In other places various accounts of his distinguished services in his chosen profession have been given and also lists of his publications and of his well-earned honors, but here perhaps a word or two of appreciation of the man himself may not be out of place.

"Those of us who had the privilege of attending his courses or working with him in his laboratory or even only hearing him deliver one of his numerous contributions to science have been struck with his remarkable clearness of thought and of expression as well as his keen penetration and masterly interpretation of results. Yet with all his brillance of mind he was sympathetic and patient with those of his associates less happily endowed. And his patience was that of Job.

"In the lecture room his modesty seemed to increase as his reputation became greater. He seldom, if ever, referred to his own contributions, but always gave credit to others, even where he himself had done all the planning. His method of presentation was so simple and so logical and his illustrations so homely that the dullest of us could not help but understand him, with the result that his courses seemed to be the easiest in the school.

"In the laboratory his kindly personality and fatherly interest in us all made him beloved by everyone. He spared no pains in training his men to do research in the scientific, orderly manner, for he had no respect for the old cookbook methods.

"Particularly were his characteristics noticeable in guiding us in our research. An indefatigable worker himself and of great painstaking in systematizing and planning work, yet he was never intolerant or sharply critical when things did not turn out satisfactorily because his advice had not always been followed. 'Try again' was his motto and when the work was done his praise and appreciation well repaid for all.

Aided Impecunious Students Delicately

"Another side of his character known to but few was his sympathy for the student who had to work his way. He constantly made opportunities for such a man to make a little extra money and he was always on the alert to see that such opportunities came his way. On more than one occasion where the offer of actual money would have hurt a sensitive person, Professor Howe thought up some research that needed doing and which at some future time might have some technical value and therefore ought to be paid for, and it was paid for generously.

"In spite of his busy life, for he worked himself to the limit, he found time to have his students home to lunch and dinner and then talking shop was barred. And yet we all came away feeling we had had a very pleasant time and rather proud of ourselves that we had been able to discourse so fluently and so brilliantly on all kinds of subjects—a thing which had never happened to us before."

W. P. Barba, a friend of Dr. Howe for many years and who collaborated with him in the preparation of the recently published article on "Acid Open-Hearth Practice in the Making of Fine Steels," writes:

"The passing of Dr. Henry Marion Howe creates an irreparable loss to the philosophic and practical consideration of the making of the utmost progress in the production of quality products in the iron and steel industry. Dr. Howe's rare insight into, first, the practice, and then the philosophy surrounding the practice of this manufacture was so deep and wide that the writer can think of no one at present prepared to step into the place vacated by Dr. Howe.

"His many publications, accurately collecting and compiling practical data, deducing therefrom the correct theories so often developed, first, through practice and then disseminating so freely and fully the correct reasoning from this observed practice, furnished to the world of iron and steel a medium of full and correct thought which has so far been unmatched by the work of any other observer.

"Dr. Howe's unfailing courtesy, unflagging energy and immense industry were directed, for more than one generation, to the end that the practice of America first and of the world in general should be correctly guided, so that the practical results, coming through the many establishments engaged in the manufacture of these products, should be of maximum benefit.

"Dr. Howe will be missed by his many friends, by his thousands of admirers and disciples, and the writer hopes that the followers of Dr. Howe will pattern after his most meritorious example."

Corrosion Tests of Chromium Steels

It appears from the series of tests which the U. S. Bureau of Standards has carried out upon the corrosion of chromium steel that the behavior of the material when subjected to the acid test is not a sure criterion of its resistance to atmospheric corrosion. Of all the alloys examined, a high nickel-chromium steel, invar, pure iron and medium carbon steel (very slowly cooled from a high temperature) were the most resistant to hydrochloric acid as measured by the loss of weight per unit area per day. High-chromium steels, for example, containing 13.7 per cent Cr and 0.29 per cent C, were found to be attacked by acid very much more readily. However, when the same specimens were subjected to a weathering test, consisting of a partial immersion in water and exposure to the air, the order of resistance was almost completely reversed. The high-chromium steels were the ones to withstand the treatment best, the low-chromium ones and the pure iron showing rust spots early in the test. The combination of both nickel and chromium appears to make the steel resistant to both acid and weather attack. In general, the steels which were quenched were found to resist corrosion better than the same material in the annealed state, but the differences found were much less than the differences resulting from composition changes, thus indicating that composition rather than treatment should receive primary consideration. Additional results will not be ready for some time.

Spectroscopic Analysis of Bronzes

The Bureau of Standards, Washington, D. C., has completed the examination of five bronzes for impurities with the purpose of establishing the spectrographic method for quantitative estimation of small amounts of aluminum and silicon which are detrimental in bronze or brass castings. The method is simple, successful and sufficiently accurate. A report on this practical application of spectrum analysis was presented at the Non-Ferrous Metals Committee meeting on April 24, and a paper entitled "Spectrum Analysis in an Industrial Laboratory" was read before the Institute of Metals Division, February, 1922, by Messrs. Bassett and Davis, of the American Brass Co.

Effect of Sulphur on Rivet Steel

Maximum Sulphur Now Allowed (0.045 Per Cent) Is at Least 0.01 Per Cent Below the Quantity Where Sulphur Will Damage the Strength of Well-Made Rivet Steel, as Far as Its Performance Can Be Predicted by Standard Tests

By ERNEST E. THUM

A "PRELIMINARY REPORT of the Joint Committee on Investigation of Phosphorus and Sulphur in Steel" has just been issued as a preprint of a paper to be presented before the American Society for Testing Materials, Atlantic City, June 28. The text merely recounts the number and kinds of tests, and presents thirty-three diagrams summarizing the results. Complete publication will ultimately be made as a Bureau of Standards technologic paper and presumably will contain all information available on the method of steel making and rolling, numerical results of tests, photographs of fractures and microscopic studies of structure. "While the Joint Committee has received all the test data in this investigation, it prefers to defer any extended discussion of the results and the drawing and publishing of formal conclusions therefrom." This attitude of the committee is unfortunate, for there is a vast amount of data contained in the pamphlet (over 5,000 physical tests and 1,000 chemical analyses were made) and few metallurgists will have the time necessary to analyze it and seek out its meaning. It must therefore be understood that only the diagrams presented herewith are vouched for by the committee—the tables (except Table I), the discussion and the conclusions have been deduced by the present writer.

Steels Used

Thirteen 75-ton heats of basic open-hearth steel varying in sulphur from 0.03 to 0.08 per cent, and one with 0.18 per cent sulphur, were made and rolled into 1-in. bars by the Carnegie Steel Co. This sulphur is "residual"—i.e., due to sulphur in the charge and fuel and not to additions of sulphides after melting. Physical and chemical tests on the material were made at Watertown Arsenal and at the U. S. Naval Engineering Experiment Station, Annapolis. Twelve complete analyses were made on each heat, giving the very uniform results shown in Table I. No nickel or chromium was found. Heat F is high in both manganese and carbon; this composition is unmistakably reflected in the physical tests, and in view of its very low sulphur contents, it would have been proper to omit this steel from the series. This done, the composition of the various materials may be regarded as: Carbon, 0.11 per cent; manganese, 0.43 per cent; phosphorus, 0.01 per cent.

TABLE I—AVERAGE CHEMICAL COMPOSITIONS, WITH MEAN DIVERGENCES

Each value is the average of separate analyses on 14 samples from each heat. The heats are arranged in the order of increasing sulphur contents.

Heat Letter	Ingot Hot or Cold	Sulphur, Per Cent	Carbon, Per Cent	Manganese, Per Cent	Phosphorus, Per Cent
A...	Cold	.0282 ± .0015	.136 ± .0037	.426 ± .021	.0062 ± .0005
F...	Hot	.0317 ± .0016	.149 ± .0043	.642 ± .0075	.0082 ± .0017
H...	Hot	.0355 ± .0015	.110 ± .0025	.362 ± .0037	.0055 ± .0015
G...	Hot	.0367 ± .0020	.137 ± .0037	.466 ± .0037	.0085 ± .0015
B...	Cold	.0377 ± .0009	.112 ± .0080	.392 ± .012	.0082 ± .0009
C...	Cold	.0444 ± .0026	.107 ± .0075	.455 ± .005	.0082 ± .0012
J....	Hot	.0492 ± .0016	.107 ± .0037	.355 ± .0062	.0062 ± .0027
K...	Hot	.0580 ± .0030	.115 ± .0050	.411 ± .0087	.0105 ± .0025
E...	Cold	.0606 ± .0033	.104 ± .0037	.457 ± .006	.0105 ± .0010
D...	Cold	.0608 ± .0012	.094 ± .0040	.385 ± .015	.0127 ± .0020
P....	Hot	.0633 ± .0018	.116 ± .0037	.432 ± .005	.0240 ± .0030
S....	Hot	.0695 ± .0028	.104 ± .0043	.420 ± .020	.0117 ± .0003
R...	Hot	.0834 ± .0033	.106 ± .0037	.472 ± .0025	.0112 ± .0030
M...	Hot	.1793 ± .0027	.106 ± .0037	.512 ± .0075	.0060 ± .0030

Even after eliminating heat F, manganese, unfortunately, varies from 0.35 to 0.51, and tends to go up with the sulphur. Therefore some of the effects of sulphur may be masked by this other element, and in the discussion which follows it should always be remembered that % S + 0.40 = % Mn.

Tests on Rivets

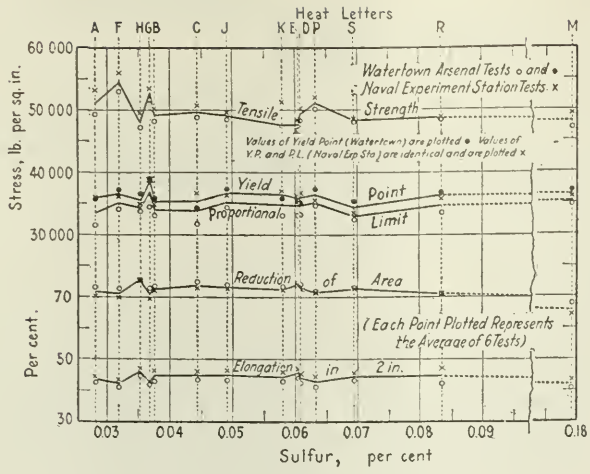
Two hundred rivets were made of each steel and tested in various ways. Twenty rivets from each test were upset two-thirds their length, ten hot and ten cold, with no failures. Ten hot rivets of each heat had their heads flattened to 2½ times the shank diameter, and six more from each heat had their shanks flattened hot to $\frac{3}{32}$ in. at the edges without failures. Eight cold rivets from each heat were bent flat upon themselves in the condition as received, without failures. Eight rivets from each heat were bent flat upon themselves after quenching from 940 deg. C. (1,725 deg. F.); the only failures recorded were in the 0.18 S steel.

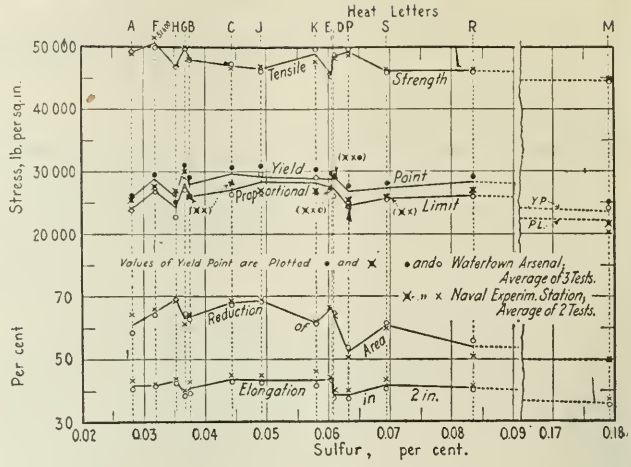
The conclusion is that sulphur up to 0.10 per cent in well-made rivet steel does not affect the hot or cold shortness. All the ingots and billets rolled satisfactorily, with exception of heat P, which cracked slightly in blooming.

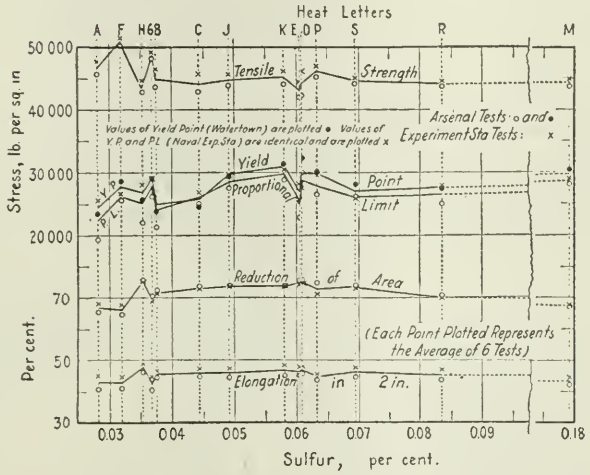
Interpretation of Curves

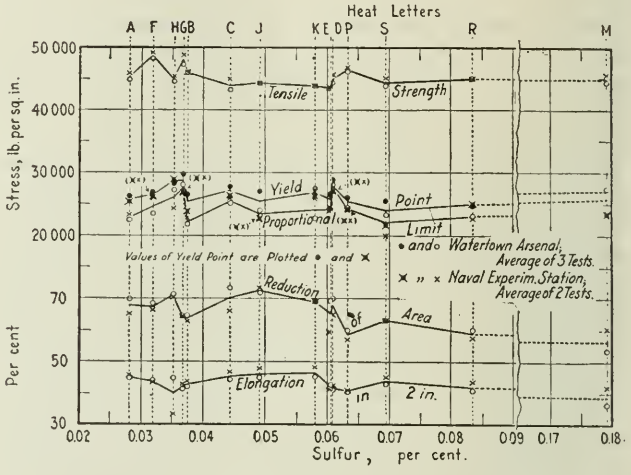
To aid in fixing the indication of the test results, smooth curves (in most cases straight lines) were penciled which approximated the general trend of the somewhat jagged lines given in the report and reproduced here. Values for 0.03, 0.06 and 0.10 per cent sulphur were then scaled from this tentative median.

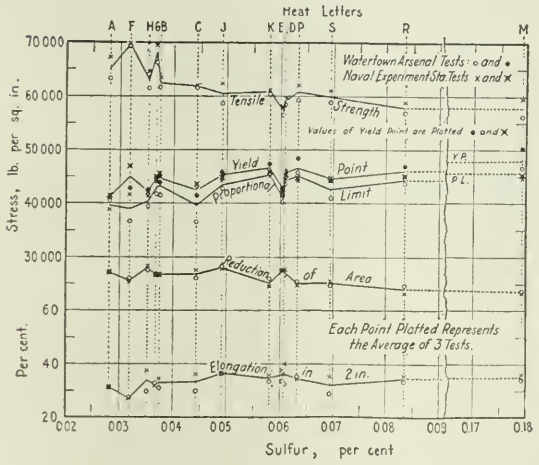
It may as well be recognized immediately that such a plan would involve a large personal factor, and if some of the readers of the report will take the trouble to do it for themselves, perhaps their results would vary several per cent from those given in the table. However, in this particular attempt, sample F was disregarded altogether, and samples A and G somewhat minimized on account of their high carbon. Sample P has (comparatively speaking) very high phosphorus. E and D, being identical in sulphur, were given special weight. A sincere effort to avoid undue influence of the single point out at 0.18 per cent sulphur was also made.

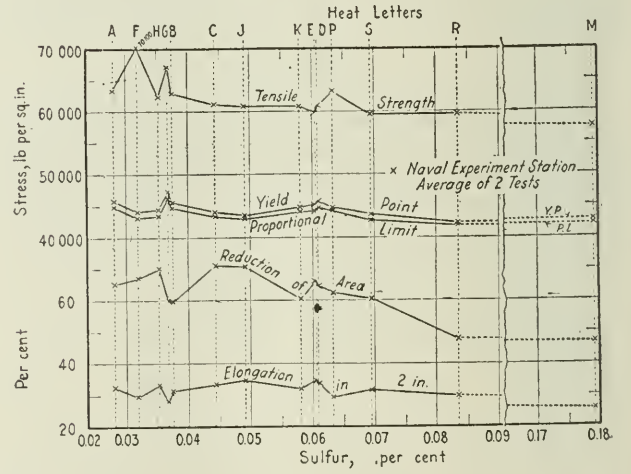

Heat Letters
A F HGB C J K E D P S R M
Stress, lb. per sq. in.
Per cent.
Watertown Arsenal Tests ○ and ● Naval Experiment Station Tests ×
Tensile Strength
Values of Yield Point (Watertown) are plotted ● Values of Y.P. and P.L. (Naval Exp. Sta.) are identical and are plotted ×
Yield Point
Proportional Limit
Reduction of Area
(Each Point Plotted Represents the Average of 6 Tests)
Elongation in 2 in.
Sulfur, per cent


Heat Letters
A F HGB C J K E D P S R M
Stress, lb. per sq. in.
Per cent
Tensile Strength
Yield Point
Proportional Limit
Values of Yield Point are Plotted ● and ×
● and ○ Watertown Arsenal, Average of 3 Tests.
× " × Naval Experim. Station, Average of 2 Tests.
Reduction of Area
Elongation in 2 in.
Sulfur, per cent.


Heat Letters
A F HGB C J K E D P S R M
Stress, lb. per sq. in.
Per cent.
Tensile Strength
Values of Yield Point (Watertown) are plotted ● Values of Y.P. and P.L. (Naval Exp. Sta.) are identical and are plotted ×
Arsenal Tests ○ and ● Experiment Sta Tests ×
Yield Point
Proportional Limit
Reduction of Area
(Each Point Plotted Represents the Average of 6 Tests)
Elongation in 2 in.
Sulfur, per cent.


Heat Letters
A F HGB C J K E D P S R M
Stress, lb per sq. in.
Per cent
Tensile Strength
Yield Point
Proportional Limit
Values of Yield Point are Plotted ● and ×
● and ○ Watertown Arsenal, Average of 3 Tests.
× " × Naval Experim. Station, Average of 2 Tests.
Reduction of Area
Elongation in 2 in.
Sulfur, per cent.


Heat Letters
A F HGB C J K E D P S R M
Stress, lb. per sq. in.
Per cent.
Watertown Arsenal Tests: ○ and ● Naval Experiment Sta Tests × and ×
Tensile Strength
Values of Yield Point are Plotted ● and ×
Yield Point
Proportional Limit
Y.P.
P.L.
Reduction of Area
Each Point Plotted Represents the Average of 3 Tests.
Elongation in 2 in.
Sulfur, per cent



FIGS. 1 TO 6—TENSILE TESTS

1 in. Rivet Bars
Fig. 1—As received.
Fig. 2—Annealed at 940 deg. C.
Fig. 3—Quenched from 940 deg. C.

$5\frac{1}{4}$ x 1 in. Flats
Fig. 4—As received.
Fig. 5—Annealed at 940 deg. C.
Fig. 6—Quenched from 940 deg. C.

Tension Test

Inspection of Fig. 1 from the report and Table II by the present writer indicates that in this series of rivet bars sulphur up to 0.10 certainly (and perhaps up to 0.18) has practically no effect on the tensile properties. The curves are nearly horizontal. Results as determined are quite uniform; variations from a straight line at samples F, G and P may be ascribed to irregularities in chemical composition (high manganese, carbon and phosphorus respectively). These facts may be summarized in the statement that:

A basic open-hearth rivet steel with composition: C 0.11, Mn 0.43, P 0.01 and S 0.03 has the following tensile properties when tested in 1-in. bars, as received from the mill: Tensile strength, 49,500 lb. per sq.in.; yield point, 36,000 lb. per sq.in.; reduction in area, 72 per cent; elongation in 2 in., 44 per cent. Each addi-

tional 0.01 per cent S up to 0.10 decreases the tensile strength 200 lb. per sq.in. and increases the yield point 100 lb. per sq.in.

One-inch bars tested transversely, in the condition as received (Fig. 4), have yield point and reduction in area much lowered, a symptom of transverse weakness independent of the sulphur content. Reduction in area is further affected markedly as the sulphur goes up, although all the tensile properties seem to show a slight downward trend with increasing sulphur.

After annealing for 30 minutes at 925 to 950 deg. C. and furnace cooling, the greatest change in tensile properties from those given in the 1-in. rivet bars as received is a pronounced drop in the yield point. Fig. 2 shows that the properties plot against sulphur content in what is nearly a horizontal straight line except that the yield point seems to increase slightly with increasing sulphur. The evidence seems to be that:

Annealing these bars for 30 minutes at 925 to 950 deg. C. and furnace cooling lowers the tensile strength 4,000 lb. per sq.in., the yield point 8,000 lb. per sq.in., but does not affect the reduction in area or elongation.

Transverse properties are substantially unaffected by annealing.

Quenching Accentuates Effect of Sulphur

Quenching in water after 30 minutes or 1 hour at 925 to 950 deg. C. increases the tensile strength and yield point of 1-in. rivet bars and 1-in. slabs (transversely) very materially, as can be seen from an inspection of Table II and Figs. 3 and 6. Elongation is

TABLE II—TENSILE TESTS

	1-In. Rivet Bars; Tested Parallel to Rolling			5½x1-In. Flats; Tested Perpendicular to Rolling		
As received	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
Tensile strength	49,500	49,000	48,000	48,500	47,200	45,500
Yield point	36,000	36,200	36,500	26,000	29,000	27,000
Reduction in area	73	73	71	67	64	50
Elongation	44	44	44	42	41	38
Annealed at 940 deg. C.						
Tensile strength	45,200	45,000	44,700	45,200	44,800	44,000
Yield point	26,000	28,400	29,200	26,900	26,500	26,000
Reduction in area	71	74	70	67	68	58
Elongation	45	46	45	44	43	41
Quenched from 940 deg. C.						
Tensile strength	63,600	59,200	56,000	63,000	61,000	58,500
Yield point	42,700	45,000	47,000	45,500	44,500	43,500
Reduction in area	75	73	70	67	65	46
Elongation	32	35	37	32	33	31

reduced correspondingly. The curves for reduction in area of quenched transverse specimens (Fig. 6) drops with high sulphurs to a much more pronounced extent than any of the previous ones.

It may now be desirable to review the data on tensile properties of rivet steel containing sulphur up to 10 points, as illustrated by Figs. 1 to 6 and summarized in Table II.

In all cases the tensile strength decreases slightly and uniformly with increasing sulphur. In nearly all cases the yield point increases slightly with increasing sulphur. These tendencies are markedly accentuated by quenching.

Curves for reduction of area always show a maximum at 0.04 to 0.06 per cent S, much more pronounced in the transverse specimens. (This might bear out the contention of certain steel makers that it is more damaging to "force" a heat of steel to remove sulphur than to leave it in, were it not for the fact that the manganese curve shows a definite minimum in the same region.) Heat-treatment has a singularly small effect on reduction of area.

TABLE III—IMPACT TESTS

	1-In. Rivet Bar; Broken Across the Fiber			5½x1-In. Flats, Broken With the Fiber Impact Parallel to Rolling			Impact Perpendicular to Rolling		
As received	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
Izod	117	114	103						
Charpy	54	53	40	26	22	16	18	16	13
Impact shear	40	39	38	40	39	38	39	38	36
Annealed at 940 deg. C.									
Izod	38 (?)	42	40 (?)						
Charpy	8.5	11	10	12	11	10	15	14	12
Impact shear	38	38	37	42	40	38	40	38	36
Quenched from 940 deg. C.									
Izod	112 (?)	112 (?)	90 (?)						
Charpy	62	54	43	40 (?)	27 (?)	17 (?)	40 (?)	27 (?)	17 (?)
Impact shear	50	47	41	50	46	41	47	45	42

Sulphur content up to 0.10 per cent seems to have little influence on elongation.

Impact Strengths

A maximum just noted in the curves for reduction in area reappears more pronouncedly in the curves for Izod and Charpy impact on rivet bars tested in the condition as received, Fig. 7. In these curves for the first time appears an unmistakable deterioration in properties when sulphur goes above 0.06 per cent. Minor fluctuations are generally paralleled each to each, in Izod and Charpy tests. Impact shear[1] on an unnotched specimen, on the other hand, is quite straight, and almost horizontal.

Ambiguous wording in Figs. 10 to 12 referring to the direction of fracture on transverse tests may be removed by a glance at Fig. 13. All transverse impact fractures are therefore fractures "with the fiber." Comparing the curves for impact shear, it appears immaterial whether an *unnotched* specimen is broken with or across the direction of rolling—the work expended is substantially the same. (It may be debatable whether such results, in view of wide variations in notched bars broken in Charpy and Izod machines, denote a uniform material or an insensitive testing method.) Charpy tests transverse and "with impact in direction of long dimension of slab" break with less than half the work it requires for rivet bars, and the effect of high sulphur is even more apparent than before, dropping from 26 ft.-lb. for 0.03 S to 16 ft.-lb. for 0.10 S.

Annealing Destroys Impact Properties

Extraordinary variation in Izod impact values is shown after annealing rivet bars 30 minutes at 940 deg. C. and cooling in the furnace. Heats A and H, whose other properties do not vary widely, have Izod impacts of 26 and 47 respectively, while E and D, whose chemical composition except for manganese is almost identical, give results of 34 and 66. These are the average of eight tests. Charpy impact results are much more regular, but are surprisingly low—about 10 ft.-lb. —and apparently unaffected by sulphur. Impact shear, as before, is featureless and quite steady at about 38 ft.-lb.

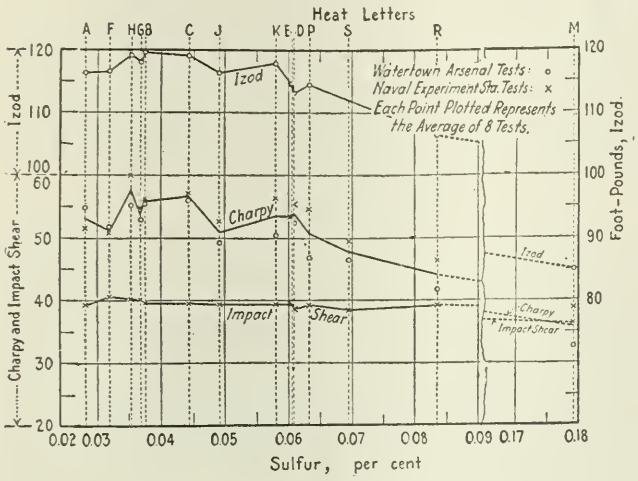
Charpy tests on annealed flats are confused and not consistent. It seems that annealing reverses the relative impact strengths, when hit on the sawed cross-section or on the flat surface, from that shown in the bars as received.

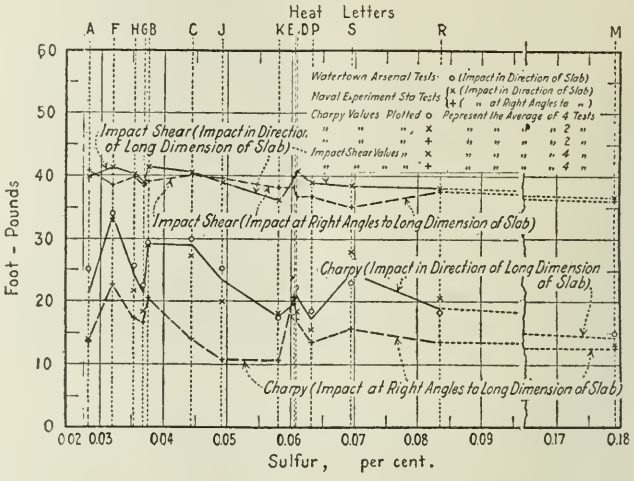
Quenched rivet bars give Charpy and impact shear

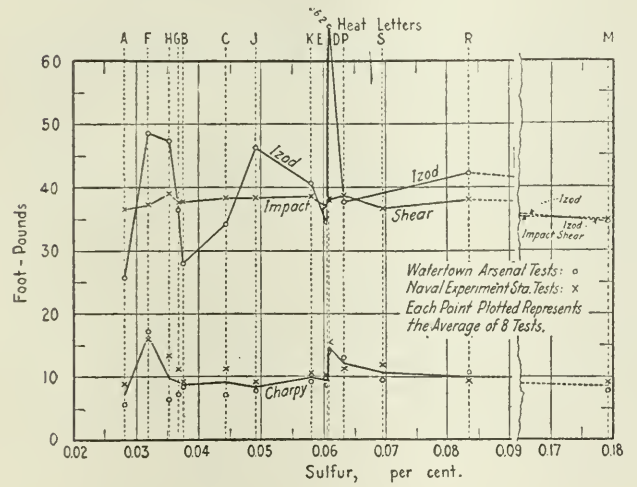
[1]Method described by D. J. McAdam, Jr., *Proceedings*, A.S.T.M., vol. 16, Part II, p. 299 (1916).

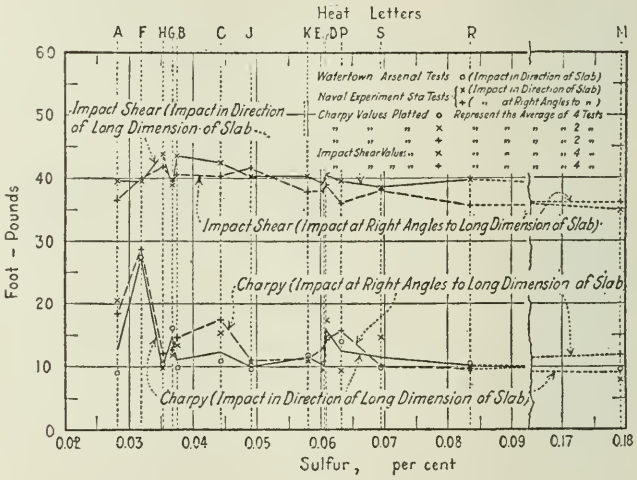
values somewhat higher than the bar as received, and the bad effect of high sulphur is accentuated by quick cooling, as was the case in the tensile properties. Izod figures are quite erratic, as before, but eliminating the high-manganese, high-carbon heat F, the impact value of quenched bars containing up to 0.06 per cent sulphur remains reasonably constant at a little over 110 ft.-lb., whereupon it takes a sharp drop. Transverse tests on quenched flats are very confusing.

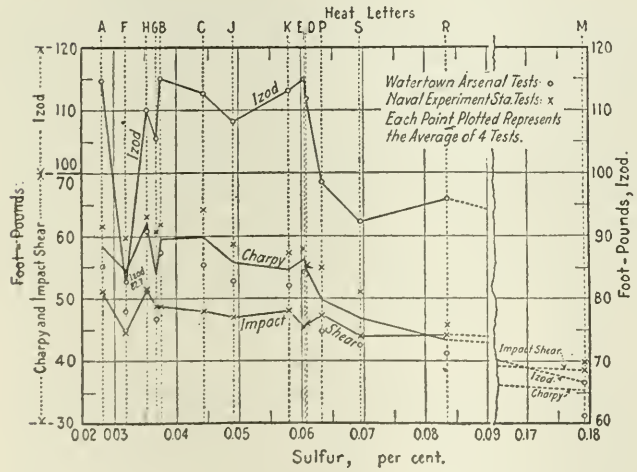
In review, it may be said that the effect of sulphur is unmistakably and strongly felt on the impact strength of rivet steel. Even one who pins his faith in the shearing strength of unnotched bars will recognize a definite if sometimes slight downward slope of all the curves with increasing sulphur content. Despite the violent fluctuations of some of the values for quenched specimens the Charpy and Izod tests magnify this downward tendency to a very marked extent. It

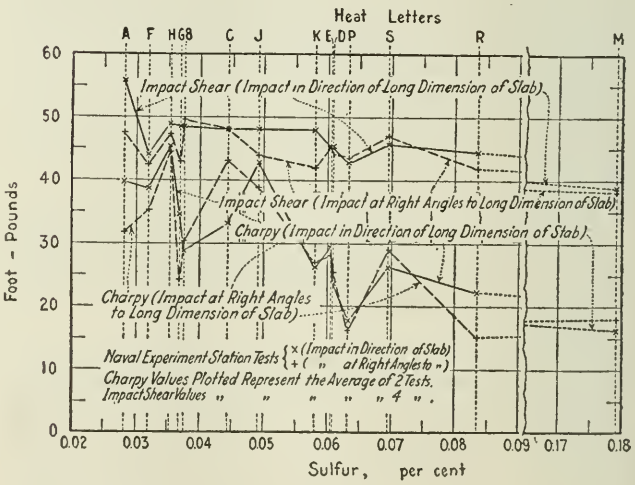



Heat Letters
A F HGB C J KE DP S R M
Watertown Arsenal Tests: o (Impact in Direction of Slab)
Naval Experiment Sta Tests {x (Impact in Direction of Slab) +(" at Right Angles to ")
Charpy Values Plotted o Represent the Average of 4 Tests
Impact Shear Values " x " " " " 4 "
Impact Shear (Impact in Direction of Long Dimension of Slab)
Impact Shear (Impact at Right Angles to Long Dimension of Slab)
Charpy (Impact in Direction of Long Dimension of Slab)
Charpy (Impact at Right Angles to Long Dimension of Slab)
Foot - Pounds
Sulfur, per cent.




Heat Letters
A F HGB C J KE DP S R M
Watertown Arsenal Tests o (Impact in Direction of Slab)
Naval Experiment Sta Tests {x (Impact in Direction of Slab) +(" at Right Angles to ")
Charpy Values Plotted o Represent the Average of 4 Tests
Impact Shear Values " x " " " " 4 "
Impact Shear (Impact in Direction of Long Dimension of Slab)
Impact Shear (Impact at Right Angles to Long Dimension of Slab)
Charpy (Impact at Right Angles to Long Dimension of Slab)
Charpy (Impact in Direction of Long Dimension of Slab)
Foot - Pounds
Sulfur, per cent




Heat Letters
A F HGB C J KE DP S R M
Impact Shear (Impact in Direction of Long Dimension of Slab)
Impact Shear (Impact at Right Angles to Long Dimension of Slab)
Charpy (Impact in Direction of Long Dimension of Slab)
Charpy (Impact at Right Angles to Long Dimension of Slab)
Naval Experiment Station Tests {x (Impact in Direction of Slab) +(" at Right Angles to ")
Charpy Values Plotted Represent the Average of 2 Tests.
Impact Shear Values " " " " " 4 " .
Foot - Pounds
Sulfur, per cent

FIGS. 7 TO 12—IMPACT TESTS

1 in. Rivet Bars

Fig. 7—As received.
Fig. 8—Annealed at 940 deg. C.
Fig. 9—Quenched from 940 deg. C.

5¼ x 1 in. Flats

Fig. 10—As received.
Fig. 11—Annealed at 940 deg. C.
Fig. 12—Quenched from 940 deg. C.

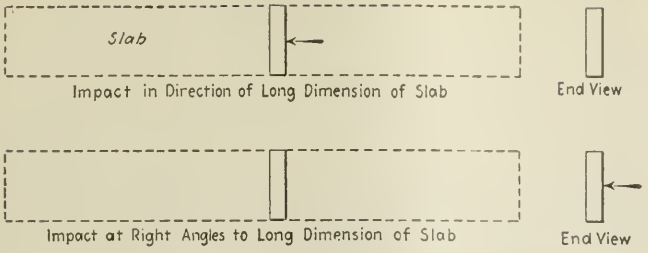


FIG. 13—METHOD OF TESTING TRANSVERSE IMPACT SPECIMENS. ARROW SHOWS DIRECTION IN WHICH HAMMER MOVES

may be contrary to expectation to find low impact strength in annealed bars and high impact strength in quenched bars. Unfortunately no metallographic studies are yet available to indicate whether or not low impact strength is associated with immoderate grain growth.

Hardness

Sulphur has practically no effect on the hardness, as is seen in Fig. 14 and Table IV. A slight trough in the curves at 0.04 to 0.06 per cent S is probably due to

TABLE IV—HARDNESS OF RIVET BARS

	By Brinell Ball			By Scleroscope		
	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
As received	97	94	94	17	17	17
Annealed at 940 deg. C.	87	87	87	15	16	17
Quenched from 940 deg. C.	138	127	130	21	19	20

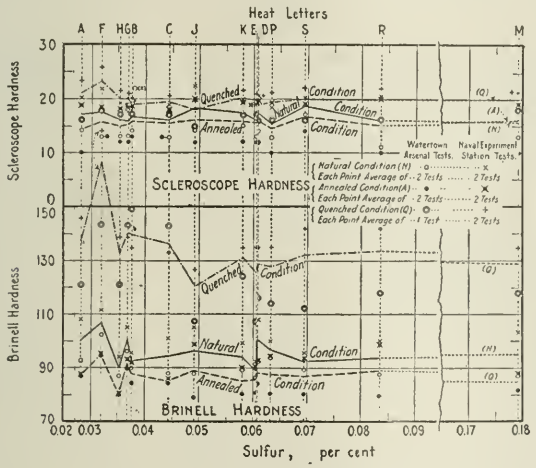

Heat Letters
A F HGB C J K E D P S R M
Scleroscope Hardness
Brinell Hardness
SCLEROSCOPE HARDNESS
BRINELL HARDNESS
Quenched Condition
Natural Condition
Annealed Condition
Watertown Arsenal Tests.
Naval Experiment Station Tests.
Natural Condition (N) Each Point Average of 2 Tests
Annealed Condition (A) Each Point Average of 2 Tests
Quenched Condition (Q) Each Point Average of 1 Test
2 Tests
0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.17 0.18
Sulfur, per cent

FIG. 14—HARDNESS TESTS

low contents of manganese, since the hardness curves parallel the amount of manganese in the samples fairly closely. It is rather remarkable that the steels delivered to Annapolis are consistently and substantially harder than those sent to Watertown (an average difference of 11 Brinell units is recorded in the bars as received).

Torsion

Torsional properties of 1-in. rivet bars are very slightly affected by sulphur up to 0.10, if at all. (See Table V.) Properties are satisfactorily approximated by a straight line, nearly horizontal. Curves for "angle of twist at break" are so jagged that it would be unsafe to draw many conclusions from the pronounced bump at 0.05 to 0.06 per cent sulphur; in fact a smoother

TABLE V—TORSIONAL PROPERTIES OF 1-IN. RIVET BARS

	0.03S	0.06S	0.10S
As received			
Stress at maximum torque	47,500	46,300	45,000
Stress at proportional limit	20,500	20,500	20,500
Angle of twist at break	31	36.5	30
Angle of twist at proportional limit	16.5	14.5	16.5
Annealed at 940 deg. C.			
Stress at maximum torque	43,700	43,300	42,800
Stress at proportional limit	14,200	15,000	16,000
Angle of twist at break	11	24	15
Angle of twist at proportional limit	10	11	12
Quenched from 940 deg. C.			
Stress at maximum torque	56,800	54,000	53,000
Stress at proportional limit	21,000	21,500	22,300
Angle of twist at break	33.5	32.5	29
Angle of twist at proportional limit	18	19.5	17

curve may be had by plotting against manganese content rather than against sulphur.

Static Shear of Rivets and Riveted Joints

In view of the use to which rivets are ordinarily put in structures of magnitude, especial attention should be given to the tests on shearing strength of rivet bars and riveted joints, shown by the committee in Fig. 15, and summarized by the writer in Table VI. Single-shear joints were made by riveting $\frac{5}{8}$-in. chromium-nickel steel plates with rivets from each heat, and then pulled apart in a testing machine; sixteen tests from each heat were made. Similarly ten tests from each heat were made on double-shear joints. None of these joints is sketched in the preprint.

As shown by the curves in Fig. 15, the shearing

TABLE VI—SHEARING STRENGTHS

	1-In. Rivet Bars			5½x1-In. Flats Sheared Along the Grain		
	0.03S	0.06S	0.10S	0.03S	0.06S	0.10S
As received	37,500	36,600	35,600	39,000	38,200	37,000
Annealed at 940 deg. C.	35,000	34,200	33,200	37,800	37,200	36,400
Quenched from 940 deg. C	50,500	47,200	46,700	47,600	46,500	45,000

Riveted Joints

	0.03S	0.06S	0.10S
Single shear	39,200	38,000	36,500
Double shear	37,800	37,200	36,500

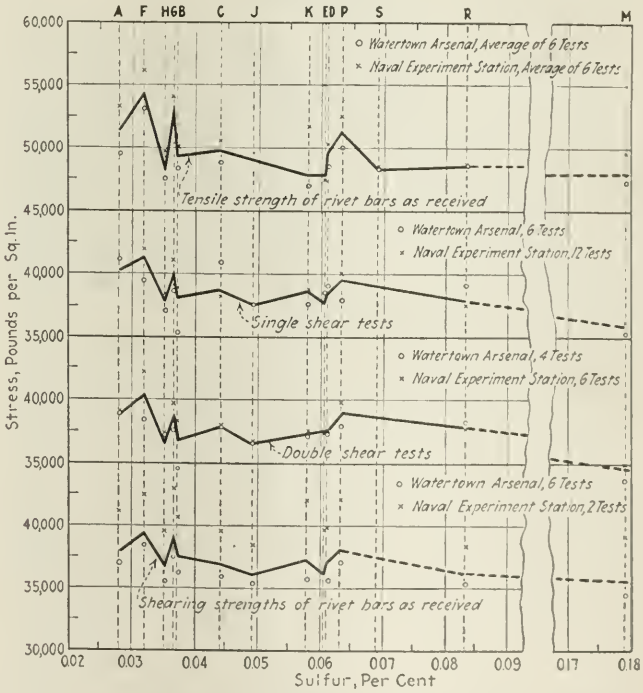


FIG. 15—SHEARING TESTS ON RIVETED JOINTS IN SINGLE AND DOUBLE SHEAR, AND ON THE RIVET BARS AS RECEIVED

strength of the rivet bar as received is almost exactly parallel to those derived from riveted joints. It appears therefore that the normal processes of making and driving a $\frac{15}{16}$-in. rivet does not materially alter the properties as determined in the original bar, as far as shearing strength in the completed joint is concerned, when tested under static loads. We may conclude that:

The static strength of rivets in single- or double-shear is closely approximated by the shearing strength of the rivet bar, and equals 38,200 lb. per sq.in. for basic open-hearth steel containing 0.11 C, 0.43 Mn, 0.01 P and 0.03 S. Each 0.01 per cent sulphur decreases this value 300 lb. per sq.in.

Conclusion

About the only recommendation the committee made in this preliminary report is that a comparative study of the various curves might be useful. Following that suggestion, I have taken the liberty of adding the curve for tensile strength of the rivet bars as received to Fig. 15. It shows that whatever may be the various factors which cause one of these steels to be slightly different from another, they seem to have a net effect on the tensile test, as they have on a rivet driven tightly in place. As far as the static properties of rivet steel are concerned the tensile strength gives as much information as any of the others.

Impact properties, measuring toughness, assuredly should be high in a rivet. Much debate may be had from proponents of certain impact machines, and from opponents of all of them. However that may be, the present series of rivet bars is so balanced in chemical composition, manufacture and treatment that the impact values are not materially lowered until sulphur passes 0.06 per cent. Indeed, indiscreet heating may do ten times as much damage as 0.10 per cent sulphur.

The maximum sulphur now allowed in structural steel rivets (0.045 per cent) is at least 0.01 per cent below the point where sulphur will damage the strength of a well-made rivet steel, as far as its performance can be predicted by known tests.

Crystal Structures of Vanadium, Germanium and Graphite

Albert W. Hull, of the Research Laboratory, General Electric Co., read a paper on the above subject before the recent meeting of the Physical Society at Washington. Vanadium has been analyzed in powdered form by the X-ray diffraction photograph method. Its lattice is a body-centered cube with side 3.04 Angstrom units. The distance between nearest atoms is 2.63 Angstrom units, and the ideal density 5.96.

Germanium is found to have a crystal structure the same as that of diamond. The side of the unit cube is 5.63 Angstrom units, the distance between nearest atoms 1.218 Angstrom units, and the density 5.36.

New and more accurate diffraction patterns of graphite have confirmed the structure described in an earlier paper—viz., a lattice of the hexagonal close-packed type. The measurements cannot be reconciled with the rhombohedral structure found by Debye. The exact distance between nearest planes cannot yet be stated with certainty. Measurements are in progress which, it is hoped, will determine this distance, and whether the three bonds are all in one plane, with the fourth bond at right angles, or whether all four bonds are symmetrically disposed as in diamond.

Production of Platinum and Allied Metals in 1921

Miners report to the United States Geological Survey a production of 538 troy ounces of crude platinum in 1921, distributed by states as follows: California, 387 oz.; Oregon, 83 oz.; Alaska, 65 oz. Refiners report the purchase of domestic crude platinum in the following quantities by states: California, 847 oz.; Oregon, 96 oz.; Alaska, 78 oz. They also report the purchase of 56,654 oz. of foreign crude platinum, of which 55,286 oz. was from Colombia, South America; 63 oz. from Canada, and 1,286 oz. of Russian origin.

Refiners report an increase of over 26 per cent in the recovery of new platinum metals in 1921, as compared with 1920. The greatest increase was in platinum. Of the metals recovered in 1921 by refiners, about 4,800 oz. was obtained from domestic material.

NEW PLATINUM METALS RECOVERED BY REFINERS, IN TROY OUNCES

	Platinum	Palladium	Iridium	Osmiridium	Other	Total
1917	33,009	4,779	210	833	.....	38,831
1918	54,399	4,024	465	539	326	59,753
1919	40,220	3,807	401	403	279	45,109
1920	36,015	4,309	418	409	393	41,544
1921	51,791	2,686	286	581	1,026	56,370

Secondary Platinum

Platinum metals recovered from scrap and other old material form an important part of the supply. The total quantity recovered in 1921, 45,794 oz., is about 20 per cent less than that recovered in 1920,

SECONDARY PLATINUM METALS RECOVERED BY REFINERS, IN TROY OUNCES

	Platinum	Palladium	Iridium	Tota
1917	59,007	3,347	9,832	72,186
1918	40,378	1,795	3,410	45,583
1919	54,545	3,467	3,504	61,516
1920	51,255	3,100	3,355	57,710
1921	39,131	4,887	1,776	45,794

Imports

Refined platinum metals are imported in considerable quantity, as well as crude platinum, which is bought by domestic refiners.

PLATINUM METALS IMPORTED FOR CONSUMPTION IN THE UNITED STATES, 1920-1921

	1920		1921	
	Quantity (Troy Oz.)	Value	Quantity (Troy Oz.)	Value
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire	80,955	$8,474,499	61,941	$4,135,235
Platinum manufactured products, vases, retorts, etc	781	* 94,408	76	† 28,524
Iridium	4,718	726,502	1,345	277,597
Osmiridium	4,473	450,241	2,603	296,277
Osmium	593	39,517	161	13,239
Palladium	6,944	612,248	11,348	629,965
Rhodium	2,053	217,385	609	53,359
Ruthenium	29	2,640	152	4,268
	100,546	10,617,440	78,235	5,438,464

* Includes wire to the value of $5,433 imported under 15 per cent duty, quantity not given, and "all other" to the value of $10,278 imported under 50 per cent duty, quantity not given.

† Includes 13 oz. wire, valued at $14,404, imported under 15 per cent duty, and "all other" to the value of $6,947, quantity not given.

Consumption

The total consumption of platinum metals in the United States in 1921 was 176,148 troy ounces, an increase of about 25 per cent as compared with the consumption in 1920. Dentists and jewelers increased their use of platinum. The consumption of the chemical and electrical industries decreased.

CONSUMPTION OF PLATINUM IN THE UNITED STATES, 1920-1921, BY INDUSTRIES, IN TROY OUNCES

Industry	Platinum	Iridium	Palladium	Total	Percentage of Total
Chemical	12,273	34	45	12,352	7.02
Electrical	20,574	1,003	7,626	29,203	16.58
Dental	13,181	75	8,501	21,757	12.35
Jewelry	101,258	2,367	1,265	104,890	59.55
Miscellaneous	3,791	3,938	217	7,946	4.50
	151,077	7,417	17,654	176,148	100.00

Studies in the Carbonization of Coal: The Mechanism of Coal Carbonization*

Critical Review of Current Theories of Secondary Carbonization Reactions — Interpretation of the Mechanism of Coal Carbonization in the Light of the Composition of a Commercial Low-Temperature Tar — A Theory of the Constitution of Coal

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IN A previous contribution a scheme was outlined for the ready examination of low-temperature coal tar, and by its means the characteristics of a commercial product were determined. Comparison with the composition of low-temperature tars produced on a small scale shows that the commercial tar represents a slightly more advanced stage of carbonization. It is thus possible in the present paper to present a new viewpoint on the much-disputed mechanism of the carbonization of coal, and to interpret distillation reactions in the light of the composition of this intermediate product. Finally, there is proposed briefly a theory of the constitution of coal which explains the composition of low-temperature tars.

Berthelot's classic theory[34] of the origin of ordinary coal tar held the field for many years after it was first advanced in 1866. Acetylene is formed, Berthelot stated, by the decomposition of such simple gases as methane in the volatile products from coal, and polymerizes immediately at high temperatures to form benzene, styrolene, naphthalene and other aromatic hydrocarbons. This theory has been rendered untenable, however, by experiments which have proved (1) that acetylene is not formed in any considerable quantity in the gaseous products of coal distilled at various temperatures, and that its reaction velocity of synthesis is not fast enough to account for this absence;[35] (3) that methane, ethane and propane do not yield acetylene as their principal decomposition products;[36] and (3) that primary distillation products of relatively high molecular weight—i.e., low-temperature tars—are obtained in the carbonization of coal.

All modern theories of carbonization, therefore, acknowledge the important rôle played by low-temperature tars in the distillation of coal. While it is thus generally recognized that ordinary high-temperature (900-1,200 deg. C.) coal tar is formed by the decomposition of tar produced at lower temperatures (500-600 deg. C.), the mechanism of this decomposition[37] is still a matter of lively dispute. No comprehensive scheme has been advanced to account for more than relatively a small number of carbonization phenomena. Investigators in general have confined themselves to limited aspects of the problem, and have sought to lay emphasis upon certain predominating reactions. Thus, the origin of the aromatic hydrocarbons of ordinary tar has been variously attributed to:

(1) Decomposition of the hydrocarbons of low-temperature tar to simple compounds, which subsequently undergo pyrogenetic syntheses (Jones, Bone, *et al.*).

(2) Hydrogenation and dealkylation of the phenols of low-temperature tar (Schulze, Fischer and Schrader).

(3) Dehydrogenation and dealkylation of the unsaturated hydrocarbons of low-temperature tar (Pictet).

The present investigation leads to evidence which supports in general the last two of these conceptions, and hence assigns to pyrogenetic syntheses a part of secondary importance. A brief review of the experimental data underlying these several carbonization theories is a necessary preliminary to the development of a more comprehensive and extended analysis of the phenomena of coal distillation.

THEORIES OF DECOMPOSITION OF LOW-TEMPERATURE HYDROCARBONS

Pyrogenetic Syntheses. Probably the most generally accepted theories of tar formation at present are those which postulate the decomposition of the primary tar to simple unsaturated hydrocarbons that condense subsequently to form aromatic hydrocarbons. Jones[38] states that "the mechanism of the breaking down of low-temperature tar consists essentially in the decomposition of the naphthenes, paraffines and unsaturated hydrocarbons present in the low-temperature tar to form olefines of varying carbon content, which condense at higher temperatures to aromatic substances."

In arriving at this conclusion he passed low-temperature tar[39] slowly through a tube filled with porous porcelain, and examined the gaseous products obtained at various temperatures between 550 and 800 deg. C. He stated that benzenoid hydrocarbons could be formed only to a limited extent[40] by the elimination of hydrogen from the corresponding naphthenes, since members of the cyclohexane series break down principally by a scission of the ring with the formation of olefines, including butadiene, and of paraffines and hydrogen. The gaseous olefines were found to be at a maximum at 550 deg., and almost disappeared at 750 deg. This

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[34]Berthelot, *Ann. chim. phys.* [3], vol. 67, p. 53 (1863); [4], vol. 9, pp. 413, 455 (1866); [4], vol. 12, pp. 5, 122 (1867); [4], vol. 16, pp. 143, 148, 153, 162 (1869).

[35]M. J. Burgess and R. V. Wheeler, *J. Chem. Soc.*, vol. 97, p. 1917 (1910); vol. 99, p. 649 (1911); vol. 105, p. 131 (1914); A. H. Clark and R. V. Wheeler, *ibid.*, vol. 103, p. 1704 (1913).

[36]T. E. Thorpe and J. Young, *Proc. Roy. Soc.*, vol. 21, p. 184 (1873); H. E. Armstrong and A. K. Miller, *J. Chem. Soc.*, vol. 49, p. 74 (1886); F. Haber, *Ber.*, vol. 29, p. 2691 (1896); W. A. Bone and H. F. Coward, *J. Chem. Soc.*, vol. 93, p. 1197 (1908).

[37]*Cf.* the analogous process of decomposition of the bitumen of shale to yield oil on distillation, R. H. McKee and E. E. Lyder, *J. Ind. Eng. Chem.*, vol. 13, pp. 613, 678 (1921); Arthur J. Franks, CHEM. & MET. ENG., vol. 25, pp. 731, 778 (1921); C. W. Botkin, *ibid.*, vol. 24, p. 876 (1921); L. C. Karrick, *Chem. Age* (N. Y.), vol. 30, p. 112 (1922).

[38]D. T. Jones, *J. Soc. Chem. Ind.*, vol. 36, p. 3 (1917).

[39]D. T. Jones and R. V. Wheeler, *J. Chem. Soc.*, vol. 105, p. 140 (1914).

[40]D. T. Jones, *J. Chem. Soc.*, vol. 107, p. 1582 (1915).

disappearance synchronized with the appearance of naphthalene, and immediately preceded a rapid increase in the evolution of hydrogen, which "must probably be attributed to the union of the aromatic molecules and to intramolecular ring closing."

Jones quotes the work of Staudinger[41] as an example of the polymerization of diolefines to aromatic substances. Moreover, Staudinger identified butadiene in the gas distilled from coal. Instances of its formation also from naphthenes, olefines, saturated hydrocarbons and petroleum vapors from cracking stills are also cited. "It is highly probable," Jones concludes, "that a necessary transition stage is the formation and condensation of olefines containing the conjugated double linkage —CH: CH. CH: CH— . Polynuclear aromatic substances are formed at 750 deg. and upward subsequent to the decomposition of the olefines." Jones, contrary to Pictet, regards phenols as primary products of coal distillation, "those of high-temperature tar being formed with certain changes from those of low-temperature tar. Much of the high-temperature pitch is formed by partial carbonization of the low-temperature pitch."

Bone,[42] from a study[43] of the behavior of the simple hydrocarbons at temperatures between 500 and 1,200 deg. C., has elaborated this theory of olefine condensations. He introduces the new conception that the thermal decomposition of the hydrocarbons of low-temperature tar "involves the *primary* formation by dehydrogenation of the unsaturated residues CH_2 (two free bonds) and CH (three free bonds), which during a fugitive but really independent existence are free to interact with the surrounding gaseous medium after their kind." Bone points out that the most favorable temperature range for aromatic formations from such residues (500-800 deg.) coincides with that giving the best yields of benzene and its homologs and is well below that which is most favorable to the hydrogenation of the residues to methane. Between 500 and 800 deg. "ethylene is, by reason of its rapid production of CH residues (three free bonds) during its primary decomposition, eminently capable of generating aromatic nuclei, although to a less marked degree than in the case of acetylene. On the other hand, ethane, which primarily produces CH_2 residues (two free bonds) only, does not form aromatic nuclei so readily as does ethylene."

Another variation of the olefine theory is advocated by Whitaker and Crowell,[44] who distilled coal in 5-lb. charges at different temperatures, and examined the liquid and gaseous products of carbonization. They suggest that the course of reactions in coal carbonization is as follows: "Solid coal→high molecular weight paraffines→low molecular weight paraffines; olefines→ acetylenes, naphthenes and polycyclic compounds→ benzene and its homologs→higher homologs of benzene →xylene→toluene→benzene, etc." Attention was directed to the apparent marked similarity between this series of decompositions and those postulated[45] for oil cracking. A somewhat similar sequence of coal reactions has recently been advanced by Wigersma.[46]

Theory of the Decomposition of Low-Temperature Phenols

The investigators whose work has been reviewed thus far have paid scant attention to the rôle of the phenols in secondary decompositions. In 1885 Schulze,[47] on the occasion of his pioneer investigation of the naphthols of ordinary coal tar, stated that coal is essentially altered cellulose and that its primary decomposition products are the phenols. The phenols on further heating (1) eliminate water to synthesize high-boiling hydrocarbons; (2) are partly reduced to low-boiling hydrocarbons; (3) are decomposed to form gases; or (4) escape unchanged. These reactions were conceived as progressing simultaneously and in equilibrium with each other. So strong was the influence of Berthelot's theory at that time, however, that Schulze made his propositions simply to supplement rather than to displace the acetylene hypothesis.

Very recently Fischer and Schrader[48] have also assigned to the phenols a part of major importance. They point out that low-temperature tars consist essentially of hydrocarbons similar to those of petroleum and of phenols, but contain no aromatic hydrocarbons. The benzene homologs in high-temperature coal tar must be formed from these phenols, they conclude, since the hydrocarbons can be converted into aromatics only to a slight extent. In support of this view experiments are cited on the decomposition of cresols and xylenols when passed through tinned tubes heated to 750 deg. in an atmosphere of hydrogen. The phenols were reduced to benzene homologs, and these in turn yielded some benzene. Thus, according to these authors' theories of the decomposition of low-temperature tar in coal carbonization, the aliphatic hydrocarbons are broken down into gases, while the hydroaromatic hydrocarbons are in part dehydrogenated and in part changed into gaseous hydrocarbons. A small portion of the phenols of the low-temperature tar remain unchanged, but most of them are reduced to such stable hydrocarbons as benzene, or take part in syntheses of napthalene, anthracene and other aromatics.

Theory of Dehydrogenation and Dealkylation

Pictet[49] passed "vacuum tar" through a red-hot tube filled with pieces of coke, and obtained the typical products of high-temperature distillation. He concluded that the hydroaromatic hydrocarbons of vacuum tar underwent dehydrogenation and detachment of side-chains to yield aromatic hydrocarbons and the large quantity of hydrogen and methane homologs characteristic of high-temperature gases. This theory is supported by the known tendency of aromatic hydrides to lose a part of their hydrogen, by the occasional presence in ordinary tar of small quantities of hydroaromatic hydrocarbons, and by the fact that the cracking of naphthenic petrols yields a certain quantity of aromatic hydrocarbons. Since cyclohexane on cracking yields little benzene, and tends rather to break the ring with the formation of unsaturated aliphatic compounds, the cyclanes of coal, Pictet states, cannot have

[41] H. Staudinger, R. Endle and J. Herold, *Ber.*, vol. 46, p. 2466 (1913).
[42] W. A. Bone, "Coal and Its Scientific Uses" (London, 1918), p. 143 *et seq.*
[43] W. A. Bone and H. F. Coward, *J. Chem. Soc.*, vol. 93, p. 1197 (1908).
[44] M. C. Whitaker and W. H. Crowell, *J. Ind. Eng. Chem.*, vol. 9, p. 261 (1917).
[45] *Cf.* publications by Rittman, Zanetti, Egloff, Leslie *et al.* in *J. Ind. Eng. Chem.* A very extensive review of the literature to 1916 on the pyrogenesis of hydrocarbons is given by E. L. Lomax, A. F. Dunstan and F. B. Thole, *J. Inst. Pet. Tech.*, vol. 3, p. 36 (1916); *cf.* W. Gluud, *Ges. Abhandl.*, vol. 2, p. 261 (1917).
[46] B. Wigersma, *Chem. Weekblad*, vol. 16, p. 1356 (1919).
[47] K. E. Schulze, *Lieb. Ann.*, vol. 227, p. 143 (1885).
[48] F. Fischer and H. Schrader, *Brennstoff Chem.*, vol. 1, pp. 4, 22 (1920); vol. 2, p. 37 (1921).
[49] A. Pictet, *Ann. chim.* [9], vol. 10, p. 322 (1918).

contributed largely to the formation of benzene and its homologs.

It is the unsaturated cyclic hydrocarbons, he argues, which are present in much larger quantity, and which are hence the principal source of the benzene hydrocarbons of ordinary tar. Certain of the polycyclic hydrocarbons, such as fluorene, also owe their existence to simple dehydrogenation, since hexahydrofluorene was found in "vacuum tar." The origin of naphthalene and anthracene was regarded as still obscure, however, since no hydrogenated derivative of either of these was found in "vacuum tar" or in the benzene extract of coal.

Limitations of Experimental Methods in Carbonization Studies

It is desired to call attention at this point to certain conditions which complicate the study of carbonization reactions. Aside from such factors of prime importance as temperature and pressure, the course which these reactions take depends upon the relative concentrations of the reacting substances, and hence the nature of the coal carbonized, and upon the path of travel of the gases in the oven.[50]

Coals of oxygen content lower than normally used in commercial carbonization practice have been employed by some observers, who consequently lost sight of the effect which the higher phenol concentration would have in the formation of the typical aromatic hydrocarbons of ordinary tar. Carbonization reactions occur simultaneously, and represent complex equilibria, the individual factors of which are difficult to divorce from one another for separate investigation. When experiments on the decomposition of isolated hydrocarbons are quoted, translation of such results to commercial conditions is obviously open to question. The strongly reducing atmosphere of coke ovens and gas retorts is a factor that too often has been ignored in pyrogenetic assumptions. Thus it has been shown[51] that at 550 deg. benzene in an atmosphere of nitrogen readily loses hydrogen with the formation of diphenyl, but in the presence of an excess of hydrogen yields only traces of diphenyl. Toluene carried through coke in a stream of nitrogen at 750 deg. yields naphthalene, anthracene and a viscous black liquid. On the other hand, the substitution of hydrogen for nitrogen greatly accelerates the decomposition of the toluene, and produces large amounts of benzene and only a small quantity of solid condensate.

Attention is directed also to the difference in the results obtained in small-scale experiments and in commercial operation. For example, when 2-g. samples of coal are distilled[52] under a high vacuum in a platinum tube, there is obtained a maximum yield of tar at 750 deg., which is nearly four times that recovered at 450 deg. It is a well-known fact, on the other hand, that the yield of low-temperature tars on a commercial scale is about double that of ordinary high-temperature tars.

Again, Jones[38] decomposed 0.1-g. samples of low-temperature tar in a glass tube filled with porous porcelain, and based much of his theory of carbonization reactions on the analysis of the gases obtained at different temperatures. If comparison is made of these results with the gas analyses of Thau,[53] who distilled coal in a commercial coke oven over the same range of temperatures, striking differences are at once manifest. The sudden increases in the evolution of hydrogen and of methane synchronizing with the disappearance of olefines and the appearance of aromatics noted by Jones is not apparent in the coke-oven analyses. As an example of the influence of retorting conditions, Thau found as a result of superheating the upper part of his coke oven that the hot surfaces of carbon were much more effective in causing decomposition than were the retort walls.

Interpretation of Carbonization Reactions in Terms of the Present Investigation

The low-temperature tar studied in the present investigation represents a stage of carbonization slightly more advanced than that which gave rise to the vacuum tars investigated by Pictet and by Jones and Wheeler. It was produced by the Carbocoal process[54] in a commercial retort that afforded an opportunity for secondary reactions to take place to a limited extent. Thus the distillation vapors came into contact with the retort shell heated to about 600 deg., and yielded a product that is distinguished from these true low-temperature tars by (1) a slight decrease in the quantity of total phenols and a marked increase in the proportion of low-boiling phenols; (2) the appearance of a large percentage of tertiary nitrogen bases; and (3) a notable increase in the ratio of unsaturated to saturated hydrocarbons.

The Decomposition of Low-Temperature Phenols During Carbonization

A true low-temperature tar contains about ten times the quantity of phenols that appears ultimately in the high-temperature tar. Thus, a 30 per cent volatile coal produces a primary tar containing about one-quarter its weight of phenols, and yields in the coke oven about half this weight of tar containing less than 5 per cent of phenols. The low-temperature phenols consist principally of the higher homologs. High-temperature phenols, on the other hand, contain about two parts of cresols to one of phenol, together with a relatively insignificant proportion of higher-boiling tar-acids. It is thus apparent that while the phenolic components of the primary tar contribute very largely to the formation of secondary products, only a small part of them survive as phenols, and then chiefly as the first members of the series.

The low-temperature phenols, as would be expected, occupy a position intermediate between the extreme low-temperature type and the phenols of ordinary tar. The phenols obtained[55] by steam distillation of a Lohberg gas coal at a temperature slightly lower than that in the case of the low-temperature phenols exceeded the latter in total quantity. The fraction of Lohberg phenols distilling below 230 deg. constituted only 7 per cent of the total weight, while the corresponding fraction of low-temperature phenols amounted to 57 per cent. It thus becomes evident that the first stage in the decomposition of the primary phenols is one which involves principally the elimination of the multiple short sidechains of the higher homologs. This reaction

[50] *Cf.* G. E. Foxwell, *J. Soc. Chem. Ind.*, vol. 40, pp. 193T, 220T (1921).
[51] J. W. Cobb and S. F. Dufton, *Chem. Trade J.*, vol. 63, p. 197 (1918); *Gas World*, vol. 69, p. 127 (1918); *Gas. J.*, vol. 143, p. 482 (1918).
[52] M. J. Burgess and R. V. Wheeler, *J. Chem. Soc.*, vol. 97, p. 1917 (1910); vol. 99, p. 649 (1911); vol. 105, p. 131 (1914).
[53] O. Thau, *Brennstoff Chem.*, vol. 1, pp. 52, 66 (1920).
[54] *Cf.* J. J. Morgan and R. P. Soule (in the first division of this paper) for a description of the conditions of carbonization in the Carbocoal process.
[55] F. Fischer, *Brennstoff Chem.*, vol. 1, pp. 31, 47 (1920).

is probably accomplished by the replacement of the methyl or ethyl groups by hydrogen from the retort gases, with the formation of methane or ethane.

Again, when low-temperature phenols are passed through a tinned tube at 750 deg. in an atmosphere of hydrogen, there are obtained[48] low-boiling phenols and hydrocarbons, together with water. Higher temperatures, therefore, must eliminate the hydroxyl groups also, and the predominating reaction then becomes hydrogenation with the production of water. Moreover, cresol when passed over coke at 750 deg. in a stream of hydrogen yields benzene and toluene.[51]

The present investigation has shown that the low-temperature phenols contain about 10 per cent of naphthol derivatives. The hydrogenation of these with elimination of water is obviously one source of the naphthalene of high-temperature tar.

If the decomposition of the primary, monocyclic phenols were confined to such hydrogenation reactions, however, there would result in high-temperature tar a much higher yield of light oils and solvent naphtha than is actually the case. Experiment has shown[51] that monocyclic aromatic hydrocarbons also undergo the same reaction—e.g., xylene is converted into toluene, and toluene is converted into benzene, with the simultaneous formation of a small amount of solid condensate. Thus it was found[44] that the temperatures of maximum formation of xylene, toluene and benzene are respectively 600, 700 and 800 deg., and that the total quantity of light oil formed decreases steadily as the temperature of carbonization is increased above 500 deg. The limited quantity of benzene itself occurring in high-temperature tar, however, makes it necessary to conclude that in addition to the reactions enumerated, a portion of the benzene participates in pyrogenetic syntheses. It is possible also that some of the phenols sustain scission of the ring and are lost from the tar as gases, or, as Fischer and Schrader[48] suggest, condense to form polycyclic aromatic hydrocarbons. However this may be, it is nevertheless evident that the phenols are the chief source of the monocyclic aromatic hydrocarbons.

The Decomposition of the Nitrogen Bases During Carbonization

Since a considerable quantity of the nitrogen bases of low-temperature tars remains after distillation in the pitch, it is difficult to determine whether the total quantity is greater or less than in ordinary tar. It was found,[56] however, that the percentage of bases (3.42 per cent) boiling under 326 deg. in a mixture of coke-oven and gas-works tar was nearly double that (1.94 per cent) of the low-temperature tar. It is probable, therefore, that low-boiling bases are formed from high-boiling bases in a manner analogous to the decomposition of the high-boiling phenols.

Pictet's suggestion[49] that quinoline is formed from dihydroquinoline by simple dehydrogenation seems to be the most rational explanation of the primary decompositions of the low-temperature bases. Secondary bases of the type of dihydroquinoline are found in "vacuum tar," but tertiary bases are absent. The fact that 80 per cent of the low-temperature bases and almost all of the high-temperature bases are tertiary compounds supports this theory of dehydrogenation.

Experiments with the low-temperature bases demonstrated the presence of unsaturated bases, the relative molecular weights[57] of which average 10 to 15 higher (Fig. 12) than the values of the corresponding high-temperature compounds. At higher temperatures (700 to 800 deg.), therefore, a process of combined dehydrogenation and dealkylation must take place to yield the ordinary bases such as quinoline and acridine. Moreover, the toluidines described by Pictet then yield the aniline of ordinary tar just as it has been shown that cresol yields phenol, and toluene yields benzene.

The low-temperature distillate was shown to contain no preponderating base, but to represent a series of

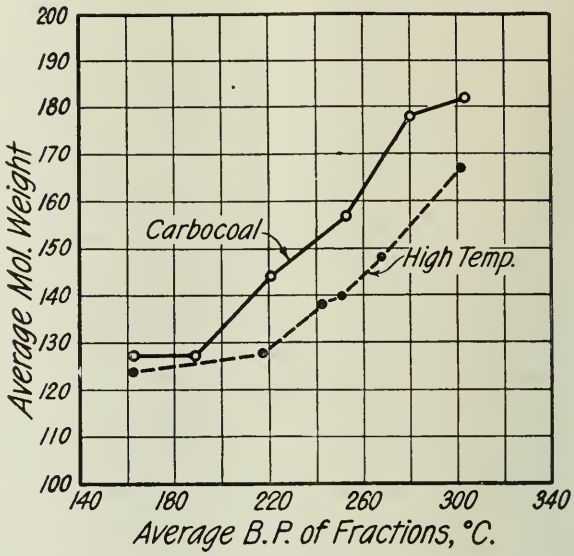

FIG. 12—AVERAGE MOLECULAR WEIGHTS OF BASES

compounds of increasing molecular weight. The distillation curves of Fig. 13 emphasize the preponderance of quinoline in the high-temperature bases, and indicate, if this theory is accepted, that the bulk of the middle-boiling bases of low-temperature tar are structural derivatives of quinoline, and yield this compound upon decomposition at the temperature of the coke oven. The physical constants obtained are consistent with this observation, and dehydroquinoline has been identified in "vacuum tar."

The Decomposition of the Hydrocarbons During Carbonization

The ratio of saturated to unsaturated hydrocarbons is highest in the tars produced under high vacuum at the lowest temperatures. Thus the saturated hydrocarbons obtained by Jones and Wheeler were about equal in quantity to the non-saturated, while in low-temperature tar they formed only one-third of the distillate and a much smaller fraction of the entire tar. The obvious conclusion, therefore, is that the initial decomposition of the primary hydrocarbons is characterized by a partial dehydrogenation of the naphthenes to form hydroaromatics.

As mentioned above, Jones[40] was led to believe from his experience in the decomposition of cyclohexane, methylcyclohexane and the di- and tetrahydro-derivatives of naphthalene that the naphthenes cannot be regarded as the direct source of the high-temperature aromatic hydrocarbons through simple dehydrogena-

[44] See first paper in this series.

[57] Only relative values are given by the ordinary Beckmann cryoscopic method, since nitrogen bases are slightly associated in benzene solution.

tion and dealkylation. The large yields obtained of both the corresponding aromatic hydrocarbon and hydrogen were explained on the basis that "the most probable course of the reaction would be for the cyclohexane first to lose two atoms of hydrogen and form cyclohexene, which then decomposes in two ways, yielding benzene and butadiene." The principal reaction and the one contributing most largely to aromatic formation was held to be the condensation of such conjugated unsaturated nuclei as the butadiene represents. These nuclei are stated to result in the distillation of coal from the decomposition of the paraffines, the naphthenes and the unsaturated hydrocarbons of low-temperature tar.

Results in the low-temperature investigation, on the contrary, lead to the contention that while the elimination of hydrogen from the naphthenes of the primary low-temperature tar is the initial step in the decomposition reactions, the intermediate di- and tetra-hydroderivatives thus formed constitute a distinct and comparatively stable stage in the carbonization of coal. Consistent with his theory Jones considered these compounds to be partly olefinic. Pictet, on the other hand, identified them as unsaturated naphthenes, and advanced the rational hypothesis that the origin of the aromatics lay in a process of dehydrogenation of the aromatic hydrides and of detachment of sidechains from alkyl derivatives. The composition of the low-temperature hydrocarbons has been shown[56] to conform with this hypothesis of Pictet and to be consistent with all the experimental facts upon which Jones bases his interpretation.

The Origin of Naphthalene in Coal Tars

The bulk of the unsaturated hydrocarbons of low-temperature tars are polycyclic. While some of the naphthalene of ordinary tar results from the hydro-

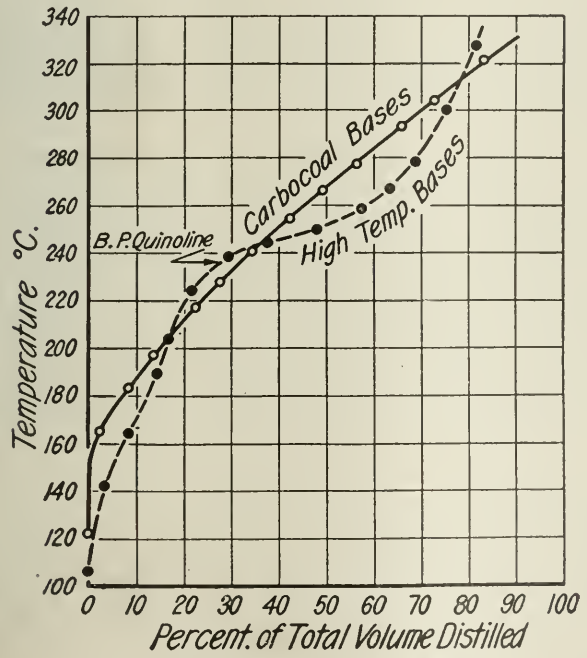

FIG. 13—DISTILLATION OF BASES

genation of naphthols, it is believed that the naphthalene and other polynuclear aromatic hydrocarbons owe their origin chiefly to the decomposition of these polycyclic unsaturated compounds. The presence of a series of homologs of hydrogenated and alkylated bicyclic hydrocarbons is indicated in low-temperature tar by the physical and chemical properties. For example, the average molecular weights[58] of the middle-boiling fractions (Fig. 14) are notably higher than that of naphthalene. Fig. 15 shows that the secondary reactions giving rise to high-temperature tar decompose these bicyclic hydrocarbons to the single stable naph-

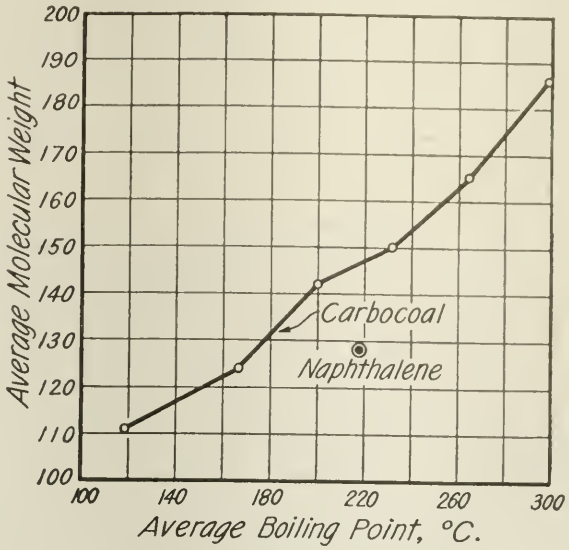

FIG. 14—MOLECULAR WEIGHTS OF NON-SATURATED HYDROCARBONS

thalene nucleus, the presence of which in large quantity is one of the outstanding features of ordinary tar. The analogy between naphthalene and quinoline in chemical structure makes more striking the similarity between the carbonization reactions of the hydrocarbons and nitrogen bases.

A Theory of the Cyclic Structure of Coal

Probably the most remarkable general characteristic of low-temperature tars is the fact that they are almost entirely cyclic in nature. So far as the various compounds have been identified, moreover, these cycles have shown themselves to be six-membered rings or combinations of six-membered rings. This structural characteristic apparently persists in the tar as the temperature of distillation of the coal is increased.

It seems reasonable, therefore, in view of the great stability of the six-membered ring, to ask if this structure is not characteristic also of the coal substance itself. Such a conception is contrary, of course, to the widely accepted cellulose-furane theory.[59] Fischer and Schrader[60] have recently stated that the plant cellulose is destroyed by bacterial activity in the early stages of peat formation, and pointed out, moreover, that while cellulose yields on decomposition almost exclusively phenol itself, low-temperature tars contain chiefly the higher homologs of phenol. In the absence of cellulose the lignin must hence be the source of the phenols of coal tar.

The cyclic structure of lignin has been advocated by these authors, who assign to it an aromatic configura-

[58] Determined in benzene solution by the Beckmann cryoscopic method.

[59] D. T. Jones and R. V. Wheeler, *J. Chem. Soc.*, vol. 105, pp. 110, 2562 (1914); vol. 107, p. 1318 (1915); vol. 109, p. 707 (1916); *cf.* also "Monograph on the Constitution of Coal," by M. C. Stopes and R. V. Wheeler (London, Dept. Sci. and Ind. research, H. M. Stationery Off.) for an exhaustive review of the knowledge on this subject in 1918.

[60] F. Fischer and H. Schrader, *Brennstoff Chem.*, vol. 2, p. 37 (1921); *cf.* Klever, Jonas and Keppeler, *ibid.*, vol. 2, p. 213 (1921), and Fischer and Schrader, *ibid.*, vol. 2, p. 237 (1921).

tion with acetyl and methoxyl groups. During coal formation the methoxyl content must eventually decrease through saponification, reduction or replacement by hydroxyl groups. In any case there results a phenol, which is considered identical with humic acid. Oxidation or polymerization of humic acid forms the alkali-insoluble humin. Further splitting off of water, carbon dioxide and perhaps methane at ordinary temperature, these authors argue, leads to lignite and coal. The whole series is thus assumed to perpetuate the aromatic structure of lignin. The production of large amounts of mellitic acid by the pressure oxidation of charcoal and ordinary coals (but not of cellulose) is contributory evidence of the presence of six-membered cycles in coal.

The present investigation leads to the suggestion, therefore, that the chemical properties of coal may be represented by a structure containing many such cycles. This structure may be pictured as an aggregate of "mosaics" of these rings. Some of the "mosaics" contain oxygen, and display the insolubility characteristic of the "cellulosic degradation products,"[59] or, according to Fischer and Schrader, the "lignin degradation products." These may be regarded as polymerized phenols, as suggested above, or as multi-molecular structures in which component rings are joined together by oxygen-containing bridges. Heating results in the breaking of these bridges with the formation of high-boiling phenols, the sidechains of which are remnants of other broken linkages.

Similarly, other "mosaics" may be pictured to represent the same typical rings held together by bridges of paraffine hydrocarbons, the breaking or detachment

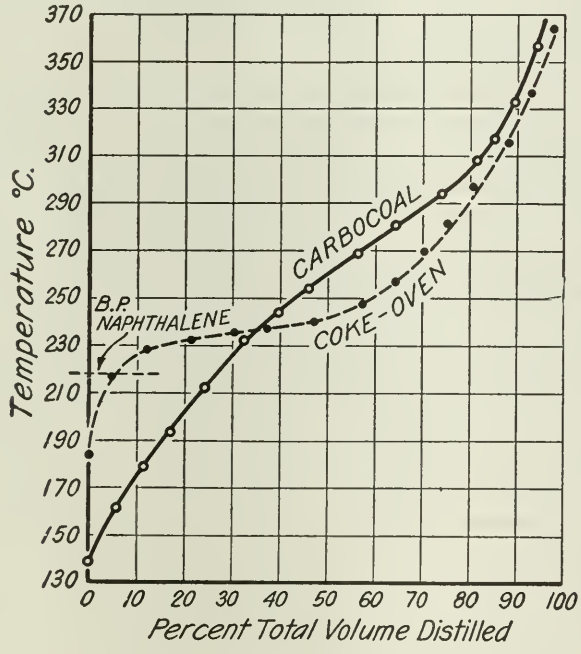

FIG. 15—DISTILLATION OF HYDROCARBONS

of which are responsible for the presence of straight-chain hydrocarbons in low-temperature tars,[61] or even in seams of the coal deposits themselves. These structures are more soluble, and have been called the "resinous constituents."[59] Nitrogen and sulphur compounds may be regarded as appearing in strictly analogous configurations.

[61] *Cf.* the "bound molecules" of Jones and Wheeler (Ref. 59).

Summary of the Mechanism of Coal Carbonization

(1) The decomposition of the coal substance to ordinary high-temperature tar when subjected to the action of heat is a process of progressive, step-by-step decomposition, in which pyrogenetic syntheses play only a secondary part.

(2) Six-membered rings and combinations thereof characterize the entire series of decomposition products from coal to high-temperature tar. The decompositions during carbonization are essentially reactions effecting the elimination of sidechains.

(3) The average molecular weights of the liquid intermediate products constantly decrease as the temperature of carbonization rises. This decrease is marked by the evolution of hydrogen, methane and ethane.

(4) The initial decomposition of the low-temperature tar first formed is brought about by (*a*) loss of hydrogen from a portion of the naphthenes with a resultant increase in the proportion of unsaturated hydrocarbons; (*b*) loss of sidechains from the phenols by hydrogenation with the resultant formation of lower-boiling phenols; and (*c*) loss of hydrogen from the nitrogen bases to form a large proportion of tertiary compounds. (This stage is represented by Carbocoal tar.)

(5) Final decompositions are at a maximum between 700 and 800 deg., and are marked by (*a*) dehydrogenation and dealkylation of the hydroaromatic unsaturated hydrocarbons and nitrogen bases to form aromatics, with the elimination of hydrogen, methane and other simple gases; (*b*) hydrogenation of the phenols to aromatic hydrocarbons and of these aromatic hydrocarbons to lower-boiling aromatics, with the formation of methane, ethane and water; and (*c*) secondary pyrogenetic syntheses of higher aromatics from simple compounds.

(6) The phenols of low-temperature tar are the principal source of the monocyclic aromatic hydrocarbons. The unsaturated naphthenes of low-temperature tar are the principal source of the polycyclic aromatic hydrocarbons.

Status of Steel Industry in South Africa

Up to the close of the year 1921 the exhaustive plans of the South African Iron & Steel Corporation had not yet materialized and the productive equipment had not reached beyond that acquired from the Pretoria Iron Works, says a special report to the Iron and Steel Division of the Department of Commerce, from Consul Pisar, Cape Town. Over two-thirds of the authorized capital of £1,500,000 remained unsubscribed, and in view of the depression prevailing at present throughout South Africa there appears to be little hope that the great iron and steel industry planned by the promoters will become a reality in the very near future. Efforts to get capital in other countries have not been successful. Quite recently the corporation's properties were visited by English steel experts who expressed themselves as favorably impressed with the prospects of this venture. Until economic conditions throughout the world become stabilized and the corporation can obtain the necessary capital and produce steel on a competitive basis, no material results can be expected.

The operations of all the steel mills in South Africa resulted in a production of 21,988 tons of steel goods in 1921. The industry gave employment to an average number of 285 white men and 866 colored laborers.

Application of Electrical Precipitation to the Wood-Distillation Process*

Tests on Experimental Wood-Distillation Retort Indicate the Possibility of Precipitating the Tar From the Hot Vapors by Means of a Cottrell Precipitator, Thus Reducing the Amount of Soluble Tar in the Pyroligneous Acid to a Point Where Direct Neutralization Is Feasible

By L. F. HAWLEY† and H. M. PIER‡

IN THE commercial distillation of hardwood for the preparation of wood alcohol and acetate of lime the first operation after the distillation of the wood and the condensation of the liquid products consists in the distillation of the pyroligneous acid for the purpose of separating the tar which is dissolved in the acid. The distilled acid is then neutralized with lime, distilled to remove the alcohol, and evaporated in order to obtain the acetate of lime. If the pyroligneous acid were not distilled before neutralizing with lime, much of the tar in solution in the crude acid would stay in solution after neutralization and, therefore, contaminate the acetate of lime. The so-called dissolved tar which is removed from the pyroligneous acid by distilling off the acid is not a tar like the settled tar consisting of oils and pitch, but is really a pitch containing very small proportions of oil, soluble in the pyroligneous acid on account of the presence of acetic acid and methanol.

Preventing Formation of Soluble Tar

Since this contaminating pitch or tar is non-volatile, it must be carried over from the retort to the condenser in the form of a fog or mist consisting of very fine drops of liquid pitch. Attempts have been made to prevent this pitch from reaching the condenser by interposing baffle plates and other mechanical devices between the retort and the condenser, but without success.

Since the Cottrell precipitator is able to precipitate fine particles of liquid or solid when carried in a stream of gas or vapor, it was thought that it could stop the non-volatile portion of the wood distillate before it reaches the condenser. In order to try out this idea a few tests were made at the Forest Products Laboratory at Madison, Wis., with a small Cottrell precipitator by treating the gases from the experimental retort, in which 50 to 60 lb. of wood is distilled per charge. The Cottrell precipitator was connected between this retort and the condenser.

Description of Apparatus

The precipitator, as shown in Fig. 1, consisted of a three-pipe unit contained in a shell made of 6-in. wrought-iron pipe and fittings. The collecting electrodes consisted of three pipes of light sheet steel, 2 in. in diameter and 24 in. long. The discharge electrodes, which hung through the central axis of the pipes, consisted of small chains, weighted at the bottom to keep them taut. The chains were later replaced by roughened $\frac{1}{8}$-in. rods. The discharge electrodes were hung from a plate above the tubes and were spaced in proper position by means of a spacer-frame below the tubes. The top plate was carried on a pipe which extended through the insulator at the top of the precipitator. As indicated in Fig. 1, this insulator served as the support for the discharge electrodes as well as an inlet bushing, and was the only electrical insulation used.

The path of the gases can be readily seen in Fig. 1. The raw gases from the retort entered the precipitator at a point just under the header plate, passed downward around the outside of the tubes, in order to insure equal distribution, and finally up through the tubes, where the tar was removed by the electrical action.[1] The cleaned gas passed from the precipitator to the condenser through a 2-in. pipe as shown.

Since the precipitator was fairly large in comparison with the size of the retort and since it, therefore, afforded a large surface for heat radiation and condensation, it was decided to prevent this condensation by lagging the precipitator and to hold the temperature at the desired point by means of external heat.

The electrical equipment used for providing the unidirectional high-voltage current for use in the precipitator is shown in Fig. 2, and consisted of a synchronous induction motor which drove a mechanical rectifier, a special high-voltage transformer and auxiliary apparatus such as switches, meters, rheostats, etc. The power supply was 110 volt, 60-cycle alternating current. This was stepped up to 220 volts by means of an autotransformer; the special high-voltage transformer raised the 220-volt current to the voltage desired (10,000 to 15,000 volts). This high-voltage current was then rectified to unidirectional current by means of the mechanical rectifier, which is practically a synchronously driven switch. The electrical connections between the various items of the equipment are shown in Fig. 3.

Defects in Experimental Apparatus

As is the case with any small-scale apparatus, there were a few inherent defects in the design of this experimental precipitator, all of which are readily eliminated in larger or commercial installations. The discharge electrodes first used in these experiments were chains hung from the top spacer-plate. As soon as the high-voltage power was applied to the precipitator, these chains showed a tendency to swing due to the electrical stresses set up and the electrical windage. These swinging chains, weighted at the bottom, acted as pendulums, and it was impossible to stop the swinging except by ceasing operations. As soon as the chains

*Presented before the American Chemical Society at Rochester, April 27, 1921.

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‡Research Corporation, Chicago, Ill.

[1]The theory of electrical precipitation has been discussed so frequently in various publications that it was not deemed necessary to repeat it in this article.

started to swing, the proper gap distance between them and the pipes was not maintained and serious disruptive arcing took place, thereby destroying the efficiency of precipitation. In order to eliminate this trouble, the chains were replaced with discharge electrodes made of ⅛-in. rods roughened to give points for electrical discharge. This eliminated the swinging, but it also meant the use of an electrode less satisfactory from the viewpoint of electrical discharge. In a commercial installation consisting of a greater number of pipes of larger size, it is a simple matter to install a rigid electrode system and still have the benefit of the superior discharge from chains.

Another difficulty encountered with this test precipitator was electrical insulation. As can be seen from the sketch of the precipitator, Fig. 1, the insulation was more or less in the path of the gas flow, with the result that any small amount of tar, oil or other material that passed through the pipes had a tendency to adhere to the rough surface of the fused silica and thus create a path for the leakage of electrical power. Several runs were characterized by insulation trouble, with a resultant loss of efficiency. In larger precipitators this is readily eliminated by installing all insulation in separate compartments entirely removed from the gas stream, thereby keeping the insulators clean at all times.

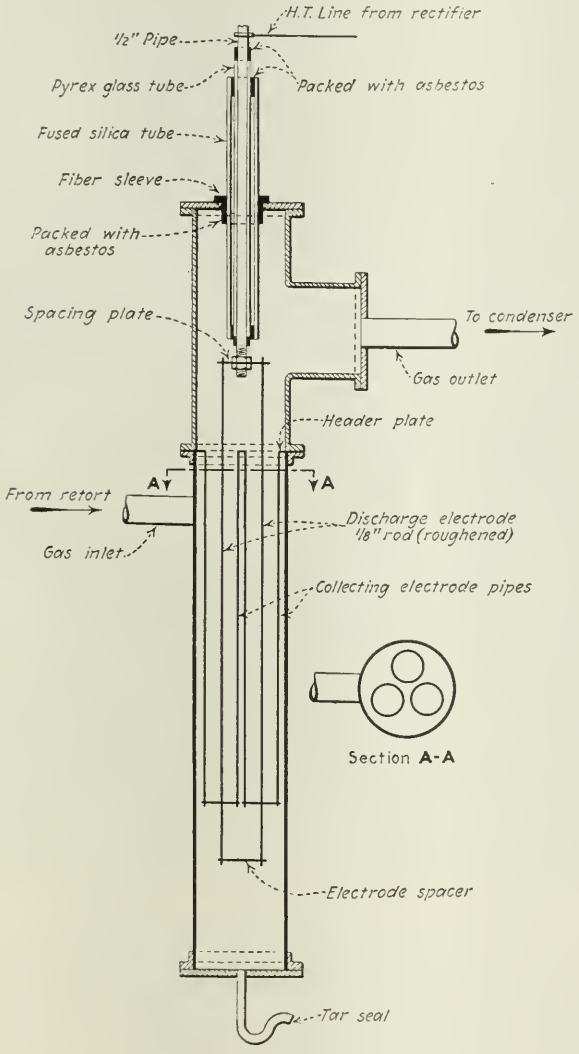


FIG. 1—TEST PRECIPITATOR FOR TAR

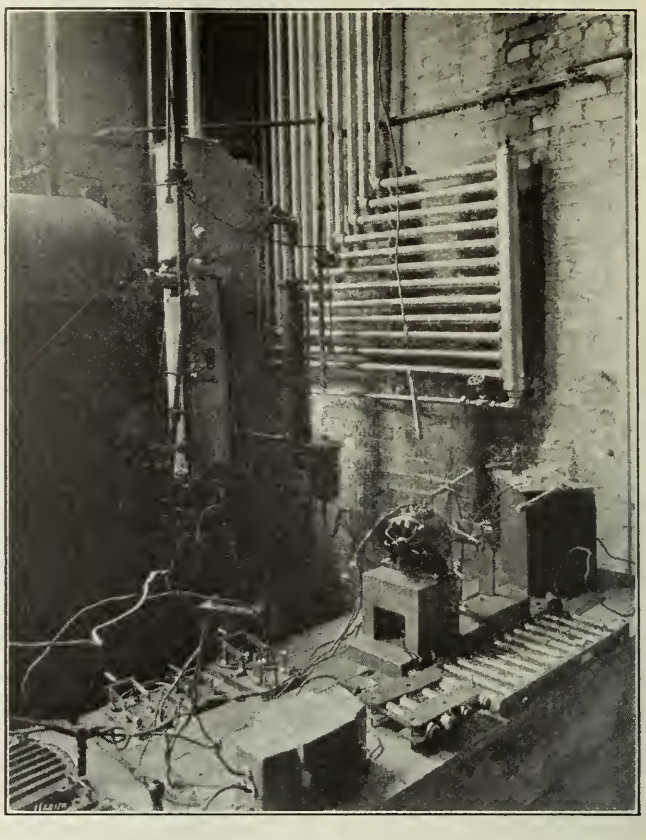


FIG. 2—COTTRELL PRECIPITATOR IN USE WITH WOOD-DISTILLATION RETORT

Tar Precipitated as Liquid Under Proper Temperature Conditions

During the first two runs the precipitator was heated to give the vapors at the outlet from the precipitator a temperature of about 160 deg. C. After the precipitator had been in operation under these conditions for a short time and before the runs were half completed serious arcing occurred in the precipitator, and the current had to be turned off during the rest of the distillation. On examining the inside of the precipitator it was found that a deposit of hard pitch had built up from the inside surface of the tubes toward the chains, and in one case this deposit reached all the way across between the tube and the chain, making a dead short-circuit. This material was very brittle and on being heated to high temperatures coked without any tendency to melt.

This indicated that the material being precipitated consisted of a pitch so very hard that at the temperature of the precipitation it did not flow readily and finally built up a solid deposit. This was probably due to the fact that at the temperature of the precipitation all the oils, even the higher boiling oils, were in the form of a pure vapor and, therefore, passed through the precipitator. Only the particles of hard pitch were in liquid form and this product was, therefore, the only material precipitated. In the next runs the temperature of the precipitator was kept near 100 deg. C. and at times a small amount of water may have been condensed in the precipitator. Under these conditions the deposit was a liquid tar containing pitch, oils, and perhaps a small amount of water corresponding to settled plus dissolved tar. This tar was not very thick even at ordinary temperature and at the temperature inside the precipitator it was sufficiently liquid so that it drained from the tubes without any difficulty and there was no

short-circuiting at any time throughout the run. This precipitated tar flowed from the trap in the bottom of the precipitator continuously throughout the latter part of the runs.

Condensate Low in Soluble Tar

The distillate which passed through the precipitator and was condensed and collected was clear and with only a little color during the first part of the run, but during the last part the color became darker and a small amount of dark-colored oil separated from the pyroligneous acid. This pyroligneous acid, however, was not so dark as that ordinarily obtained and on distillation it was found to contain only 3.3 per cent of soluble tar, whereas the ordinary pyroligneous acid obtained from the same retort contains from 12 to 15 per cent soluble tar.[2] An acetate of lime made by neutralizing this pyroligneous acid just as it came from the condenser contained 77.8 per cent calcium acetate whereas laboratory-made acetate of lime from redistilled pyroligneous acid contained 82.5 per cent calcium acetate.

Although a large proportion of the pitch had been stopped in the precipitator, yet a sufficient quantity came through to contaminate the acetate seriously. Another run was made in which it was attempted to keep the voltage higher, but this could not be done without serious arcing. It was finally decided to make another

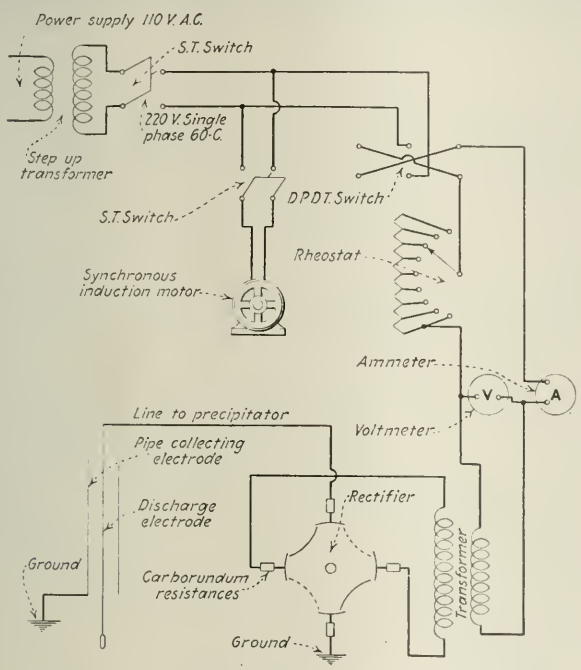


FIG. 3—TYPICAL PRECIPITATOR CIRCUIT

trial in which the distillation would be run at slower speed and this was done with a distillation taking 5½ hours instead of the usual time of 3½ hours. Even under these conditions, however, no better results were obtained.

Some Tar May Pass Through Precipitator as True Vapor

It is impossible to tell whether the soluble tar found in the pyroligneous acid which has come through the precipitator is due to a small proportion of tar fog which escaped precipitation or whether it is due to materials which came through the precipitator as a pure vapor but which polymerized to a non-volatile pitch either on neutralizing with lime or on distilling during the soluble tar determination. This assumption that the contaminating material came through the precipitator at least in part as true vapor is very plausible, since Klason[3] has shown that there is a continous decomposition of the primary tar from the distillation of wood into a secondary tar consisting of pitch and heavy oils. In the small retort used in these experiments the distance from any decomposing particle of wood to the precipitator is very short and the transformation of the primary tar into secondary tar may not have been complete before the precipitating chamber was reached. If this was the case, there might be a formation of non-volatile pitch in the vapors after they had passed through the precipitating chamber. Therefore, a non-volatile material would be found in the distillate through no fault of the precipitating apparatus.

Commercial Units Should Give Better Results

There is more opportunity in a commercial-sized retort for the decomposition of primary tar to secondary tar before the precipitator is reached, in which case the tar would be removed from the gas in passing through the precipitator. On the other hand, if this tar came through the precipitator as a fog, it was because the velocity of the gas passing through the pipes was too great to permit of complete precipitation. The use of a greater number of pipes would overcome this, as the efficiency of precipitation varies inversely as the velocity of the gas through the precipitator.

Conclusions

Although the small-scale experiments have not removed the last traces of pitch and although a satisfactory acetate of lime could not be made from the directly neutralized pyroligneous acid, yet the experiments have shown that the general idea of precipitating tar from hot vapor is a possibility. Furthermore, there is still no reason to believe that in commercial-scale apparatus the formation of secondary tar may not be more complete before the vapors leave the retort and that a purer pyroligneous acid might not, therefore, be obtained by this method.

Switzerland's Aluminum Industry

Before and even during the war, the production policy of the Swiss aluminum industry was directed toward supplying the German aluminum-working industries with raw aluminum. The depreciation of the mark and the increase in German aluminum production during the war, however, induced the German aluminum-working industries to abandon the Swiss metal. While in 1913 5,644,700 kg. of aluminum and in 1920 3,542,400 kg. were exported to Germany, these exports dropped in 1921 to 1,646,100 kg. This compelled the Swiss aluminum industry to look for new markets, which were found in 1921 in the United States and Japan. Thus in 1921, 3,420,600 kg. of aluminum, to the value of 8,523,000 francs, went to the United States, and 894,100 kg., valued at 2,075,000 francs, to Japan. Besides this, Switzerland's aluminum industry, concentrated in the Aluminium Industry Society of Neuhausen, is paying more attention to the aluminum-working industries of Switzerland.

[2] Although these figures might give the impression that the precipitator was only 15 — 3.3. ÷ 15 = 78 per cent efficient in removing tar from the vapors, it must be noted that not only 78 per cent of the soluble tar but all the settled tar was removed. This is an efficiency of about 90 per cent.

[3] *J. prakt. Chem.* (2), vol. 90 p. 413 (1914).

Evaporation of Potash Brines at Deep Springs Valley, California

Some Interesting Modifications in the Methods of Recovering Potash From Natural Brines Have Been Introduced at the Experimental Plant of the Inyo Chemical Co.— Checking Foaming in Evaporation—Removal of Borax in Centrifuge

By LEROY A. PALMER

EXPERIMENTAL and research work in the treatment of potash brines at a pilot plant in Deep Springs Valley, Inyo County, California, has developed what appears to be a very practical process for the economical extraction of the valuable portions of the great saline deposits found at different localities in the American desert.

The brine is obtained from a "salt marsh" or "dry lake," as the deposits are frequently called, of an area of about 1½ square miles. It is a typical saline deposit formed by the dessication of a Quarternary lake having no outlet, in which waters only moderately alkaline became, by continued addition of solid matter and evaporation of the water, a highly concentrated mass of alkaline minerals. The deposit is covered by a glistening snow white crust, the principal constituent of which is sodium chloride.

Nature of the Deposit

The strength of the solution increases toward the center of the deposit, which is marked by a "crystal body" in which supersaturation has occurred so that various sodium and potassium minerals have crystallized out in many interesting and unusual forms. The interstices of these crystals are filled with the brine from which they were thrown down, while below and on all sides of the crystal bed is a deposit of thin watery mud, in which the minerals exist, but, due to the presence of the mud, in less proportion than in the brine.

It is not the purpose of this paper to discuss the origin of this deposit. The reader who is interested in that phase may refer to Hoyt S. Gale's "Salines in the Owens, Searles and Panamint Basins, Southeastern California"[1] and in the portion referring to Searles Lake will find a description of conditions generally similar to those at Deep Springs Lake.

While this similarity of origin exists, the Deep Springs brines and muds have been found to be somewhat richer than those of Searles Lake. Gale reports[2] six analyses of anhydrous salts from Searles Lake by Walton Van Winkle of the Geological Survey which show an average of 6.28 per cent K and one by W. H. Ross of the Bureau of Soils which shows 6.06 per cent K, equal to 7.48 per cent and 7.28 per cent K_2O respectively. The hypothetical combinations in the anhydrous residue of the Searles Lake brine, based on an average of these seven analyses reported by Gale, are given in column A of Table I.

[1]U. S. Geological Survey Bull. 580. See also "Potash From Searles Lake," by Alfred D. Ropp, Jr., Chem. & Met. Eng., vol. 19, No. 6c, pp. 425-38, Sept. 26, 1918, and "Salts Refining at Owens and Searles Lake," by L. W. Chapman, Chem. & Met. Eng., vol. 24, No. 16, April 20, 1921.

[2]U. S. Geological Survey Bull. 580, pp. 276-277.

Columns B and C are analyses of two samples of brine taken from one of the test wells put down in the crystal body at Deep Springs Valley. Both samples are from the same hole, but C is lower than B due to the fact that surface water had got into the hole after B was taken and had diluted the brine. It is given for the purpose of certain comparisons to be made later. B_1 gives the hypothetical combination of the anhydrous residue of B. The potash content of these on a basis of percentage of the total solids is 25.6 per cent KCl in B and 21.5 per cent in C.

The muds, too, contain an appreciable amount of potash, but they also carry a large proportion of water-insoluble matter, principally silica, which amounts to more than 80 per cent of the total solids. Their potash content, due to this fact, is so much lower than that of the brine and there is so much of the latter available that we are justified in leaving the muds out of consideration as a future source of potash salts.

Separating the Salts

The process for separating the different salts contained in the brine is one of boiling out in which the temperature of the solution is varied and the salts are

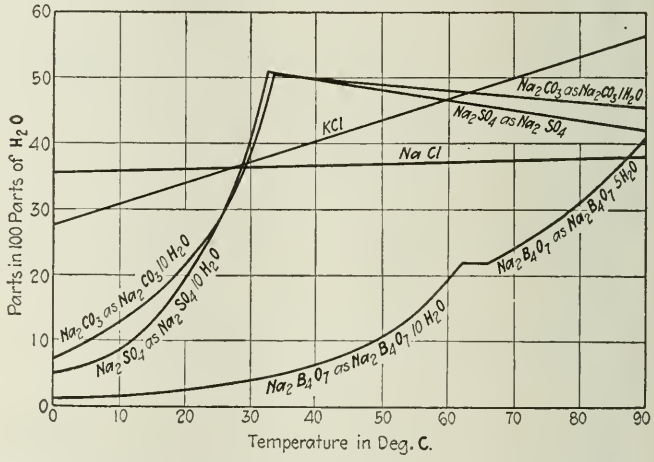


FIG. 1—SOLUBILITY CURVES FOR ALKALI SALTS FOUND IN POTASH BRINES

thrown down in the order of their solubilities. Fig. 1 shows the solubility curves of the commoner alkali salts reckoned in parts of the salt in one hundred parts of water and based on experiments with the individual salts. No curves showing the solubilities of the various salts in combination have been determined, as the solubility of each would vary with every change in the proportion of the salts to each other.

The principle involved in the process is simple and

has been applied, in one form or another, in many attempts to make a commercial product from natural brines of this character. But, as is frequently the case, efforts to develop the process on a practical basis have been beset by many obstacles, most of them unforeseen and of an unexpected nature.

The work at the Inyo Chemical Co.'s plant has been carried on by the Industrial Research Co. of San Francisco, under the direction of its president, Clinton E. Dolbear, and it is claimed that the process developed has overcome the usual obstacles and simplified the entire cycle of operations.

The experimental plant, shown in Fig. 2, has been built on the shore of the lake, into which a light pier

FIG. 2—EXPERIMENTAL PLANT ON SHORE OF DEEP SPRINGS LAKE

or runway has been built for a distance of about half a mile, so as to reach the crystal body. At the end of the pier is a gasoline engine and centrifugal pump, by which the brine is pumped to four concrete vats, each 20 x 20 x 1 ft. (3,000 gal.) on the shore adjacent to the plant.

In actual practice refrigeration will be used to chill the brine in these vats. Artificial chilling was not necessary in the experimental work, as this was carried on in the fall and winter when the nights were sufficiently cool at this altitude—about 5,000 ft.—to give the desired temperature by natural means.

The first step in the segregation process takes place in these cooling vats, in which the temperature is reduced to 10 deg. C., at which point the greater part of the sodium sulphate and some of the sodium carbonate crystallize out. The experiments show that an average of 31 per cent of the salts is removed at this stage and that the crystals take with them an equal proportion of the water of the brine as water of crystallization and as entrained moisture.

The effect of refrigeration is shown in column D of Table I, which is an analysis of sample C after it had been subjected to the chilling process described. The same on a moisture-free basis is given in column D_1.

The liquor remaining after the partial crystallization resulting from the chilling is drained to a sump in the mill and there mixed with the mother liquor from previous treatments in the approximate proportion of two parts of refrigerated brine to one mother liquor. A centrifugal pump raises the mixture from the sump through a 2-in. pipe line to a 1,000-gal. galvanized-iron tank on the second floor, preparatory to the second stage of the process.

A typical analysis of the mixture of refrigerated brine and mother liquor is shown in column E.

Evaporation

Evaporation is effected in a 30-in. single-effect Swenson "steam basket" type evaporator shown in elevation in Fig. 3. The evaporator is filled by gravity from the 1,000-gal. tank through the 2-in. liquor inlet shown at the left. In the first filling the liquor goes direct to the evaporator, but when this is filled and evaporation is under way the liquor is bypassed to a small tank in which is a float valve connected to a half-inch feed pipe. The flow to the evaporator is regulated by this valve so that a uniform water level is maintained about 3 in. above the top of the steam basket and a fixed volume of brine is kept in the evaporator. The float valve thus regulates the feed so that the inflow and evaporation balance.

The essential feature of this type of evaporator is the steam basket in the lower half of the cylindrical portion. This steam basket is cylindrical in shape, 20 in. in diameter, 30 in. in length, with thirty tubes, each 2 x 30 in., set in it longitudinally. Live steam is admitted through the 2½-in. steam line shown on the left, passes through the pipe in the upper part of the cylinder and into the top of the basket, the purpose of which is merely to expose a large heating surface to the brine which surrounds the basket and fills the tubes. One can get a good mental picture of the process by comparing it with the well-known water-tube boiler, the brine taking the place of the boiler water and the steam the place of the furnace gases. With the large radiating surface presented by the steam basket the brine is quickly brought to boiling, which, at this altitude, is from 211 to 217 deg. F., according to the density.

Checking Foaming

Here occurs one of the bugaboos of evaporation as applied to these natural brines. Due, supposedly, to the presence of organic matter, the liquor foams violently when the temperature is raised to boiling—

TABLE I—ANALYSIS OF NATURAL POTASH BRINES AND RESIDUES OBTAINED THEREFROM (RESULTS EXPRESSED IN PER CENT)

	A	B	B_1	C	D	D_1	E	F	G	H	H_1	I	J
	Hypothetical Composition of Searles Lake Residue*	Brine From Deep Springs Valley	Hypothetical Combinations in Residue From B	Brine From Deep Springs Valley	Brine C After Refrigeration	Hypothetical Combinations in Residue From D	Refrigerated Brine and Mother Liquor Mixture	Wasted Liquor During Run	Wasted Liquor at End of Run	Composition of Enriched Liquor	Composition of Anhydrous Residue From H	Mother Liquor for Re-use	Average of Nine Lots of Final Product
Specific gravity	....	1.3065	....	1.2896	1.2496	....	....	....	....	1.358	....	....	....
Potassium chloride (KCl)	12.07	8.82	25.57	7.27	9.82	32.91	9.53	5.58	8.08	22.33	51.10	8.94	96.91
Sodium chloride (NaCl)	51.61	4.82	13.97	11.53	11.19	35.08	10.27	52.07	46.78	8.99	20.78	8.42	1.63
Sodium sulphate (Na_2SO_4)	19.22	14.59	42.27	8.88	1.81	7.29	2.07	15.56	20.36	1.35	3.12	2.60	0.14
Sodium carbonate (Na_2CO_3)	12.79	6.27	18.17	5.36	5.94	21.20	7.76	11.66	21.20	7.32	16.92	11.41	0.26
Sodium biborate ($Na_2B_4O_7$)	3.23	.....	.....	0.70	1.09	3.50	1.76	3.16	4.06	3.50	8.08	3.11	0.13
Sodium arsenate (Na_3AsO_4)	0.17	....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Average based on seven analyses reported by H. S. Gale.

so violently, in fact, that the capacity of the evaporator is greatly reduced and a period of 38 hours was required in this case to concentrate the brine to saturation with KCl. Obviously a cycle of that length was expensive and some means was necessary to reduce the time required.

This foaming during evaporation is a trouble that has been encountered in all attempts to boil these natural brines, and a great deal of experimental work has been carried on at different plants in efforts to devise means to overcome it. Various processes, most of them only partly successful, have been tried. These have included the use of crude oil, gasoline, animal fats and oils, passing all brine through decolorizing charcoal, etc. Some of these were only partly successful, while others were successful in the matter of checking the foaming, but were too expensive to be of any value from a practical standpoint.

The introduction of slop distillate, not a new expedient, was tried at this plant by feeding it in slowly

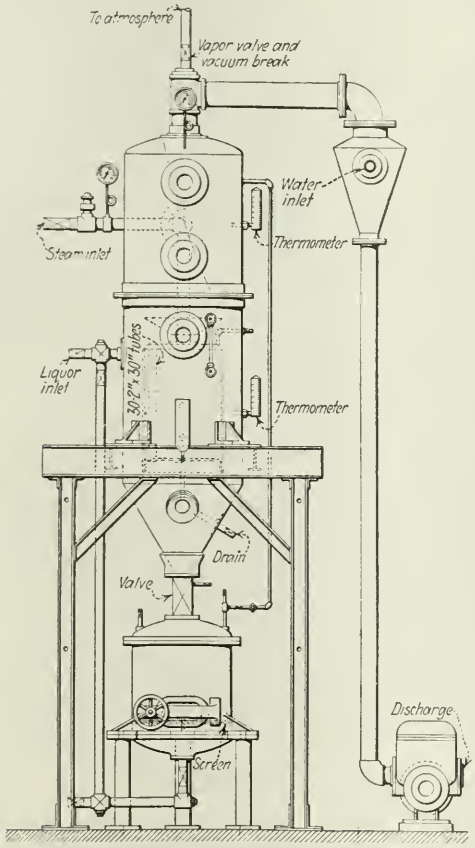


FIG. 3—ELEVATION OF SINGLE-EFFECT PATENTED BASKET TYPE EVAPORATOR

from a small reservoir. By increasing the surface tension of the liquor in the evaporator the introduction of the distillate retarded the foaming and cut the time required for saturation to 14 hours.

This was still much longer than was desired, and another method was tried. Thin strips of sheet lead were suspended in the brine with one end of each strip in contact with the steel of the evaporator. This set up a galvanic current between the lead and the steel which liberated oxy-chlorides from the brine and these exerted an oxidizing action on the organic compounds that were causing the trouble, the reaction serving to retard the foaming. The use of the lead strips cut the time required for saturation to 14 hours, the same as

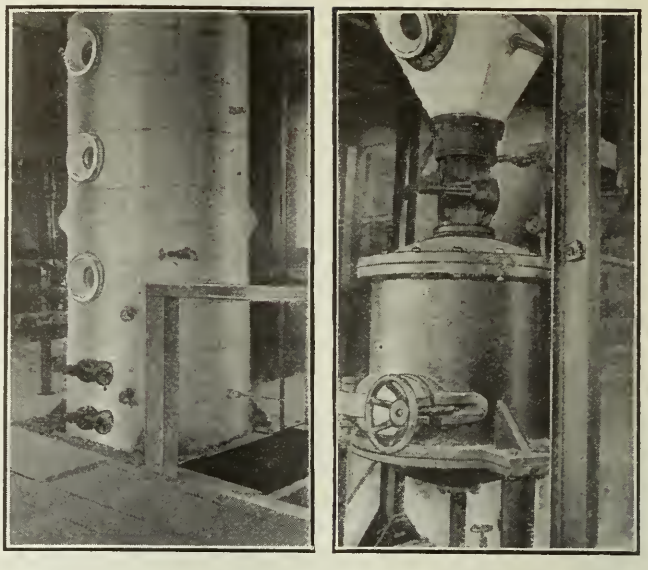


FIG. 4—VIEWS OF UPPER (AT LEFT) AND LOWER PORTIONS OF EVAPORATOR

with the slop distillate. The next step was a combination of the two and this met with success, complete salting out so far as possible at this stage taking place in 4 hours.

Salting Out

Reference to the solubility curves shows that above a temperature of approximately 65 deg. C. potassium chloride has a greater solubility than any of the other salts under consideration. With the increase in temperature in the evaporator sodium chloride is crystallized out, and almost immediately thereafter all of the remaining sulphate except about 3 per cent is thrown down, leaving a concentrated liquor in which KCl is the principal constituent.

During evaporation the brine is tested by drawing off about 50 c.c., permitting it to stand 30 seconds and then filtering it through a Gooch crucible. The dried salts from the filter paper are redissolved and tested with sodium cobalt nitrite, and if the reaction shows a satisfactory potash content, the evaporator is emptied.

The chloride, sulphate and carbonate crystals settle through the conical part of the evaporator into the lower cylindrical portion, from which they are removed through the door held by the hand-wheel and are then wasted. The enriched liquor is drained through the screen shown below the door with the hand-wheel and carried through the 2-in. pipe to the "crystallizer," which is merely two concrete tanks, each 2 ft. deep.

The refuse is emptied twice during a run. In column F is a typical analysis of the refuse at end of the first half of the run and G at the close, while column H gives the composition of the enriched liquor as collected in the crystallizing vat and H_1 the anhydrous residue of the same.

Separation of Potash

As the solution cools in the crystallizing vats, the potassium chloride and borax crystallize out together and are removed before the solution has cooled sufficiently to throw down the carbonates and sulphates remaining in the liquor. Column I gives a typical analysis of the mother liquor remaining at this stage, which is mixed with refrigerated brine and re-used.

The potash and borax crystals are heated in their

wet state by steam, which causes the borax to dissolve in the water entrained with the crystals and in its own water of crystallization. The potash and dissolved borax are then charged into a centrifuge the moving part of which is a vertical perforated cylinder 26 in. in diameter and 10 in. deep, lined with canvas filter cloth and turned at the rate of 1,350 r.p.m. As the centrifuge revolves, a jet of wet steam is turned into it to assist in driving the dissolved borax through the filter cloth so that the potash crystals are retained in the cylinder. The product that remains in the centrifuge contains about 2 per cent of water and small amounts of the various salts, other than potassium chloride, that make up the natural brine.

The last column (J) in Table I gives an average, on a moisture-free basis, of nine different lots of potassium chloride made by this process. The borax, although small in amount, is recovered in marketable quality. The entire cycle requires about 5 hours after the preliminary chilling.

Two patents have been applied for in connection with this process. One of these covers the process used to check foaming in the evaporator, and the other covers the use of the centrifuge for separating the potash and the borax. The latter has been issued, but the former is still pending.

The process as a whole, as described above, has been adopted by the Inyo Chemical Co. and construction has been started on a plant to have an initial output of 10 tons of potash per day.

I am indebted to Henry W. Carr, president of the Inyo Chemical Co., and to Clinton E. Dolbear, president of the Industrial Research Co., for assistance in collecting the above data and the arrangement thereof.

Legal Notes

By Wellington Gustin

Arkell Patents on Manufacture of Crinkled Paper Held Void for Lack of Invention

The United States Circuit Court of Appeals upheld the decision of the District Court holding the Arkell patents 790,021 and 790,022 void for anticipation and lack of invention, in view of the prior art, and holding his patent 790,023 void for lack of invention. These patents were granted in 1905 on applications granted in 1901, 1903 and 1904 respectively. The court finds that the plaintiff is using rights that belong to the public and are not subject to any monopolistic control under the patents named.

Broadly, the claims of the patents are on the process and on a machine for converting finished paper into stretchable crinkled paper for wrapping and packing purposes. The gist of this process is that the finished paper is first moistened or saturated in one or two baths, smoothed or "laterally stretched" by a convexed roller, pressed against and drawn around a smooth roller, from which it is detached by striking against a blunt blade, called a doctor blade, after which it is pulled off on a carrier so regulated in speed as to leave in the crinkled paper the desired percentage of stretch as the paper is dried.

The court found that crinkling moist paper by the general method of striking it against a doctor to be old. Such crinkled, stretchable paper was manufactured in substantial quantities by the use of the doctor as early as 1892. The Lysle patent 414,557, of 1889, shows knowledge of this process, as does the English patent 1927, of 1894 to Lewer and Edwards (272 Federal R. I.).

It is said that if moistening finished paper so that it will crinkle as paper still moist from the process of manufacture will crinkle involves invention, then Bainbridge's patent 584,108, issued in 1895, covered that point. The court says it makes no difference whether the moistening is done by submerging a roll around which paper is passing, or by running the paper from roll to roll through one or more saturating baths, or by spraying, or by a combination of any or all these processes. To dampen finished paper so that it will crinkle may be done in a great variety of ways, with only ordinary mechanical skill applied to devices in common use for decades.

The court says the "selection and putting together of the most desirable parts of different machines in the same or kindred art, making a new machine, but in which each part operates in the same way as it operated before and effects the same result, cannot be invention.

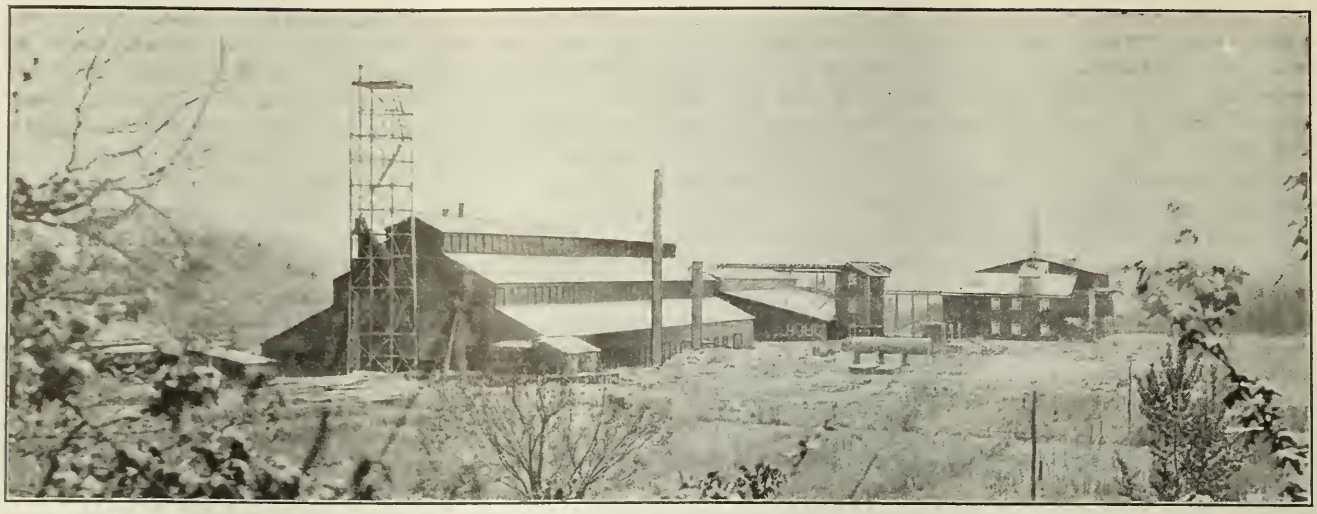
"To sustain a patent on a combination of old devices, it is well settled that a new result must be obtained which is due to the joint and co-operating action of all the old elements."

Precedent Opinion Cited

The advice of the United States Supreme Court in Atlantic Works vs. Brady (107 U. S., 192) should be valuable to those interested in patents. It was applied in this case. It says:

"The process of development in manufactures creates a constant demand for new appliances, which the skill of ordinary head workmen and engineers is generally adequate to devise, and which, indeed, are the natural and proper outgrowth of such development. Each step forward prepares the way for the next and each is usually taken by spontaneous trials and attempts in a hundred different places. To grant to a single party a monopoly of every slight advance made, except where the exercise of invention, somewhat above ordinary mechanical or engineering skill is distinctly shown, is unjust in principle and injurious in its consequences.

"The design of the patent laws is to reward those who make some substantial discovery or invention, which adds to our knowledge and makes a step in advance in the useful arts. Such inventions are worthy of all favor. It was never the object of those laws to grant a monopoly for every trifling device, every shadow of a shade of an idea, which would naturally and spontaneously occur to any skilled mechanic or operator in the ordinary progress of manufactures. Such an indiscriminate creation of exclusive privileges tends rather to obstruct than to stimulate invention. It creates a class of speculative schemers who make it their business to watch the advancing wave of improvement, and gather its foam in the form of patented monopolies which enable them to lay a heavy tax upon the industry of the country, without contributing anything to the real advancement of the arts. It embarrasses the honest pursuit of business with fears and apprehensions of concealed liens and unknown liabilities to lawsuits and vexatious accountings for profits made in good faith."



THE BELLE ALKALI CO. PLANT AT BELLE, W. VA.

Up-to-Date Methods in a Bleaching Powder Plant

The Bleaching Powder Plant of the Belle Alkali Co. at Belle, W. Va.—How a War-Born Plant Has Introduced Modern Methods That Help to Overcome the Disagreeable Side of a Standard Method of Manufacture—Industrial Trend Indicated by This Improvement

BY GRAHAM L. MONTGOMERY

UTILIZING the legacy of chemical plants left on our hands as an inheritance from the late war has not proved a uniformly easy task. It has either been necessary for the war-born plant to create a market for a new product in a time of depression or the plant has had to compete with the products of long-established plants in the manufacture and sale of a staple product. Under these conditions there are in general only two cases which have permitted the profitable exploitation of these properties. First, where there is a real demand for a product not formerly made in this country and not at the present time brought in from abroad at an unduly low price; and second, where, through some factor such as location, equipment or organization, the new plant can sell the same product on at least as favorable terms as the old, or can produce a better product to sell on the same terms.

THE BELLE ALKALI CO.

One of the plants where location and equipment have enabled a business to be built up in the face of old-established competition is to be found in the Belle Alkali Co., at Belle, W. Va. This plant was erected by the government during the war for the production of chlorine gas; but was never operated under government supervision, being completed only after the armistice had been signed. Some time thereafter the Belle Alkali Co. was organized, and purchased the plant from the government. The plant was extended and changed to make possible the manufacture of bleaching powder and caustic soda in addition to chlorine.

The object of locating a chlorine plant at Belle is the immediate proximity of a supply of salt. In fact, the plant stands over the wells, and the brine, which occurs at the 500-ft. level, is pumped up as needed. This gives a supply of the basic raw material of manufacture for chlorine in the desired form without any outlay for shipping. The other principal item needed for the chlorine manufacture is electrical power. Here again the Belle plant is unusually fortunate, as it has on the property sufficient flow of natural gas to supply all power needs at the present, and if in the future the gas wells should run out, there is also on the property a mine of high-grade bituminous coal. Being in the valley bottom of the Kanawha River, a plentiful supply of good water is assured at all times.

From the point of view of accessibility to market, Belle is also rather well situated. It is on the main line of the Kanawha & Michigan R.R., with ready access to the main line of the Chesapeake & Ohio R.R. at a mid-point between the markets of the Central and Eastern sections of the country and also within easy access of the Southern textile markets. In addition, a good labor supply is almost always assured, as the overflow of labor from the extensive West Virginia coal-mining fields should always be sufficient to take care of this need. Here, then, is a plant where all the factors governing sound location seem to be satisfied.

GENERAL MANUFACTURE AT BELLE

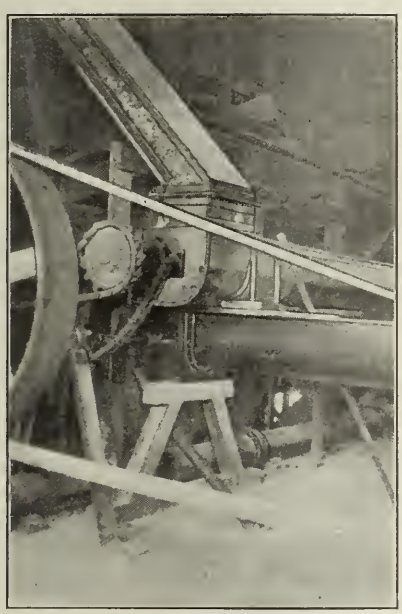
The primary manufacture of this plant was chlorine, by electrolytic methods. This is still the basis of manufacture, and chlorine and sodium hydroxide are the primary products. The market for the chlorine is not sufficient to absorb it all in the liquid or gaseous form and hence a part is now made into bleaching powder. The caustic is sold in the form of flaked

caustic soda, an up-to-date flaking plant having been added to the equipment left by the government.

The bleaching powder plant is the newest addition to the property. It is in building the plant wherein this manufacture occurs that modern and highly efficient mechanical equipment has been adopted. This equipment marks a step in overcoming the usual difficulties under which a bleaching powder plant labors and points the way for a perhaps more extensive use of mechanical methods which will some day eliminate these difficulties altogether. Also, it is largely due to these methods that this company has been able to turn out a good product on such advantageous terms as to assure its place in the market.

Manufacture of Bleaching Powder

The manufacture of bleaching powder has been a standardized process for many years. The only changes that have occurred in this manufacture are refinements in method and are not basic. Briefly, the process consists of bringing hydrated lime into contact with chlorine gas in a suitable chamber, the lime combining with the chlorine to form the bleaching powder. This is a simple process; but it is an intensely disagreeable one for the workers to handle if hand methods are in force for its operation. In the first place, the lime is generally received at the bleaching powder plant in an unslaked condition and must be



CENTRAL POINT OF LIME-CONVEYING SYSTEM, SHOWING ELEVATOR *D* AND CONVEYORS 5, 6, 7

hydrated. This slaking is attended by the evolution of heat and gas and there is much dust raised. As a consequence, hydrating machines in which the lime is thoroughly treated with just the correct amount of water have been designed and their use is now general.

After the lime has been hydrated and screened to the proper size it is introduced into the chlorinating chamber or chambers. In its simplest terms, the chlorinating chamber consists of a lead-lined or concrete chamber about 20 ft. in width and from 40 to 100 ft. long and from 6½ to 10 ft. in height. The hydrated lime must be spread over the floor of this chamber, generally to a depth of about 4 in. In order to make a more efficient contact between the lime and the gas, it is found necessary to scarify the surface of the lime into ridges, until the whole surface is made up of alternate hills and valleys, the sides at an angle of 45 deg. This is a hard job for the workers, for some chlorine is likely to be present in the chamber and the dust from the lime is also unpleasant in effect. In making bleaching powder from the weak concentrations of the gas which result from some of the methods of

CONVEYOR 6, ABOVE CHLORINATING CHAMBERS, ALSO SHOWING CHLORINE DISTRIBUTING SYSTEM

chlorine manufacture, machines have been introduced to do this work mechanically, but with the strong gas available from electrolytic methods these machines do not yet seem to be in the form where continuous and efficient service can be obtained from them. So, for the present at least, this operation remains a hand operation.

Difficulties in Packing Bleaching Powder

After the lime has been chlorinated, it remains to remove it from the chlorinating chamber and pack it in the container in which it is to be shipped as the bleaching powder of commerce. To remove the bleaching powder from the chamber it is either raked to one end and hence out or it is raked to chutes leading from the floor of the chamber, the chamber being raised and the containers being loaded underneath. It is scarcely possible to get all the chlorine gas out of the chamber and there are always fumes and deleterious dust given off from the powder, so that the work of emptying the chamber is extremely trying. The powder is then to be packed into containers and these containers to be sealed before shipment. In this last process, more or less dust always escapes from the chute and container and gets in a paste on the floor of the packing room. This paste is an active oxidizing agent, and causes rapid deterioration of everything with which it comes in contact that may be oxidized. Also, there is a certain amount of chlorine which escapes from the bleaching powder when it is freed to the air, and this adds to the difficulties in this part of the work.

In most plants in this country today the lime in both the slaked and unslaked state is handled by mechanical equipment from its receipt in the plant through the hydrating process, the screens and to the chlorinating chamber. Due to the activity of the material beyond this point in oxidizing the usual metals of which

handling equipment is made, no attempt is made to use any machinery beyond the entrance to the chamber. This is with the exception that several plants have installed an industrial railway under the chambers. In this case, the container is filled while on a car and is then pushed to the header and the scales and so to shipment or storage as desired. This method employs about as much labor as the full hand method, does not save a great deal of time and is subject to the same labor turnover, due to unpleasant working conditions, that causes the chief drawback of the older methods. Also, the relatively expensive industrial railway equipment is subjected to a rapid deterioration.

At Belle this later succession of operations—i.e., the filling of the container and all the subsequent handling—has been made as nearly automatic as possible. Thus one more of the disagreeable factors that cause a high labor turnover and hence a high labor expense in this manufacture is on the way to solution, and one more cause of industrial disability is at least partly removed.

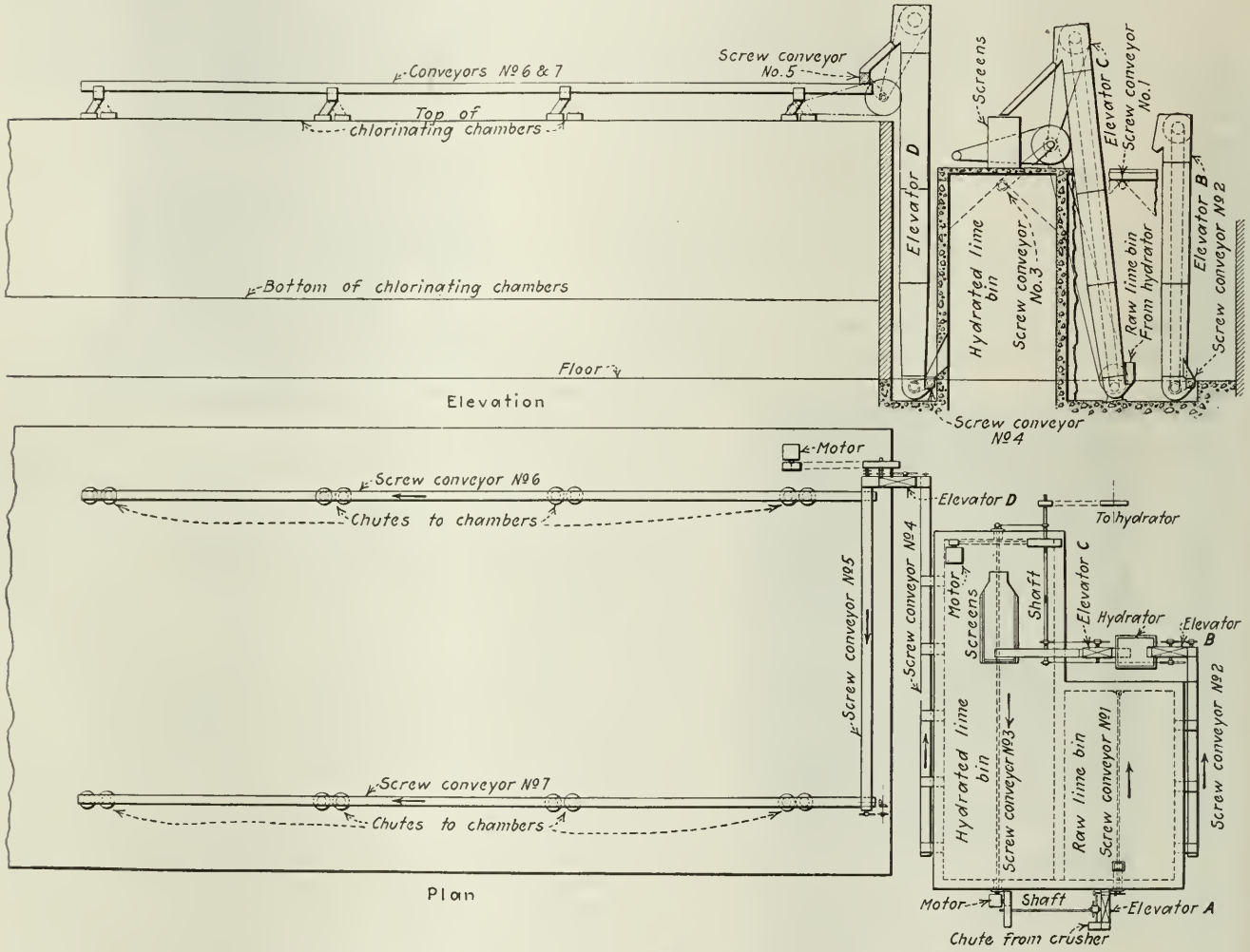


FIG. 1—CONVEYING SYSTEM FOR TAKING LIME TO THE CHLORINATING CHAMBERS

Making Bleaching Powder at Belle

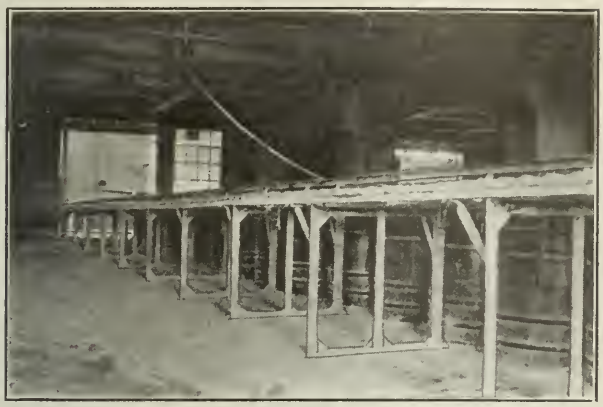
At Belle the unslaked lime is delivered in cars on the siding adjacent to the lime crusher shown in Fig. 1. This lime is unloaded by means of a portable belt conveyor directly to the hopper of the lime crusher. After passing through the crusher, the lime is delivered to the boot of the bucket elevator marked *A* on Fig. 1. This elevator, which has a dustproof casing, raises the lime a total distance of about 28 ft. and discharges it into the raw crushed lime storage bin. As the discharge into this bin is at one point only, it is necessary to have a means of distribution in order to utilize to full advantage the available storage space of the bin. This end is accomplished by the conveyor marked 1 on Fig. 1, which is a screw conveyor running open within the bin at the top and along the longitudinal center line.

From one side of the bottom of the raw crushed lime bin are three spouts which may be regulated to deliver an exactly determined amount of lime to the conveyor marked 2. This conveyor is a screw conveyor housed in a dustproof housing. The bottom of the bin is sloped to the side from which the discharge is taken so that the bin may be cleared without anyone going inside. Conveyor 2 delivers to the boot of bucket elevator *B*, also shown on Fig. 1, which is a standard bucket elevator housed in a special dustproof casing. Elevator *B* delivers the crushed lime to the hydrator. This is a mechanically driven hydrator wherein the lime is treated with the exact quantity of water necessary to slake it thoroughly and to leave it in the proper state for use in the chlorinating chambers except for the screening operation.

The lime, in being hydrated, passes down through the hydrator and is delivered from it into the boot of bucket elevator *C* at a point near the floor level as shown in Fig. 1. This elevator, like the others a standard elevator in a special dustproof casing, elevates the hydrated lime and introduces it into the screens. Here the material which is sufficiently fine is passed into the

hydrated lime storage bin by means of gravity chutes, while the small quantity which is too large is rejected to be reworked. A distributing conveyor, marked on Fig. 1 as conveyor 3, runs open in the top of this bin in the same manner as conveyor 1 runs in the raw crushed lime storage bin. The hydrated lime storage bin is a concrete bin similar to the raw crushed lime bin, with a sloped bottom to facilitate delivery of the lime. The gates of the spouts through which the lime is withdrawn are not in this case, however, of the regulating type, as there is no particular object in keeping strict account of the amount of lime taken from this bin.

The spouts in the bottom of the hydrated lime storage bin feed the screw conveyor marked 4 on Fig. 1. This conveyor delivers the lime to the boot of bucket elevator *D*, a standard elevator in a dustproof casing which raises the lime to a point about 40 ft. above the floor of the room, which is a sufficient height to deliver the lime by



GRAVITY CONVEYOR UNDER CHLORINATING CHAMBERS

gravity to the distribution system, which takes it to the different chlorinating chambers. This distribution system consists of a screw conveyor marked 5 on Fig. 1, which takes the lime from elevator *D* and delivers it to either screw conveyor 6 or screw conveyor 7. These two conveyors are located on top of the chlorinating chambers one about 10 ft. back of either face, and are sufficiently elevated to deliver the line through spouts by gravity into the chambers.

The chlorinating chambers are of concrete throughout and are 20 x 60 ft. by 10 ft. high. They are arranged in two tiers of four each, making a total of eight chambers, and have a clearance above the working floor under the lower chambers of about 10 ft. In each end of each chamber is a door of wireglass in a wooden frame which can be sealed gas tight and through which the process can be watched. These doors also permit the workers to enter when the lime is to be spread or the finished powder to be removed. The lime is introduced by means of two separate spouts for each chamber, one leading from conveyor 6 and one from conveyor 7. The chlorine is introduced through an appropriate system of tile piping under a slight suction, which is utilized at the close of the process for a means of exhausting any excess gas from the chamber. The finished powder is removed by means of four chutes leading from each chamber on the longitudinal center line and extending down to a point immediately above the highest point to which a container resting on the conveyor in the working space beneath would reach. It is still found necessary to do all the work of spreading the lime in the chamber preparatory to chlorinating and of raking up the finished powder and directing it down the chute to the container by hand. This is a disagreeable job and one attended by some danger, as the concentration of chlorine present, even with the utmost care, may sometimes exceed that which can be well withstood by the human system. The chambers are, however, exhausted until the continuous test on the exhaust gases does not show a trace of chlorine, and it is only chlorine that may be given up from the powder that causes the trouble. Besides this, all workers in the chambers wear an air helmet.

Handling the Finished Product

Directly under the chlorinating chambers is situated the conveying system used for loading, sealing and weighing the containers and delivering them to the shipping dock, and shown on Fig. 2. This is a new application of conveyors. Formerly, due to the oxidizing action of the bleaching powder, which it is impossible to keep off of any conveying system, it has not been thought feasible to introduce conveyors at this point. The system used here consists of a specially designed gravity roller system. In order to provide against corrosion as much as possible, this conveyor system has been made especially heavy in construction, a fact that was also made necessary by the heavy weight of the containers when filled with the powder, this weight going up to about 800 lb. It is expected that the frame, which is of heavy angle-iron construction, and the rollers, which are made of special heavy steel tubing, will withstand the effect of the bleaching powder for about 3 years. The particularly hard problem to be overcome was to get a free working bearing that would not be destroyed by the corrosive action.

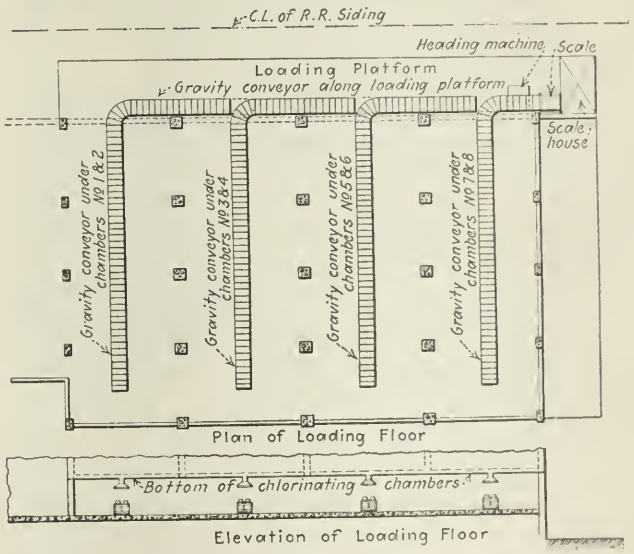
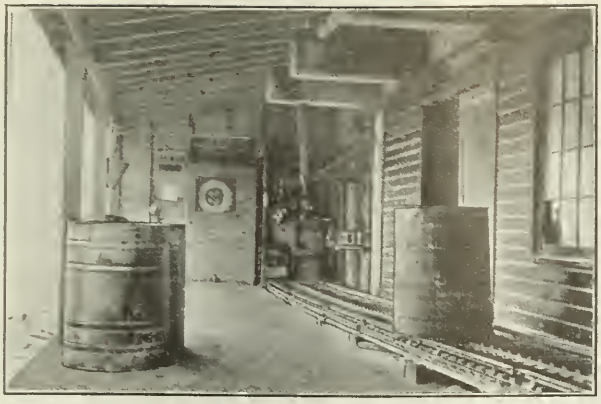

C.L. of R.R. Siding
Heading machine
Scale
Loading Platform
Gravity conveyor along loading platform
Scale house
Gravity conveyor under chambers No 1 & 2
Gravity conveyor under chambers No 3 & 4
Gravity conveyor under chambers No 5 & 6
Gravity conveyor under chambers No 7 & 8
Plan of Loading Floor
Bottom of chlorinating chambers
Elevation of Loading Floor

FIG. 2—CONVEYING SYSTEM FOR HANDLING FINISHED BLEACHING POWDER

This problem has been solved in the following manner: The end caps of the rollers have been made of heavy cast iron. In this casting a ball bearing is embodied, which is protected from the gas by having all joints threaded. Even with this precaution, there are openings into the bearing where the shaft goes through and where the means of lubrication is provided. In order to overcome this, an experiment has been tried which after nearly 6 months' use has been proved satisfactory. The bearings are all provided with Alemite lubricators, as shown in the accompanying illustration. This is a lubricator originally designed for use in automotive work, whe e it is necessary to introduce



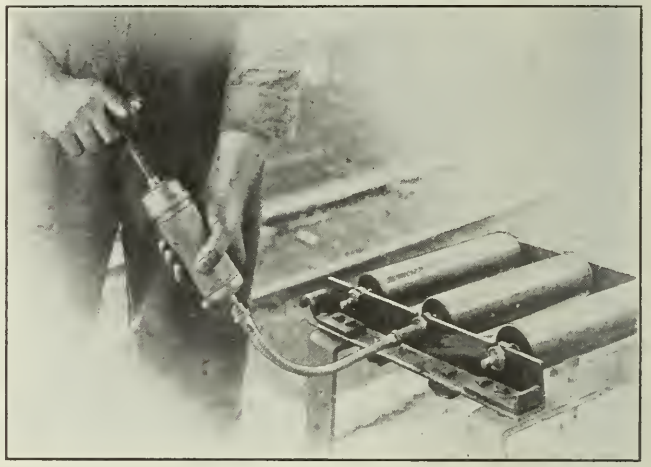
HEADING MACHINE, SCALE AND LOADING PLATFORM

the lubricant under pressure. In this case, the initial pressure under which the lubricant is introduced serves to keep any of the fumes from the powder from entering the bearing and the only precaution that has been found necessary is to keep the bearing well filled with this pressure lubricant.

The method in which this gravity conveying system is used is as follows: An empty container, which is in this case a large steel drum with one head removed, is placed on the gravity directly under one of the chutes leading from the chlorinating chamber above. A canvas extension is attached to this, leading down into the drum, which serves the purpose of preventing the bleaching powder from scattering while the drum is being filled. The gate in the chute is then opened and the drum is filled to the required height. The gate is then closed, and the canvas extension chute removed. Then, without any disturbance of the powder, the drum runs along the conveyor, which has such slight inclination that it is necessary to push the drum lightly to move it. The conveyor takes the drum around the curve shown on Fig. 2 and out onto the loading platform. Near the end of the gravity conveyor is the heading machine, where the drum, still without being moved in such a way as to cause any spillage of the powder, has the steel head sealed in place. It then runs onto a section of the conveyor which is situated on the platform of a dial scale and the weight of the filled container is taken, the tare having been noted before the drum was filled. It will be noted from Fig. 2 that there is one run of gravity conveyor under the center line of each tier of chlorinating chambers and that these all feed into a common line on the loading platform, which is served by a single heading machine and a single scale. The floor under the chambers and the loading platform are at car floor height so that the drum may be easily tipped onto a hand truck as it leaves the scale and wheeled into the car or stacked in some of the extra space under the chambers which serves as a storage reservoir for drums awaiting shipment. Special hinged sections are provided in the gravity conveyor along the loading platform so that these may be raised and the drums which are to be stored wheeled back into the building.

Advantages of This System and Its Significance

The most important advantage following the use of this conveying system for loading drums and handling them to shipment is that it is possible in this way to handle a greater volume in a given space and still maintain much cleaner working conditions than is the case with either the industrial railway or the hand methods. This is of real importance, as the conditions in this packing space are generally so disagreeable as to make the turnover among the employees overhigh, so high, in fact, that the cost of the work is unduly increased through breaking in new men and through delays incidental to having at times an inefficient crew. The gravity conveyors have been in service a sufficient time to prove their workability, and it is apparent that, even though the effect of the corrosion does cause them to wear out in a much shorter time than they would in other circumstances, the savings made through their use will more than make up for the replacement charges and the benefits derived from making the plant a healthier and safer place for men to work in will have a reflex action on plant conditions in general which will be felt throughout the plant. There is also to be considered that a gravity conveyor involves no operating charges for power and that it is the cheapest form of conveyor from the maintenance standpoint. All the parts are standard and it is very simple to replace a worn-out part without delaying the use of the conveyor for any appreciable time. This is one of the cases where it is better practice to employ a cheap and simple conveyor, even if it



SPECIAL ALEMITE LUBRICATION FOR GRAVITY CONVEYORS

does wear at what seems on first glance to be an unduly high rate, than it is to struggle along under the increased labor expense and burden of management which follow if the conveyor is not used.

It is worth while pointing out that such an installation as is described above indicates a tendency that is coming more to the fore in industry at the present time than it has ever before. That is the tendency to introduce refinements into present methods of manufacture which will make them more economical and safer to operate rather than to seek some entirely new way of doing things. It is to be hoped that such a tendency will not increase to a point where legitimate pioneering is discouraged; but it is a fact that in general the best profits are to be found in making a product for which there is already a good market in the most economical and best way. Very often this best way is to be sought rather in the refinement of an existing process than in the development of a new one.

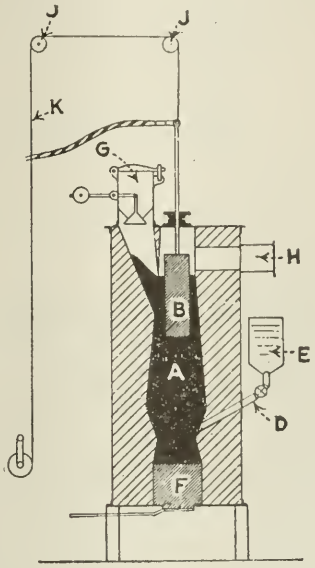
The writer desires to express his thanks to the management of the Belle Alkali Co., for permitting the above information to be gathered at its plant; and to thank the Alvey-Ferguson Co., which manufactured the conveyors described herein, for the layouts here reproduced.

Recent Chemical & Metallurgical Patents

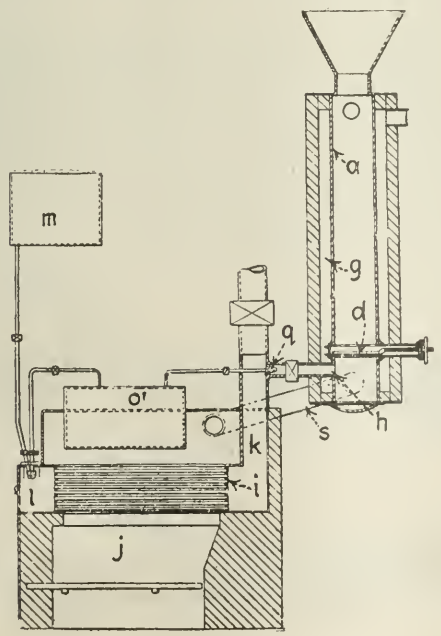
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Building, Chancery Lane, London, England.

Carbon Bisulphide.—Apparatus for the production of carbon bisulphide comprises a shaft, *A*, provided with two electrodes, *B*, *F*, the latter being adjustable by means of the rope *K* and the rollers *J*. The adjustable electorde *B* rests freely on the layer of charcoal in the shaft, and is also surrounded by coal supplied through the hopper *G*. A moderate voltage between the two electrodes raises the temperature of the carbon column sufficiently to cause a brisk reaction between it and the sulphur, which enters through pipe *D* from heated vessel *E*. The sulphur enters near the constriction in the shaft which is the hottest region. Products pass away through the flue *H*. (Br. Pat. 174,040. Not yet accepted. Chemische Fabrik Griesheim-Elektron, Frankfurt-on-Main. March 8, 1922.)



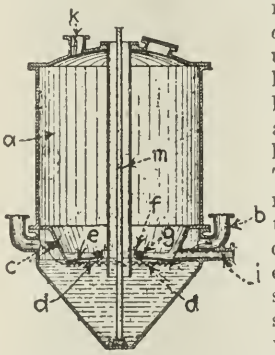
Gas Manufacture.—Coal or other carbonaceous material is treated in an externally heated retort with a gas containing 60 to 70 per cent of hydrogen or with a mixture of such gas and superheated steam at a temperature of from 500 to 600 deg. C., whereby an increased yield of condensable hydrocarbons, ammonium sulphate and coke is obtained. The coal is charged into a vertical retort *a* inclosed in a wall and having a perforated valve *d* for admission of the gases and for discharging the coke. Hydrocarbon oil, a byproduct of the process, from a tank *m* is sprayed with steam from a boiler *o*¹ into a vaporizing-chamber *l*, from which the mixture enters and is heated in iron pipes *i* communicating by a conduit *k* with the inlet *h* of the retort *a*. Superheated steam may also be supplied from a nozzle *q*. The hot gases from the furnace *j* serve to heat the pipes *i* and pass by a flue *s* to the space *g* around the retort. The distillation products leave the retort by an outlet and a rotary ram, having ribs on its under side and operated by a hand wheel serves to consolidate the fuel in the retort if required. To obtain a hard coke, during the last 20 to 30 minutes of coking the gas and steam, or steam alone, may be introduced at a temperature of from 700 to 900 deg. C. (Br. Pat. 174,165. J. Moeller, of Devon, and L. di Fonblanque, of Farnham, England. March 15, 1922.)



Carbonizing.—Carbonaceous materials such as lignite, brown coal and peat are powdered, mixed to form a paste with a hydrocarbon such as creosote, and ground to colloidal dimensions, the mass being then ground with coal tar or the like to form a liquid as described in specification 172,065. This colloidal liquid is passed under a pressure not exceeding 25 atmospheres through piping of small bore heated to not exceeding 500 deg. C. and is injected into a chamber in which vaporization takes place. The vapors are condensed and the permanent gases separated, leaving a liquid which may be used for fuel or may be further vaporized in the chamber, a semi-liquid mass remaining which is suitable as a binder for briquets, or, on still further vaporization, a residue from which briquets are formed is obtained. These briquets may be distilled to produce gas, coke, etc., or may be used in a gas producer. (Br. Pat. 175,670. G. P. Lewis, Westminster. April 20, 1922.)

Tanning.—After mineral or vegetable tanning, hides are soaked in an aqueous solution of pyridine to fix the tanning elements and permit subsequent washing and rapid drying without sweating or exudation to cause streaking or discoloration. The hides are usually soaked for 4 to 12 hours in a 10 to 25 per cent solution of pyridine. (Br. Pat. 175,362. T. B. Carmichael of Waterloo and W. H. Ockleston of Kelsall, England. April 12, 1922.)

Ammonium Sulphate.—A saturator, for use more particularly in the manufacture of ammonium sulphate, is constructed so that the passage of gas through the liquid is mainly horizontal. The saturator *a* is fitted with a bell *c* beneath the upper edge of which are the gas inlets *b*. The lower edge *d* of the bell is serrated, and extends for a short distance only below the level of the liquid in the saturator. The bell is fitted with a disk *e* by means of which the gas is made to traverse a radial path until it escapes through the aperture *f*. The edge of the bell is kept free from salt incrustations by means of a sprinkler tube *g*, the liquor from which flows through apertures and is kept at constant level by the overflow *i*. The gas finally leaves through the outlet *k*, and the salt is discharged through the siphon *m*. (Br. Pat. 175,649. Not yet accepted. H. Egeling, Weitmar, Germany. April 20, 1922.)



Depilation of Hides—Relates to the depilation of hides and skins in closed chambers by the action of heat and gaseous ammonia and consists in the use of ammonia in concentration of approximately 150 to 300 g. per cu.m. of chamber capacity and at temperatures of about 37 to 45 deg. C. The hides are previously soaked or wetted according to condition and are hung in a chamber, steam being admitted to raise the temperature and maintain a degree of humidity. Ammonia is admitted at the same time in the concentrations indicated and after 3 to 6 hours, when the roots of the hairs have been slackened, the ammonia is expelled from the chamber and that remaining in the hides is dissolved by rinsing either in the form of ammonia or after conversion into a suitable salt, such as ammonium carbonate, by admission of carbon dioxide or flue gases. The hairs are removed by hand or mechanically, the hides being kept warm by immersion in warm water or otherwise until the depilation has been effected. (Br. Pat. 175,314. O. Richter, Brandenburg. April 12, 1922.)

Synopsis of Recent Chemical & Metallurgical Literature

A High Pressure, Yielding-Plunger Pump for Vegetable Oil Expression.—Joseph Davidson of Atlanta, Ga.[1], speaking before the recent meeting of the American Society of Mechanical Engineers, described a new type of pressure pump that is being successfully used in connection with the extraction of vegetable oils by hydraulic pressure. The manner of applying the pressure has an important bearing on the efficiency of the expression process and also in the economy of the cloth used for covering the oil-bearing materials. The new pump is described as a high-pressure yielding-plunger pump and is claimed to represent a decided improvement in the hydraulic method.

A simple low-pressure pump is also used with plungers having a constant stroke, working in connection with a weighted accumulator and bypass valve, which maintains a pressure of approximately 600 lb. per sq. in. This supplies the pressure in large volume up to 600 lb. per sq.in. on all presses, and also supplies the pressure for operating the machine that forms the material into cakes, preparatory to being put into presses.

Referring to Fig. 1, the eccentric *A* imparts a reciprocating motion to the crosshead *B*. Yoke *C* is connected to crosshead *B* by means of two rods (one on either side, not shown in this figure) and moves fixedly with crosshead *B*. The two plungers *D* are fitted loosely, one in *B* and the other in *C*. Each plunger *D* has a collar *E* fitted against a shoulder. Between these collars *E* and the crosshead *B*, in one case, and the yoke *C* in the other, is placed a double-coil spring *F*, which receives the thrust of the plungers. The initial tension in the springs will stand a pressure of approximately 1,800 lb. per sq.in. against the plunger without yielding, but when the pressure in the pump barrels *G* reaches 1,800 lb. per sq.in., the springs will begin to yield, and continue to do so more and more as the pressure increases. Thus the stroke of the plungers is gradually reduced until the maximum pressure is reached, when they will cease to move; then the maximum pressure is held constant until the extraction of the oil is completed. The pressure is then released, and the cakes are discharged from the press, which is then refilled for another pressing operation.

Each chamber *I* around the discharge check has a ½-in. discharge connection, and the common practice in applying pressure to vegetable-oil presses is to run a separate and independent ½-in. pipe from each discharge connection to a press. Thus the high pressure on each press is supplied independently by one plunger, the pumps being constructed so as to provide one high-pressure yielding plunger for each press to be served. These ½-in. high-pressure pipes are connected directly to each press cylinder, no valve being required to cut off the pressure. Each press is equipped with an inlet valve for low pressure and a discharge valve; also a check to prevent the high pressure from leaving the press cylinder through the low-pressure inlet valve. When the discharge valve on the press is closed, the high pressure is confined and builds up the pressure to the maximum required. The springs supporting the plungers are then in action, taking up the movement of the crosshead. When the discharge valve is open while the cakes are being discharged and the press boxes refilled, the plungers are moving full stroke and the springs are not being compressed; the volume of liquid being moved by these plungers merely circulates under no pressure through the press cylinder, and out of the open discharge valve, back into the tank supplying the liquid to the suction of pump.

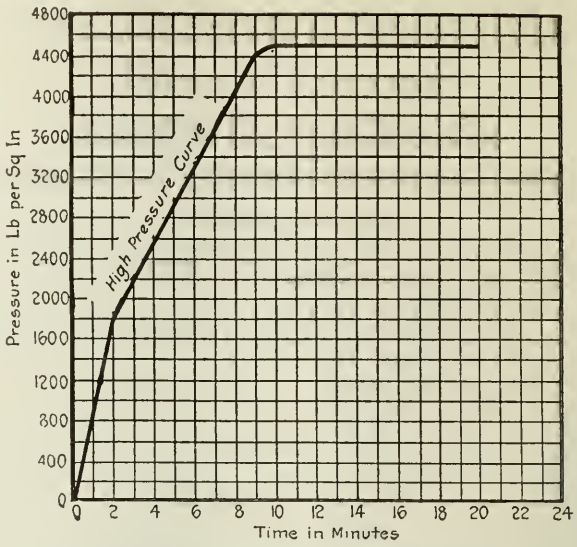


FIG. 2—PRESSURE CURVE WITH PLUNGERS WORKING AT 60 STROKES PER MINUTE

The use of this pump in supplying pressure to the presses used in the vegetable-oil industry obviates the necessity for any outside controlling devices such as safety valves, retarding, or choker valves, etc.

The power required is the minimum for the amount of work being done. The peak load comes when the pressure reaches 1,800 to 2,000 lb. per sq.in., and while the plungers are still moving full stroke. But from the moment the plungers begin to yield and the pressure continues to rise until it reaches the maximum and the plungers cease to move, the power required decreases; so that the maximum pressure is maintained with little more power than is actually necessary to overcome the friction of the moving parts of the machine.

Fig. 2 shows the pressure curve obtained by this pump when the plungers are making 60 strokes per minute.

This constantly and gradually increasing pressure, especially above 1,800 lb. per sq.in., obtains the maximum oil extraction due to the fact that the density of the material being pressed is increased very slowly. This gives time for the oil to be forced out of the material with the least possible resistance which would be set up in case the density was increased too suddenly by a rapid rise of pressure.

[1]Davidson & Kennedy, oil mill engineers and manufacturers. Mem. Am. Soc. M. E.

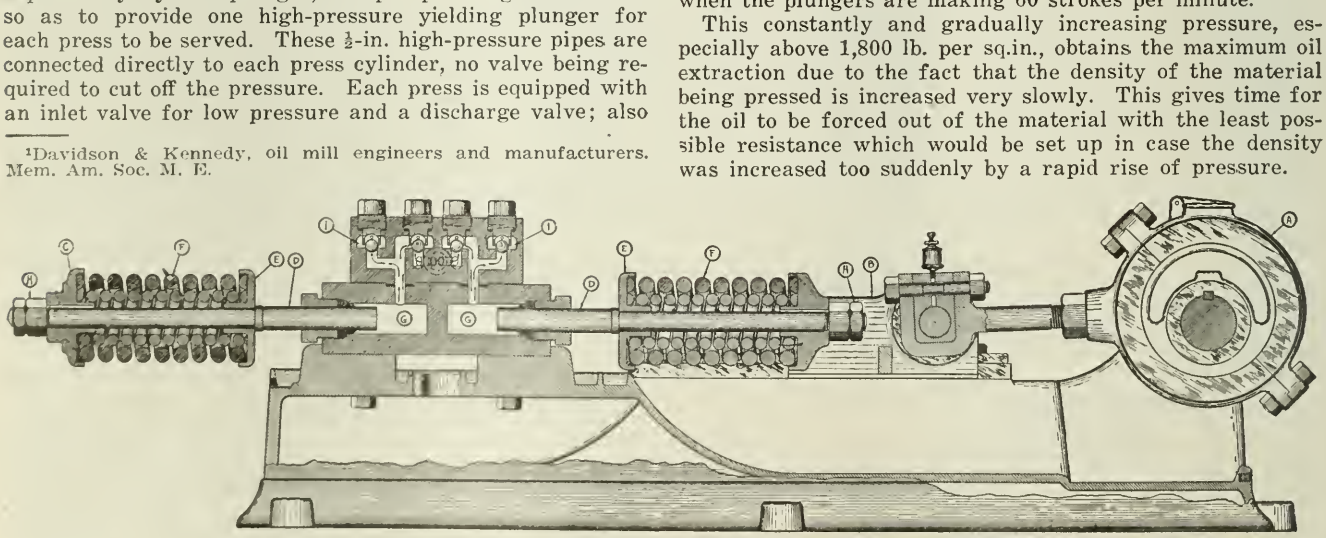


FIG. 1—LONGITUDINAL SECTION THROUGH HIGH-PRESSURE PUMP WITH YIELDING PLUNGERS

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Appropriations Announced for Chemical Projects of Department of Agriculture

The appropriation bill carrying funds for the Department of Agriculture for the year beginning July 1 is now a law, having been approved by the President. For the Bureau of Chemistry the bill appropriates a total of $1,277,631, of which $954,561 is for various investigations and $323,070 for administrative expenses.

Among the appropriations made are the following: Investigations relating to the application of chemistry to agriculture, $75,400; co-operation with other government departments desiring chemical investigations, $14,000; investigation and experiments in utilization for coloring, medicinal and technical purposes of raw materials grown or produced in the United States in co-operation with persons, associations or corporations, $56,260; investigations to determine methods for manufacture of table sirup and sugar and methods for manufacture of sweet sirups by utilization of new agricultural sources, $15,000; enforcement of food and drug act, including investigation of character of chemical and physical tests applied to American food products in foreign countries, $671,401; enforcement of act forbidding importation of impure tea, $38,000; investigation of naval stores, $10,000; investigation and development of methods of manufacture of insecticides and fungicides, $20,000; study and improvement of methods of dehydrating materials used in food, $20,500; investigations to prevent grain dust and other plant dust explosions, $25,000; investigation and development of methods of utilization of wool scouring, $9,000.

The Bureau of Soils is given $23,110 for chemical investigations of soils and $70,000 for fertilizer investigations.

The Bureau of Public Roads is given $175,000 for investigation of chemical and physical character of road materials and $15,000 for supervision of distribution of picric and other acids in clearing lands. For enforcement of the insecticide act $31,500 is provided for salaries and $156,510 for general expenses.

Sentiment Favors Embargo on Helium Exports as Military Precaution

Legislation proposing an embargo on helium exports, which soon is to be considered by a committee of the House of Representatives, differs from embargoes on commercial articles, it is pointed out, in that helium is primarily a weapon of warfare. Moreover, it is a weapon on which the United States has a monopoly. It seems to be the consensus among army and navy officials concerned with helium that it would be foolish to permit the exportation of this gas to a possible enemy.

The helium bill, it is further pointed out, does not put the government into business. There are numerous precedents in which the government develops fundamental facts and brings a process to the point where it can be developed commercially. In the case of helium, the cost of experimental work and the uncertainty as to its outcome would have precluded exploitation of helium resources by private capital indefinitely.

Syracuse Section, A.C.S., Elects

At a recent meeting of the Syracuse, N. Y., Section of the American Chemical Society held at Syracuse University the following officers were elected: A. C. Houghton, Solvay Process Co., president; Prof. Ross A. Baker, Syracuse University, vice-president; L. C. Jordy, Syracuse University, treasurer, and William Hicks, secretary.

Five-Year Course for Engineering Students Favored by Conference of Educators

Five year courses for students in engineering were favored by the deans and representatives of fourteen colleges at a conference held in Chicago, May 19. It was agreed that the first four years should be broadened to include more fundamental subjects and less highly specialized engineering and the last year should be devoted to intensive specializing in the chosen field. It is hoped that this concerted action will bring about the publication of the new courses of study in time to be effective not later than 1924. The resolutions embracing the conclusion of the conference follow:

> The undersigned engineering deans, directors and representatives, in conference assembled, hereby
>
> Resolve: That in order to meet the constantly enlarging responsibilities of the engineering profession we favor an advance in engineering education at this time that shall provide for five years of collegiate training for those engineering students whose aim is to be qualified to take positions among the creative leaders in the profession, and that such advance shall be made in substantial accordance with the following plan:
>
> 1. Remodel the present four-year engineering curriculums by substituting a substantial proportion of humanistic and fundamental subjects in place of an equivalent amount of advanced technical work. It is desirable that so far as possible the curriculums in the different branches of engineering shall be sufficiently uniform to permit students to defer their final choice of a specialty at least to the end of the second year.
>
> 2. Add a fifth year of advanced work, mostly or wholly technical and specialized to such an extent as desired.
>
> 3. The first four years of work shall lead to a bachelor's degree, and the fifth year to an advanced degree in engineering.
>
> Resolved: That each member of this conference will present the above recommendations to the authorities of his institution, and will report back at the second session of this conference, which is to meet at Urbana, Illinois, during the week of June 18, 1922, on call of the chairman.

Dean W. G. Raymond, State University of Iowa, Iowa City, Iowa, chairman; Dean O. N. Leland, University of Minnesota, Minneapolis, Minn., Secretary; Dean E. A. Hitchcock, Ohio State University, Columbus, Ohio; Dean A. A. Potter, Purdue University, Lafayette, Ind.; Dean M. E. Cooley, University of Michigan, Ann Harbor, Mich.; Dean G. W. Bissell, Michigan Agricultural College, Lansing, Mich.; Dean C. R. Richards, University of Illinois, Urbana, Ill.; Director J. F. Hayford, Northwestern University, Evanston, Ill.; Prof. Edward Bennett, University of Wisconsin, Madison, Wis.; Dean E. J. Babcock, University of North Dakota, Grand Forks, N. D.; Dean O. J. Ferguson, University of Nebraska, Lincoln, Neb.; Dean Anson Marston, Iowa State College, Ames, Iowa; Dean W. E. McCourt, Washington University, St. Louis, Mo.; Dean H. S. Evans, University of Colorado, Boulder, Col.

Aluminum Company Sues on Nitro Sale

The International Aluminum Co. has filed suit in federal court against the Charleston Industrial Corporation, the Virginian Power Co., A. B. Leach & Co., James Douglass, H. G. Scott, D. C. Schaeffer, C. S. Jenner and W. B. Payne, in connection with the transaction by which the federal government sold its $125,000,000 war-time explosive plants at Nitro for $3,000,000.

The International Aluminum Co. is asking damages of $50,000.

Better Progress on Tariff Bill—Dye Schedule Will Meet Opposition

Reports from Washington as to the chances of the passage of the tariff bill are more encouraging. Republican leaders believe that the filibuster is about spent and look for more rapid progress from this time forward, with the prospects favoring the passage of the bill late in July. Most of August would be required for the conference between the two houses. There are some who do not expect to see the bill become a law until after the November elections, but the consensus among Republican leaders is that the new tariff act will bear a September date.

May Abandon Dye Embargo

It is expected that Democratic opposition to the dye provisions of the tariff bill will get a great deal of Republican support. Senator George H. Moses of New Hampshire, Senator La Follette of Wisconsin and possibly Senator Lenroot of that state and Senator Norris of Nebraska may line up against the Republican program of protection for the dye industry. Senator Smoot of Utah is opposed to the embargo.

In the event that Senator Frelinghuysen of New Jersey, who is leading the proponents of the embargo plan, fails to "sell his idea" to the Senate it is probable that this type of protection will be dead for all time. High rates, however, will be provided and little or no opposition will be raised to protection by tariff rates.

Protests on Potash Rates

Senator Heflin of Alabama opposed the tariff on arsenic potash and fertilizer on the ground that it would be a burden to the farmers. Other protests on fertilizer rates are being registered by a committee of the National Fertilizer Association, which, on a platform of "free plant food," is in Washington favoring the free importation of potash, ammonium sulphate and nitrogenous waste of leather and tanning factories. The committee consists of Horace Bowker of New York, W. D. Huntington of Baltimore, F. H. Whipple of Hartford and J. Russell Porter of Atlanta, president of the Southern Fertilizer Association.

The Southern Fertilizer Association, through its president J. Russell Porter, has entered a protest against the potash tariff in a telegram to the House Ways and Means Committee.

"The Southern Fertilizer Association is strongly against a potash tariff," says the protest. "The burden of such a tariff will fall heaviest upon the Southern cotton farmer, and anyone at all familiar with the condition of the cotton farmer knows he is not able to bear it. Not only has the Southern farmer suffered heavily in consequence of the reverses of the deflation period, but on top of that has come the greatest disaster from the boll weevil ravages that the South has ever experienced.

"The cotton farmer is heavily in debt. His rehabilitation largely depends on fertilizers, and every cent added to the cost of fertilizers by the Fordney tariff bill will delay the time and increase the difficulties of his recovery.

"According to the provisions of the Fordney tariff bill, the cotton farmer must pay $25 more per ton on his sulphate or muriate of potash than he would pay if there were no tariff. It means just that much handicap to the cotton farmer in fighting his way back to prosperity.

"The tobacco farmer and truckers, though not in as deplorable a condition as the cotton farmer, would feel the tariff keenly, because these crops require large amounts of potash."

Paint and Pigment Schedules Passed

The Senate adopted the duty of 28 cents a pound on vermilion reds containing quicksilver, rejecting a motion of Senator Simmons of North Carolina to reduce it to 15 per cent ad valorem, by a vote of 18 to 31.

The duty of 30 per cent on paints, colors and pigments was adopted by the Senate, which on motion of Senator Smoot, for the Finance Committee, struck out the provision that any of these articles composed in chief value of coal-tar dyes or colors shall be classified under the coal-tar products schedule at 60 per cent ad valorem and 7 cents a pound.

On motion of Senator Smoot the Senate reduced the duty on strontium from 50 to 25 per cent ad valorem on the ground that the product is virtually controlled in this country by one concern.

The Senate then voted on various lead pigment duties, defeating by 21 to 47 an amendment of Senator King reducing the litharge duty from 2½ to 1½ cents a pound, and then adopting the 2½-cent duty.

Senator Jones of New Mexico argued that there was no justification for a duty on lead pigments, except the compensatory duty for the lead ore duty. An amendment by him to reduce the red lead duty from 2¾ to 1½ cents a pound was defeated, and the 2¾-cent duty adopted. An amendment by Senator Jones reducing the white lead duty from 2½ to 1½ cents a pound was also defeated 19 to 47.

On motion of Chairman McCumber, the Senate reduced the duties on chrome colors in paragraph 67 from 30 to 25 per cent ad valorem, defeating an amendment by Senator King to reduce them to 20 per cent, by a vote of 20 to 46. The duty on iron oxide and iron hydroxide pigments was reduced from 25 to 20 per cent ad valorem. By a vote of 21 to 42 a motion by Senator Underwood of Alabama to reduce the duty to 10 per cent was rejected.

Following extended debate in which the rates were attacked by Senator Jones of New Mexico, the Senate adopted the zinc oxide rates. The rates adopted are 1¾ cents per pound on zinc oxide and leaded zinc ores containing not more than 25 per cent of lead; ground or mixed with oil 2¼ cents per pound; lithopone 1¾ cents a pound.

On motion of Senator Smoot, the duty on thorium nitrate and oxide was reduced from 45 to 40 per cent. The duty on tin compounds was fixed at 25 per cent ad valorem, the Senate rejecting by a vote of 14 to 39 a motion of Senator Jones of New Mexico to reduce it to 10 per cent. The antimony salts duties as recommended by the committee were also adopted.

Army Engineers Urge Hydro-Electric Development of Tennessee River

The mineral resources and power possibilities of the Tennessee River and its tributaries in North Carolina, Tennessee, Alabama and Kentucky are the subject of exhaustive reports of army engineers transmitted to Congress. Reference is made to possible power developments on the river from Chattanooga to Riverton; and at Coulter Shoals, 40 miles below Knoxville. Recommendation is made that a more detailed survey be authorized looking to development of the rivers for navigation and power purposes.

The reports show that a large amount of hydro-electric power is now wasted annually in the upper section of the Tennessee River. It is stated that at Coulter Shoals a minimum 24-hour capacity of 14,000 hp. can be developed. Its transmission would be principally to Knoxville, where there is said to be a demand for power in excess of the supply. It is stated that for 90 per cent of the time in an average year 18,400 hp. would be available, while for 57 per cent of the time from 40,000 to 44,000 hp. may be developed. The initial cost of the project at Coulter Shoals is estimated at $6,346,500 and $257,300 annually for operation if built by the government. If built by private enterprise, the initial cost would be increased by $400,000.

Association of Chemical Equipment Manufacturers Announces Committee on Exposition Plans

A committee has been appointed by Dr. C. H. Kimberly, acting chairman, to work out plans for the future exposition exhibits of the Association of Chemical Process Equipment Manufacturers. The association was organized at a meeting in New York on May 11.[1]

The personnel of the committee is as follows: W. W. Smith of the Duriron Co., chairman; A. H. Stevens, of the Bethlehem Foundry & Machine Co.; H. T. Matthew, of the Quigley Furnace Specialty Co.; R. C. Campbell, of the United Filters Co. and C. L. Bryden, of the Vallez Filters Co.

[1]See Chem. & Met., vol. 26, No. 20, May 17, 1922.

Tariff Commission Issues Preliminary Summary of Census of Dyes and Coal-Tar Chemicals

A preliminary summary of Census of Dyes and Coal-Tar Chemicals, 1921, has been issued by the Tariff Commission on the request of Senator McCumber, chairman of the Finance Committee. This summary represents a special investigation made by the Tariff Commission as to the production and sales of dyes and other coal-tar chemicals in the United States. The final report will appear later under the title "Census of Dyes and Organic Chemicals, 1921."

The preliminary survey is based upon the production of 200 firms. It contains a brief summary of important developments in the output of dyes and coal-tar chemicals during 1921. Detailed tables are given showing the production of crudes, dyes and intermediates, and other coal-tar chemicals in 1921. In addition these tables contain, for the first time, the quantity and value of the sales of each product. Figures for each product are given in all cases where publication does not reveal the operations of individual manufacturers. Prices of a selected list of dyes from 1917 to 1921 are tabulated, with the invoice values of the same dyes imported in 1914. Comparison tables showing the quantity of production in 1920 and 1921 are given; also a comparison of the production of dyes classified according to method of application.

A detailed census of dyes imported for consumption in the United States during the calendar year 1921 is contained in the report. This tabulation shows the quantity and value of imports of individual dyes and the percentage of the quantity of each dye by countries or origin. A list of manufacturers whose production during 1921 was reported to the Tariff Commission is also included.

Affiliated Technical Societies of Detroit Hear Tour on Atmospheric Nitrogen

At a meeting of the Affiliated Technical Societies of Detroit, Mich., in that city on May 19, R. S. Tour, professor of chemical engineering at the University of Cincinnati, spoke on the fixation of atmospheric nitrogen.

The importance and necessity of nitrogen production was first mentioned in its relation to nitrogen fixation and the three commercial processes were described in a general way and their relative advantages and disadvantages stated. With the aid of lantern slides, the applications of the cyanamide and Haber processes at the United States nitrate plants were pointed out. The conditions under which these plants were built and their relation to the power project at Muscle Shoals were also considered. Finally, the proposals now before Congress for the private operation of the Muscle Shoals project were mentioned and their important points described. The address was followed by two reels of films showing Nitrate Plant No. 2 in construction and operation.

Badische Reports Increased Earnings

According to the *Boersen Courier* the Badische Anilin- und Soda-Fabrik realized in 1921 gross earnings of 404,733,311 marks, against 194,185,659 for the previous year. The net profit stands at 165,261,933 marks, as compared with 65,184,493 for 1920, and the dividend on the ordinary shares is 30 per cent, against 20 per cent last year, but owing to the increase of capital the amount distributed this year to ordinary shareholders is 120,000,000, compared with 36,000,000 last year. The report states that the Oppau ammonia works resumed operations in December and has been working at full capacity since February.

Charge Illegal Dye Sales Methods

The Federal Trade Commission has issued formal complaint against Dudley G. Gessler, engaged in selling dye and dyestuffs, in Philadelphia, Pa. The respondent has thirty days in which to answer, after which the case will be tried on its merits.

Respondent is charged with giving cash commissions or gratuities in substantial amounts to textile mill operators and supervising officials of customers to secure purchase for respondent's commodities over and to the exclusion of respondent's competitors' commodities.

Synthetic Chemical Industry Championed in House as Giant of Utility

A plea for support instead of criticism of the synthetic chemical industry was made by Representative Layton of Delaware in a speech before the House in which he characterized the synthetic chemical and the electrical industries as twin giants of modern power and usefulness.

Mr. Layton stated that while electricity enjoys the approbation of the public, the synthetic chemical industry is surrounded by ignorant prejudice which retards its progress and may if continued extinguish its development. He charged that the cry against those engaged in the national development of the synthetic chemical industry came from demagogue, German interests and the selfishness of the textile industry. The Congressman recalled the former public aversion to the steel, oil and copper interests, but said they were now looked on with pride as being part of our national strength and greatness.

"But when now the question of dyes comes up, involving the potentiality of our wage," he continued, "a howl of protest is raised against those engaged in manufacturing this and other products of coal tar as if some enormity were being perpetrated or perfected against the welfare of the people, notwithstanding the fact that synthetic chemistry and its results are paramount to any other scientific pursuit with characteristics of a fundamental necessity in peace and war. This is an age of chemistry. The dreams of the ancient alchemists have come true. The chemical laboratory possesses a greater productive power for health, agriculture, national defense, for use in textiles, for bodily ailments and for a multitude of other things than we find in all the electrical, steel or other establishments of the land."

Mr. Layton emphasized the great importance of fostering protection and establishment upon sure and impregnable basis of the industry founded upon science. It would be stupidly criminal for Congress to be influenced by forces that seek to destroy the industry, he asserted. He referred to Senator King of Utah as the chief champion of the interests of the German dye manufacturer in opposing the dye industry, and closed by advocating protection for the American industry.

Sodium Nitrate Awards

Seventy-nine bids were received by the Director of Sales for the 16,450 short tons of sodium nitrate sold on May 17. The average price received was $38.44. The successful bidders were as follows:

Trojan Powder Co.	Allentown, Pa.	200 tons	$42 20
Hubbard Fertilizer Works	Baltimore, Md.	100 tons	42 00
Senior Powder Co.	Cincinnati, Ohio	100 tons	41 40
Trojan Powder Co.	Allentown, Pa.	200 tons	41 20
Senior Powder Co.	Cincinnati, Ohio	100 tons	41 20
G. F. Taylor, Inc.	New York City	200 tons	41 00
Senior Powder Co.	Cincinnati, Ohio	100 tons	40 70
King Powder Co.	Cincinnati, Ohio	500 tons	40 50
Senior Powder Co.	Cincinnati, Ohio	100 tons	40 30
E. I. du Pont de Nemours	Wilmington, Del.	2,000 tons	40 30
Trojan Powder Co.	Allentown, Pa.	200 tons	40 20
Grasselli Chemical Co.	Cleveland, Ohio	1,000 tons	40.00
International Agricultural Corp.	New York City	165 tons	40.00
Granton Chemical Co.	New York City	375 tons	40.00
G. F. Taylor, Inc.	New York City	200 tons	40 00
Farmers Fertilizer Works	Elizabethtown, Pa.	100 tons	40.00
York Chemical Works	York, Pa.	100 tons	40.00
Trojan Powder Co.	Allentown, Pa.	200 tons	39 20
Union Explosives Co.	Clarksburg, W. Va.	250 tons	39.00
G. F. Taylor, Inc.	New York City	200 tons	39.00
Calco Chemical Co.	Bound Brook, N. J.	400 tons	38.50
Trojan Powder Co.	Allentown, Pa.	200 tons	38.20
Merrimac Chemical Co.	Boston, Mass.	150 tons	38.20
Wessel-Duval & Co.	New York City	4,000 tons	38.10
G. F. Taylor, Inc.	New York City	200 tons	38.00
Hubbard Fertilizer Works	Baltimore, Md.	100 tons	38 00
York Chemical Works	York, Pa.	100 tons	38.00
Atlas Powder Co.	Wilmington, Del.	5,000 tons	38.00

Power Company Supplements Shoals Offer

An offer to the War Department to purchase the Gorgas power plant and the government's interest in the railroad and transmission line from Gorgas to Muscle Shoals for $2,500,000 has been made by the Alabama Power Co. The offer has been submitted to the Senate Agriculture Committee by the War Department, this committee having under consideration the various lease offers.

Committee on Agriculture Investigates Charges of Fertilizer Monopoly

Charges which have been made in both houses of Congress of an alleged fertilizer trust are being investigated by the Senate Committee on Agriculture in connection with its consideration of the lease offers for Muscle Shoals. Secretary of Agriculture Wallace will be among those heard by the committee in an effort to get at the truth.

The charges that a "fertilizer trust" controls prices, fixing them so high that the farmers are unable to buy in quantities sufficient to meet their needs, were declared to be largely without substance by Francis L. Hawes, of the Federal Trade Commission.

Mr. Hawes told of the investigation of the fertilizer industry concluded in 1915 by the Federal Trade Commission, and declared that so far as the commission had learned since that time there was "no combination in restraint of trade" in the fertilizer business. Supply and demand, he said, were the factors regulating the industry at the present time. The committee, however, decided to look into the charges further.

Dedication of State Ceramics Building Arranged by Ceramic and Clay Workers' Societies

The New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society is perfecting arrangements for the dedication of the new state ceramics building at Rutgers College, State University of New Jersey, New Brunswick, on June 13, to be carried out during the regular annual commencement period at the institution. The building is now nearing completion, and represents an aggregate investment of close to $125,000, including donations made by companies in the industry in the state and vicinity. Brief addresses will be made by a few prominent speakers, including R. H. Minton, president of the Clay Workers' Association.

On the day following, June 14, the association will hold its regular mid-year meeting at the Country Club at Trenton, N. J. The business session will be limited to the afternoon, the morning being given over to sports and sightseeing, with possible visits to local potteries.

Petroleum Testing Methods Published

The long-promised report on "Methods for Testing Petroleum Products" as adopted by the Government Interdepartmental Petroleum Specifications Committee, is now available as Technical Paper 298 of the Bureau of Mines. These methods are formulated in what is virtually a handbook for inspecting laboratories. The use of the methods is compulsory under government purchases. The specifications required for such government purchases are included in another technical paper of the bureau also issued recently. It is Technical Paper 305 of the Bureau of Mines.

It is being urged that the standard testing procedures and the standard specifications thus recommended by the government be widely adopted in the interest of uniformity of petroleum marketing and tests. Copies of each paper can be obtained on application to the Bureau of Mines.

Chemical and Oil Company Organizations

During the month of April twenty companies were organized with a capital of $50,000 or larger to manufacture chemicals, chemical byproducts, drugs, etc., with aggregate capitalization of $20,055,000. This compares with a total of twenty-five such concerns formed in March, with combined indicated capital of $12,625,000. In the corresponding month of April of a year ago the aggregate capitalization of new companies formed was $9,390,000.

In this same month, April, 1922, ninety-five oil companies were organized, with an indicated gross capitalization of $154,590,000, as compared with an aggregate of seventy-nine oil companies, with capital of $50,000 or larger, formed in the preceding month, with combined capital of $156,571,000. In the same month of April a year ago 110 such companies were chartered, with a gross indicated capital of $227,470,000.

Personal

William Hutton Blauvelt has resigned his position with the Semet-Solvay Co., of Syracuse, N. Y., and has opened an office as consulting engineer in the Equitable Building, 120 Broadway, New York City, where he will give special attention to the carbonization of fuels and allied subjects. Mr. Blauvelt has been connected for many years with the Semet-Solvay and Solvay Process companies, and has taken a prominent part in the development of the byproduct coke industry in America. On account of his broad experience in the carbonization of coal, production of gas for domestic and industrial purposes, the recovery of byproducts and the general utilization of fuels, he is a recognized authority on these subjects. The first important installation of byproduct recovery gas producers, of the Mond type, was brought to this country and put into operation under his direction during the earlier years of his association with the Solvay companies.

F. F. Chapman of E. I. du Pont de Nemours & Co. is on a prolonged tour of the Western acid plants of the company.

Bjarne Colbjornsen, chemical engineer of the Stockholm Superphosphate Works, is in this country, making a survey of American fertilizer manufacturing practice.

Prof. A. C. H. Fasig, head of the department of applied sciences of Muhlenberg (Pa.) College, addressed the Kiwanis Club, Allentown, Pa., at its regular weekly dinner meeting at the Hotel Allen, May 18, on the subject "The Growth of Chemistry in the United States."

Francis J. Hall, vice-president of the Central Iron & Steel Co., Harrisburg, Pa., and connected with the company for the past 20 years, has resigned, effective May 31.

John R. Johnson, who will receive his doctor's degree in June from the University of Illinois, has been awarded one of the Field scholarships to France. He will continue his research at the Sorbonne.

Hugo C. Larson, of the University of Illinois, has received a fellowship from the Scandinavian-American Foundation and will sail in June for Stockholm, where he will work in the Royal Technical Institute on the metallurgy of special steels.

F. J. Metzger was elected vice-president of the Air Reduction Co., Inc., in charge of research and development, at a meeting of the board on May 24.

Frank R. Miller has left the American Agricultural Chemical Co. after 38 years of service, to open an office as an "advertising engineer" in the Widener Building, Philadelphia, Pa.

H. Stirling Snell has just returned from a trip of inspection through some of the principal French chemical manufactories in the interest of William Heap & Sons, of Grand Haven, Mich., with which concern he is connected.

Charles R. Spare has been elected president of the American Manganese Bronze Co., Philadelphia, Pa., with plant in the Holmesburg Junction section. He organized the company about 15 years ago and is the inventor of the bronze manufactured by the company.

Prof. Haakon Styri, director of research, SKF Laboratories, Philadelphia, discussed before the Washington Chapter of the American Society for Steel Treating on May 22 the subject "Preparation and Heat-Treatment of Ball-Bearing Steel."

Obituary

Edward G. Locke, founder of the Locke Glazed Paper Co., Philadelphia, Pa., died at his home at Camden, N. J., on May 16, from paralysis. He was 65 years of age. Mr. Locke is survived by his wife and a daughter.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Our Service Department

A great many things come to an editor's desk and no small proportion of them are questions. Subscribers, advertisers and casual readers are constantly writing in for information and the editorial department of a technical magazine is looked upon as a depository replete with miscellaneous knowledge of practically every field of human endeavor. To some small extent, perhaps, this is justifiable, for in general the editor's experience is remarkably catholic and a wide range of informational sources is usually available to him.

CHEM. & MET.'S editorial staff is no exception to this rule and certainly if we are to judge from some of the appreciative letters which we have recently received from our readers, the practice has come to be regarded as a valuable part of the magazine's service to industry. CHEM. & MET. has gradually developed within its organization an informational bureau equipped to supply data on practically every phase of the chemical, metallurgical and allied industries. This service is offered to its readers with the single reservation that it is in no sense competitive with the admirable work of the professional consultant. In fact we consider it a part of our service to recommend to our inquirers the consulting chemists and engineers who are best qualified to handle the research problems that lie beyond the natural limitations of a gratuitous informational bureau. Technical problems concerning processes, producing operations and equipment are so closely related to editorial matter that they have always received special attention. Furthermore, our research department stands ready to co-operate in locating new sources and uses for materials and equipment.

Naturally the market editors receive a goodly share of these queries, for their field touches on the products of all our industries. In these letters from our readers it is the commercial and economic information about particular commodities that is most often sought. Latest statistics on production, consumption, imports and exports are in demand and in most instances they can be supplied without delay. Others of our readers are desirous of following the trend of prices over some definite period or in greater detail than is afforded by our weighted index number. And, too, we are often asked to review conditions affecting the market for an individual chemical or metallurgical product. Such factors as tariff changes, embargoes and strikes have a prevailing influence on market conditions, and it is our business to keep in touch with these developments.

Our service department has been designed to serve our readers and all are invited to make use of it. Pertinent inquiries will receive careful, intensive study and every effort will be made to supply reliable information bearing on the problems of the chemical and allied industries.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	157.72
Last week	160.49
May, 1917	222
May, 1920	279
April, 1918 (high)	286
April, 1921 (low)	140

The sudden recession of the index number during the past week has resulted from the lower prices quoted for several of the most important commodities on which the index is based. Thus the decline of ammonium sulphate, caustic soda and cottonseed and linseed oil was sufficient to cause a drop of almost 3 points. The fall in the case of linseed oil amounted to 4 cents on the gallon.

The Ten Per Cent Reduction in Freight Rates

Excessive transportation charges are generally regarded as one of the most important factors affecting costs in the chemical and allied industries. These are the industries that furnish most of the basic materials of commerce, and no small share of the delivered cost of their products is directly attributable to the freight rates. Particularly is this true in the case of the heavy chemicals and other bulky materials of comparatively low unit costs.

The general rate reduction of 10 per cent, announced by the Interstate Commerce Commission on May 24, is of more than usual significance, therefore, to the industries that make materials. This is evidenced by the fact that in extended investigation, which began last December and concluded March 15, the commission paid particular attention to such basic commodities as coal, iron and steel, cement, fertilizers, petroleum, paper and pulp and to miscellaneous chemical products such as the alkalis, creosote oil, explosives, glass, insecticides, naval stores, soda ash, etc.

The Commission's Findings

The commission found that on and after July 1, 1922, freight rates would be unreasonable to the extent that they may exceed the rates in effect Aug. 25, 1920, by specified percentages in the various rate groups of the country, so applied to make reductions in each group equivalent to 10 per cent. These percentages are as follows:

In the Eastern group, also between points in Illinois territory and between Illinois territory and the Eastern group, 26 per cent instead of the 40 per cent authorized in the last decisions.

In the Western group, and between the Western group and Illinois territory, 21.5 per cent instead of the 35 per cent previously authorized.

In the Southern and mountain-Pacific groups, 12.5 per cent instead of the 25 per cent previously authorized.

On interterritorial traffic, except as otherwise provided, 20 per cent instead of the 33⅓ per cent previously authorized.

These rates, in the opinion of the commission, will enable the railroads to earn a net return of 5.75 per cent upon the aggregate value of railway properties. This is a reduction of one-fourth of 1 per cent in the fair return authorized March 1, 1920. It is also pointed out that the 10 per cent reduction does not apply in the case of reductions which have been made since August, 1920, except in cases where reductions have been made for the purpose of equalizing rates and correcting inconsistencies.

Freight Problems in the Process Industries

The commission's report, which bears the title "Reduced Rates, 1922," contains a number of interesting references to the freight problems of the chemically controlled industries. Under the heading "Cottonseed Products, Vegetable Oils and Soap," the report makes the following comment:

There are about 750 cottonseed-oil mills in the cotton-growing territory of the South. They represent an investment of about 250 million dollars and crush 85 per cent of the cotton seed produced. The products are cottonseed oil, meal, hulls and linters. In 1921 this industry brought its costs down materially below those of 1920. About 500 of the mills were operated in the season 1921-22, 300 of them continuously. The failure to operate more nearly to capacity is attributed in part to high freight rates.

Soap moves for the most part in carlots from factories to distributing points, but there is also a considerable less-than-carload movement from factories. From dis-

tributing points the movement is in less than carloads. The principal raw materials used are fats, greases and oils. Caustic soda, soda ash, lime and borax are also largely used. The aggregate inbound and outbound tonnage of materials and product was estimated at 3,000,000 tons annually, much of it moving for considerable distances. Delivered prices of soap were said to be about 33⅓ per cent over those of 1914. The soap manufacturers asked that as soon as a reduction in rates is possible it be made horizontally in all rates.

The paper manufacturers asked for rate reductions not only on their finished product but on their raw materials such as woodpulp, coal, clay, sulphur, resin and tallow. Between 3 and 4 tons of these materials are required to produce 1 ton of newsprint. The principal contention of the papermakers was that the rates on paper from New England were relatively lower than those in effect from Western mills. The New England shippers urged the commission "to prescribe rates on newsprint paper not exceeding 80 per cent of the rates on book, printing and wrapping paper, with sixth-class rates as maxima, and further that reductions should be made from New England to Chicago and Western points, even though reductions were not made from the Western mills. They also contended that, if reductions are to be general, the rates from New England to points in the Eastern group should be lowered to a greater extent than rates from Western mills."

The commission declared, however, that the evidence does not warrant fixation of the proper rate relationship between these competing mills.

The report points out that the fertilizer industry is most seriously concerned with transportation charges for two reasons: (1) The manufacturer pays both the freight on his raw materials and the outbound charges on the finished product. (2) The price of fertilizer is very closely approaching its 1914 price. This is recognized by the commission, which reports on the situation as follows:

> The extent to which fertilizer is used is determined to a considerable degree by the farmer's ability to obtain credit. This is confirmed by the carriers. Local dealers or distributors have been accustomed at the beginning of the planting season to extend such credit to mature with the crops, in turn depending upon the fertilizer manufacturers for credit. Some of these manufacturers said that since the price to the farmer is practically upon a pre-war level, rate reductions must be made, and the benefit retained by them in order to enable them to continue the customary extension of credit, thereby indirectly benefiting the farmer. Others said that a reduction will immediately inure to the purchaser.
>
> The fertilizer for use in production of this year's crops has already moved, but the annual movement of raw materials into the fertilizer plants does not begin until May. Fertilizer manufacturers asked that reductions ranging from 20 to 25 per cent be made on fertilizer materials and that on fertilizer we prescribe for the southern group a distance scale of rates suggested by them.

The New York Market

New York, May 29, 1922.

Activity in the chemical market during the past week was limited to a few special items and a feature among these has been the recent strength of the prussiates. Both the soda and the potash salts have recorded new high levels for the year, with the former showing pronounced advance because of the scarcity of spot material. Caustic soda remained very firm for nearby shipments of standard brands. The export demand continues in good proportions from continental Europe, Italy and the Far East. British and French prices remain considerably above American prices and this condition is causing a demand for American goods. Soda ash continues along its former lines, with demand only moderate for domestic and export consumption. Permanganate of potash was a shade easier due to competition. Arsenic is showing the effect of renewed interest and the market was somewhat firmer. Copper sulphate continues very strong, with a steady demand for domestic consumption. There has been very little business done in the rest of the list and the general buying movement was quite irregular.

General Chemicals

Arsenic—Some improvement is recorded in this item from consuming quarters and sellers are asking 7¼@7½c. per lb. for spot and nearby shipments of the white powdered. Supplies are not very heavy and the market is set for an advance.

Barium Chloride—Dealers of spot material report a pronounced scarcity. Producers, however, are offering material at $95 per ton f.o.b. works. Quotations among resale dealers range around $100@$105 per ton. June delivery from abroad is held at $95 per ton.

Bleaching Powder—Domestic factors quote large drums at $1.60 per 100 lb., f.o.b. works. Imported goods remain unchanged at $1.65 ex-dock. The demand is only moderate.

Caustic Potash—Small-lot sales have been made around 6c. per lb. for the imported 88-92 per cent, but a conspicuous absence of round-lot trading was noted. Any additional inquiries will have a strengthening effect on spot prices.

Caustic Soda—Foreign inquiries covering a wide range continue to reach this market and the undertone is quite firm. Domestic shipments of standard brands are quoted at $3.85@$3.90 per 100 lb. f.o.b. New York. Large producers report a steady call for contract shipments.

Chlorate of Potash—Domestic makers quote 8c. per lb. for prompt shipment. Odd lots of imported material are on the market at 6¾@7c. per lb. The inquiry has shown no unusual activity during the past week.

Chlorate of Soda—Sales of spot material are reported by dealers, but only for small quantities at 6½c. per lb. Large lots can be shaded down to 6¼c. per lb. Leading producers quote the market at 6¾c. f.o.b. works. A moderate consuming inquiry is recorded.

Prussiate of Soda—The consuming industry has become more interested in this item during the past week, through reduced spot offerings and the steadily advancing prices. The tone of the market late in the week became exceptionally buoyant and several advances were recorded. Holders were asking 25c. per lb., with only a few odd tons available.

Sal Ammoniac—A few lots of imported white granular were on the market at 7c. per lb. Domestic goods were quoted at 8c. per lb. Gray offerings were not very liberal and most sellers were holding prices at 8c. per lb.

Waxes

Beeswax—The feature in the market was the strength in African Crude, which sold as high as 19½c. per lb. Stocks in all grades are rather light.

Carnauba Wax—Demand for this product was not very active, but prices held steady at primary centers. No. 3 North Country was offered at 16c. per lb. No. 2 North Country held around 25c. per lb.

Japan Wax—There were offerings on spot at 16½c. per lb., with nearby goods quoted at 16c. and futures at 15½c. per lb. The market was somewhat quiet and the general tone was barely steady.

Montan Wax—Supplies were very plentiful on spot and the market was irregular, ranging from 4c.@4½c. per lb.

Paraffin Wax — The domestic demand is up to expectations, but the export inquiry is very dormant and trading is rather quiet. Match wax is moving moderately, with leading dealers quoting 4¼@4½c. per lb. Crude scale, 122-124 deg. melting point, was offered at 2¼c. per lb. Fully refined, 123-125 deg. melting point, sold under 3c. per lb. during the week.

Naval Stores

Turpentine (Spirits) — While trading in general was rather quiet toward the latter part of the week, the advance in prices was sustained and the market closed at 95c. per gal, ex-yard. Supplies on spot were reported limited.

Rosins—Trading in the different grades was active during the past week and with the Southern market higher, prices in the local market advanced from 10@25c. per barrel. The market during the latter part of the week was quiet, but prices ruled steady.

The St. Louis Market

ST. LOUIS, MO., May 23, 1922.

There have been no changes of importance in the industrial chemical market in this locality since our last report. Business continues to increase and prices generally are very firm.

ALKALIS

The *caustic soda* market remains firm and fairly active, the demand for small lots being especially good. Prices have not changed any since our last report, but a gentle rise would not be altogether unexpected. *Soda ash* is remaining uniform both in price and quantity, no variations being felt either way in this market. *Sodium bicarbonate* has become somewhat stabilized since our last report, with no decline noted recently. *Sal soda* continues to move in its regular channels and at uniform prices as of our last report.

GENERAL AND SPECIAL CHEMICALS

Heavy mineral acids continue to move in a fair way. However, a much larger volume of business could be transacted if it were not for the fact that the steel mills are being restrained in their operations, due to the coal situation. One manufacturer reports a good demand from the fertilizer trade. *Citric acid* is still in good demand with no change in price. *Acid tartaric* and *cream of tartar* are beginning to show signs of improvement, and orders of larger volume are now passing. The market for *white arsenic powdered* has shown some slight improvement. Prices generally are firm and quoted at 6½@7c. f.o.b. New York. *Carbon bisulphide*, being a seasonable article, is now moving very freely. *Glycerine* continues weak and although the regular market quotation is 15c. in drums, a good-sized substantial contract was recently placed at less than 14½c. *Sodium fluoride* is now in better demand, with prices firm. *Sulphur* continues in stiff demand and prices need not be expected to drop. The present time is proper for placing large orders, since there is no indication of a decline. The prices quoted in our last report for *zinc sulphate* remain unchanged. However, an advance is anticipated owing to the increase in price for *zinc spelter*.

VEGETABLE OILS AND NAVAL STORES

Linseed oil has not changed since our last report and continues firm at $1.07 basis raw oil. It is rather unusual that the market on linseed oil should not fluctuate in two weeks, but the lack of contract inquiries probably accounts for this. *Turpentine* reached the remarkable height of $1.04 a few days ago, but is now back to $1. With the *rosin* market regaining its natural health, turpentine bids fair to hold up. *Castor oil* is unchanged. Prices firm and demand good.

PAINT MATERIALS

The recent sunshine has worked a wonderful improvement both in demand for material and in the attitude of the grinders. No price changes have been noted, but a fair amount of carload business on dry earth colors has been done recently, the purchasers seeking to get covered before the expected import duty goes into effect.

The Iron and Steel Market

PITTSBURGH, May 26, 1922.

Except for decided activity in connection with three important lines of steel consumption, the turnover in steel products is now light, much lighter than in March and April. The mills are well sold up for a couple of months or more, and buyers, with some exceptions, are well covered. The relation is such that the sellers have the advantage.

The three lines of steel consumption in which active buying at the present time is represented are the building of freight cars and motor vehicles and the erection of skeleton steel work. Freight car orders, having averaged, roughly speaking, about 15,000 cars a month since the first of the year, are still in evidence, even more strongly than in the first 2 or 3 months of the year. The buying is at about the average pace that obtained in the 10 years 1904 to 1913. The proportion of steel production passing to the railroads is, however, greatly reduced, for there is less steel called for by railroads in lines outside of freight cars, and the steel-making capacity is greatly increased.

Production of passenger automobiles this month will probably exceed 200,000 cars, an almost complete report for April having shown 196,412 cars, apart from 21,944 trucks. With steel required for accessories, equipment, etc., the automobile industry at large is probably consuming finished rolled steel at the present time at a rate of nearly if not quite 150,000 gross tons a month. Production of finished rolled steel at a rate of 2,300,000 or 2,400,000 gross tons a month.

In the past 2 months placing of fabricated steel contracts has been approximately equal to the fabricating shop capacity, while contracts in the first quarter of the year represented only a trifle over half the capacity, and the average for the year 1921 was 35 per cent.

STEEL PRICES STRONG

With steel production at only about 70 per cent of the full capacity, a market has been produced as strong as obtained before the war only when the mills were operating at 90 to 100 per cent. The coal strike, apparently, makes the difference.

Bars, shapes and plates are quotable at 1.60c. as the minimum of the regular market, and are by no means easy to buy at that price. Several mills are quoting $2 to $3 a ton more, and are probably booking some business, when prompt delivery is requisite. Particularly attractive orders for plates and shapes may possibly go at concessions, especially if, as in the case of the average freight car order, the negotiations were started long ago.

Hoops are being quoted at 2.25c. It is not long since that the market firmed up to 2c. Apparently the mills have larger delivery obligation than they thought they were taking when they were so eager to sell early in the year. Sheets and tin plates are very stiff at regular prices, while in sheets not a few mills are asking $5@$7 a ton extra.

The higher prices now ruling for steel do not increase profits. The familiar experience of its requiring several months of activity for the mills to dispose of low priced business is being repeated, hence there is particular interest in the subject of steel demand next Autumn. A continuance of present pressure for steel will result in reasonable profits. There is easily enough momentum to carry the mills through the summer, normally a dull period in the market.

PRODUCTION HEAVY

Steel ingot production is running at somewhat over 37,000,000 gross tons a year. Output last December was at a rate of 20,000,000 tons, the rate rising rapidly in 3 months, to about 35,000,000 tons April 1. Since then there has been a slight increase, despite the coal strike.

LOWER COKE PRICES

Connellsville coke, which advanced sharply about 10 days ago, had an equal drop early this week, and is now quotable at $3.25@$3.50 for steam grade. Dealers attribute the drop to Secretary Hoover's interest in coal prices, not that producers voluntarily reduced their asking prices, but that some Eastern buyers, expecting lower prices, withdrew from the market, and the relation between demand and offerings effected the change.

Connellsville coke, on the other hand, has advanced nearly a dollar a ton in the week. Offerings have been very limited and at times there has been practically no inquiry, but a few days ago buying orders began to appear, in connection with the possible resumption of two steel works furnaces. The makers involved appear to be getting such premiums for their steel as to be able to pay rather fancy prices for coke, especially since furnace grade is now $7@$7.50.

The pig iron market remains stagnant, inquiry being almost absent. Prices are practically nominal, at $26 for bessemer, $25 for basic and $24 for foundry, f.o.b. valley furnaces.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	..... –	$0 38 – $0 40
Acetone	lb.	$0 08 – $0 09	.09¼ – .10
Acid, acetic, 28 per cent	100 lbs.	2 35 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9 25 – 9 50	9 75 – 10 25
Boric, crystals	lb.	.11 – .11½	.11¾ – .12
Boric, powder	lb.	.11 – .11½	.11¼ – .12½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	11 – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3 25	3.30 – 3 75
Muriatic, 20 deg. (see hydrochloric)	....	..... –	..... – .....
Nitric, 40 deg	lb.	.06 – .06½	.06¾ – .07
Nitric, 42 deg	lb.	.06½ – .06¾	.07 – .07¼
Oxalic, crystals	lb.	.13½ – .14	.14¼ – .14½
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08¾ – .09½
Picric	lb.	.22 – .24	.24½ – .30
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	15 00 – 16 00	..... – .....
Sulphuric, 66 deg., drums	ton	19 00 – 20.00	20.50 – 21 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19.50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22.50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32 00	33 00 – 34.00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – 45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.28 – .28½
Tartaric acid, imported, powdered	lb.	..... –	.28½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1.10
Alcohol, ethyl	gal.	..... –	4.75 – 4.95
Alcohol, methyl (see methanol)	.....	..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.32 – .34
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.32 – .34
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¾ – .04	.04¼ – .05
Alum, chrome lump	lb.	.07½ – .08	.08¼ – .08½
Aluminum sulphate, commercial	100 lb.	1.50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.31 – .33
Ammonium carbonate, powder	lb.	.07 – .07¼	.07½ – .08
Ammonium nitrate	lb.	.06 – .06½	.06¾ – .07½
Amylacetate tech	gal.	..... –	2.00 – 2.25
Arsenic, white, powdered	lb.	.07¼ – .07½	.07¾ – .08
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium chloride	ton	105.00 – 106.00	107.00 – 110.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21¼ – .22
Barium nitrate	lb.	.06½ – .07	.07¼ – .08
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ – .0	.04¼ – .04½
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	1.60 – 1 75	1.80 – 2.75
Blue vitriol (see copper sulphate)	.....	..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)	.....	..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1.75 – 2.00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24.00 – 24.50	24.75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02¼
Calcium peroxide	lb.	..... –	1.40 – 1.50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.79 – .81
Carbon bisulphide	lb.	.06½ – .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)	.....	..... –	..... – ....
Caustic soda (see sodium hydroxide)	.....	..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04¾ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.05½ – .06
Chloroform	lb.	..... –	.35 – 37
Cobalt oxide	lb.	..... –	2.00 – 2 10
Copperas	ton	20.00 – 22.00	23.00 – 30 00
Copper carbonate, green precipitate	lb.	.19 – .20	.20¼ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	6.00 – 6 15	6.25 – 6 50
Cream of tartar	lb.	..... –	.25 – .26
Epsom salt (see magnesium sulphate)	..	..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.08½ – .08¾	.09 – .09½
Fullers earth, f.o.b. mines	net ton	16.00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30.00 – 32 00	..... – .....
Fusel oil, ref.	gal.	..... –	2 15 – 2 50
Fusel oil, crude	gal.	..... –	1.30 – 1.50
Glauber's salt (see sodium sulphate)	...	..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.15 – .15½
Iodine, resublimed	lb.	..... –	4 20 – 4 25
Iron oxide, red	lb.	..... –	.12 – 18
Lead acetate	lb.	..... –	.09⅝ – 12
Lead arsenate, powd	lb.	.14 – .14½	.14½ – .15½
Lead nitrate	lb.	..... – ...	.15 – .20
Litharge	lb.	.07½ – .08	.08 – .09
Magnesium carbonate, technical	lb.	.08½ – .08¾	.09 – .09½
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2.60	2 65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1 00 – 1 80
Methanol, 95%	gal.	..... –	.57 – 58
Methanol, 97%	gal.	..... –	.59 – 60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.11 – .11½
Phosgene (see carbol chloride)	.....	..... –	..... – .....
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	..... –	.30 – .35

		Carlots	Less Carlots
Potassium bichromate	lb.	.09¾ – .10	.10⅛ – .10½
Potassium bromide, granular	lb.	..... –	.17 – .20
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04¾ – .05	.05½ – .06
Potassium chlorate, powdered and crystals	lb.	.06¾ – .07	.07½ – .08
Potassium cyanide	lb.	..... –	.42 – .45
Potassium hydroxide (caustic potash)	100 lb.	6.00 – 6.25	6.35 – 7.00
Potassium iodide	lb.	..... –	3.30 – 3.40
Potassium nitrate	lb.	.07⅜ – .07½	.08 – .09
Potassium permanganate	lb.	.14 – .14½	.14¾ – .20
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	.32 – .32½	.32½ – .33
Rochelle salts (see sodium potas. tartrate)	....	..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07¾ – .08
Salammoniac, gray, granular	lb.	.07¾ – .08	.08½ – .08¾
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	20.00 –25.00	..... – ....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.90 – 2.00	2.10 – 2.50
Soda ash, dense	100 lb.	1.95 – 2.05	2.10 – 2.60
Sodium acetate	lb.	.05 – .05¼	.05½ – .06
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07¼ – .07½	.07¾ – .08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04¾ – .05½
Sodium chlorate	lb.	.06 – .06½	.06¼ – .07
Sodium chloride	long ton	12.00 –13.00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09 – .09½	.09¾ – .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.85 – 3.90	3.95 – 4.25
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03½	.03½ – .03¾
Sodium nitrite	lb.	.08¾ – .09	.09¼ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03¾ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.25 – .25¼	.25½ – .25¾
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.25
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.05	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04¾ – .04¾	.04¾ – .05½
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03⅞ – .04½
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18 00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran	lb.	.06 – .06½	.06¼ – .08
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.15 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.50 — .55
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.25 — .27
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06¼
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	2.40 — 2.50
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	$0.12 —	$0.15
Ortho-toluidine	lb.	.14 —	.18
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.13 —	16
Paranitroaniline	lb.	.75 —	.77
Para-nitrotoluene	lb.	.60 —	.70
Para-phenylenediamine	lb.	1.55 —	1.60
Para-toluidine	lb.	1.00 —	1.10
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1 35
Resorcinol, pure	lb.	1.75 —	1.80
Salicylic acid, tech., in bbls	lb.	.25 —	.25½
Salicylic acid, U. S. P	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	.25 —	.28
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.10 —	.12
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities.

Bayberry Wax	lb.	$0 20 —	$0.21
Beeswax, refined, dark	lb.	.26 —	.28
Beeswax, refined, light	lb.	.30 —	.32
Beeswax, white pure	lb.	.35 —	.40
Candellila, wax	lb.	25 —	.26
Carnauba, No. 1	lb.	.45 —	.46
Carnauba No. 2, North Country	lb	.25 —	.25½
Carnauba, No. 3, North Country	lb.	.16 —	.16½
Japan	lb.	.16½ —	.17
Montan, crude	lb.	.04 —	.04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04¼ —	....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02⅜ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.02 —	.03
Paraffine waxes, refined, 125 m.p.	lb.	.03 —	.03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04¼ —	.04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05½
Stearic acid, single pressed	lb.	.09 —	.09¼
Stearic acid, double pressed	lb.	.09½ —	.09¾
Stearic acid, triple pressed	lb.	.10½ —	.10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.40 —	$5.55
Rosin E-I	280 lb.	5.70 —	5.90
Rosin K-N	280 lb.	6.00 —	6.60
Rosin W. G.-W. W	280 lb.	7.25 —	7.75
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	96 —	96½
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.10
Pine oil, pure, dest. dist	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y	100 lb.	3.50 —	3.60
Blood, dried, f.o.b., N. Y	unit	3.55 —	3.65
Bone, 3 and 50, ground, raw	ton	27.00 —	28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate soda	100 lb.	2.70 —	2.80
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	3.75
Tennessee, 78-80%	ton	7.00 —	7.50
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0 18 —	.18¾
Upriver coarse	lb.	.12¼ —	.12½
Upriver caucho ball	lb.	.13 —	.13¼
Plantation—First latex crepe	lb.	.14 —	.14¼
Ribbed smoked sheets	lb.	.14¼ —	.14½
Brown crepe, thin, clean	lb.	.13 —	....
Amber crepe No. 1	lb.	.15 —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.11 —	$0.11½
Castor oil, AA, in bbls	lb.	.12 —	.12¼
China wood oil, in bbls	lb.	.13½ —	.13¾
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.09¼ —	.09½
Coru oil, crude, in bbls	lb.	.11¼ —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	$0.10 —	$0.10¼
Cottonseed oil, summer yellow	lb.	.12 —	.12¼
Cottonseed oil, winter yellow	lb.	.13 —	13¼
Linseed oil, raw, car lots (domestic)	gal.	.86 —	.87
Linseed oil, raw, tank cars (domestic)	gal.	.82 —	.83
Linseed oil, in 5-bbl lots (domestic)	gal.	.89 —	.90
Olive oil, denatured	gal.	1.15 —	1.17½
Palm, Lagos	lb.	.07⅞ —	.07½
Palm, Niger	lb.	.06¼ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10
Peanut oil, refined, in bbls	lb.	.12¾ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.85 —	.86
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.11¾ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	....

FISH

Light pressed menhaden	gal.	$0.54 —	....
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

Prices remain same as previous report.

Refractories

Quotations remain unchanged.

Ferro-Alloys

Prices same as previous report.

Ores and Semi-finished Products

All quotations remain unchanged.

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.875
Aluminum, 98 to 99 per cent	19.00
Antimony, wholesale lots, Chinese and Japanese	5.40-5 50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	30.00-33.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.00
Lead, New York, spot	5.50-5.625
Lead, E. St. Louis, spot	5.40-5.45
Zinc, spot, New York	5 45
Zinc, spot, E. St. Louis	5.20

OTHER METALS

Silver (commercial)	oz.	$0.72½
Cadmium	lb.	1.15-1.20
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium	lb.	1.05
Platinum	oz.	85.000.
Iridium	oz.	150.00@175.00
Palladium	oz.	55.00
Mercury	75 lb.	55.50

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	18.75
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	23 00
Brazed bronze tubing	28 00
Seamless copper tubing	20 75
Seamless high brass tubing	18.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and arger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York*	Chicago
Structural shapes	$2.48	$2.48
Soft steel bars	2.38	2.38
Soft steel bar shapes	2 38	2.38
Soft steel bands	2 98	2.98
Plates, ¼ to 1 in. thick	2.48	2.48

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

BATESVILLE—The American Manganese Co. has preliminary plans under way for the construction of new mills for considerably increased output. The company has an extensive tract of manganese ore in the Batesville-Cushman district and is arranging for extensive development. To provide funds for expansion, a bond issue of $250,000 is being sold. Norman E. Brokaw is president.

EL DORADO—The El Dorado Oil & Pipe Line Co. has work under way on the rebuilding of its oil refinery, recently destroyed by fire, and will install considerable new machinery. It is expected to have the plant ready for service at an early date.

California

SAN PABLO—The San Pablo Pottery Co. will build two new kilns at its plant and make other extensions.

OAKLAND—The Westgate Metal Products Co., recently organized with a capital of $2,500,000, to manufacture iron, steel and other metal castings, has tentative plans under consideration for the erection of a new plant. A. T. Burch, 78 El Camino St., heads the company.

Connecticut

HAMDEN—The Kiss Brothers Co., Meriden, manufacturer of pottery products, has acquired the local plant of the Joseph Dixon Crucible Co., and will remodel for a new pottery. Clay properties in this section have also been secured. The company will install necessary equipment and occupy the plant at an early date.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co. has awarded contracts for additional buildings at its new local refining plant, now in course of erection, comprising a 4-story melting and washing building, 60x90 ft., and 1-story power plant, 95x150 ft., to be located at Christiana Ave. and B St. Harding & Craig, Buffalo, N. Y., are contractors. W. J. Wayte, Inc., 125 East 46th St., New York, N. Y., is engineer.

WILMINGTON—James J. O'Neill, manufacturer of leather, has acquired property now occupied under lease on Commerce St., near Dock St., heretofore held by E. Paul du Pont, for a consideration of $55,000, as a permanent site for his leather tannery. Improvements, it is said, will be made in a number of buildings.

Florida

BRADENTOWN—J. H. Humphries is planning for the establishment of a new plant on local site for the manufacture of commercial fertilizer products.

Georgia

ATLANTA—The Standard Sanitary Mfg. Co., 295 Peachtree St., manufacturer of sanitary earthenware products, has preliminary plans under way for the erection of an addition.

RUTLEDGE—The Rutledge Oil Co. is planning for the rebuilding of the portion of its mill, recently destroyed by fire with loss estimated at close to $150,000, including equipment. The company is operated by Stanton & Wofford, Social Circle, Ga.

Illinois

CHICAGO—The Chicago Pottery Co., 1924 Clybourn Av., has completed plans for the erection of a 2-story addition, 113x190 ft., and will commence erection at an early date. L. E. Russell, 25 North Dearborn St., is architect.

LEMONT—The Illinois Pure Aluminum Co. has awarded a contract to E. W. Sproul, Pershing Road and Robey St., Chicago, for the erection of a 1-story addition, to cost about $35,000. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, is engineer.

Kansas

TOPEKA—The Sunflower Oil & Refining Co. is reported to be planning for the rebuilding of the portion of its plant recently destroyed by fire with loss of about $40,000.

Louisiana

CEDAR GROVE—The Gulf States Chemical Co., a subsidiary of the National Window Glass Co., is planning for the early operation of its new local plant, now nearing completion, for the manufacture of insect powders and kindred chemical specialties. D. N. Skinner is secretary.

Maryland

BALTIMORE—Ernest E. Stanley, Calvert Bldg., is organizing a new company for the establishment of a plant for the manufacture of chemical products. A building has been leased at Biddle St. and Madison Ave., for the proposed new works.

BALTIMORE—The Argol Sulphite Co., has plans nearing completion for the erection of a new 1-story plant, 40x100 ft., at Curtis Av. and Birch St., and will break ground at an early date.

BALTIMORE—The Edward Richardson Brass Co., 318 North Holliday St., has acquired through its president, Edward Richardson, the former plant of the Zirconium Co. of America, Monument and 11th Sts., recently offered at public auction. The works comprise a group of buildings, with power house, machine shop, etc., and will be used by the new owner. The purchase price is said to be $38,500.

Massachusetts

DANVERS—The Danvers Welt & Leather Co. is considering tentative plans for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about $40,000, including equipment and stock.

Michigan

SAGINAW—The Aero Cushion Inner Tire & Rubber Co., 907 Ford Bldg., has plans nearing completion for the erection of a new 1-story plant for the manufacture of tires and other rubber products, 80x200 ft., estimated to cost about $75,000, including equipment. J. J. O'Shaughnessy is general manager.

DETROIT—The Detroit Soda Products Co., 9077 West Jefferson St., has awarded a general contract to the Bennage-McKinstrie Co., 1460 Baldwin Ave., for the erection of a 2-story plant addition, 60x80 ft. L. B. Alger is president.

Montana

COLUMBIA FALLS—The Cyanide Gold Mining Co. has preliminary plans in preparation for the erection of a new mill and cyanide plant, with capacity of about 150 tons a day. It is proposed to commence work at an early date and have the plant ready for service before the close of the year. James La Fountain and T. J. Hollinger head the company.

New Jersey

PERTH AMBOY—The Novo Laboratories, Inc., 651 Catherine St., will commence the immediate erection of a 1-story plant addition for grinding, mixing, etc., to cost about $25,000. Contract for the building and certain machinery has been awarded. The structure will provide about 2,500 sq.ft. of floor space.

TRENTON—The Clay Products & Mining Corp., recently organized, is arranging to take over the property of the Southern Refractories & Kaolin Co., Fort Payne, Ala. A number of improvements will be made, with extensions for increased production. The company is capitalized at $1,500,000, and is headed by Richard M. J. Smith and W. P. Cubberly; it is represented by Samuel C. Kulp, 150 East State St., Trenton.

GARWOOD—Three 1-story foundry buildings will be erected by the National Boiler Co., South Ave., estimated to cost in excess of $30,000. Hooper & Co., 116 Market St., Newark, are architects.

MENDHAM—Leo Robinson, borough clerk, will take bids until 8 p.m., June 12, for the construction of a filter plant and appurtenances at the waterworks.

New York

BUFFALO—The Buffalo Smelting Co. has acquired property, 276x301 ft., on Tonawanda St., as a site for the erection of a new plant for the smelting and refining of copper, brass and other metals. It will consist of a main building, 50x90 ft., and smaller adjoining structures. George Giessen is president.

ALSEN—The Hudson Valley Portland Cement Corp. has work under way on the third unit of its finishing mill, and plans to have the structure equipped and ready for service at an early date. It is proposed to develop an annual output of 1,140,000 bbl. at the plant. To provide for expansion, additional working capital, etc., the company has arranged for a bond issue of $1,000,000.

PORT JERVIS—Swinton & Co., 47 Main St., will build a new 1-story foundry at their stove works, 72x150 ft., to cost about $40,000, including equipment. Work will be commenced at once. Robert Livingston, 2 Rector St., New York, is engineer. J. D. Swinton is head.

North Carolina

ASHEVILLE—The Felstone Co., 326 Haywood Bldg. recently organized with a capital of $100,000, to manufacture concrete and cement products, has plans under way for the erection of a new 1-story plant, 54x100 ft., on site selected near Biltmore, N. C. It will cost close to $30,000, including equipment. W. L. Gravatt, Jr., is secretary.

OLD FORT—The Old Fort Pottery Works, Inc., recently organized, has preliminary plans in preparation for the erection of a new local plant for the manufacture of earthenware specialties. J. A. Lowery and J. H. Young head the company.

Ohio

CINCINNATI—The Triangle Paper Co., 943 West 6th St., plans for the rebuilding of the portion of its plant destroyed by fire, May 8, with loss estimated at about $30,000.

Oklahoma

IDABEL — The City Council has plans under way for the construction of a new filtration plant, in connection with a new pumping plant at the waterworks, to cost about $150,000. The Benham Engineering Co., Gumbel Bldg., Kansas City, Mo., is engineer.

Oregon

SALEM—The Oregon Pulp & Paper Co. is planning for extensions and improvements in its plant to cost about $55,000. C. F. Beyerl is general manager.

Pennsylvania

PHILADELPHIA—The H. H. Barton & Son Co., 109 South 3rd St., manufacturer of sandpaper and kindred specialties, will soon take bids for the erection of a 2-story plant addition. 40x100 ft. Tilden & Register, 1525 Locust St., are architects. Charles B. Barton is president.

MARCUS HOOK—Fire, May 16, destroyed a portion of the grease-manufacturing plant at the refinery of the Sun Oil Co., Finance Bldg., Philadelphia, with loss estimated at about $60,000, including equipment and stock.

EAST STROUDSBURG—The Scott-Warman Glass Co., manufacturer of bottles, will commence the immediate rebuilding of its plant, partially destroyed by fire last January, with loss approximating $150,000. The new structure will cost close to a like amount.

South Carolina

GREENVILLE—The Gray & Son Glass Co., Falls Creek, Pa., manufacturer of rough and ribbed glass, is considering the erection of a new branch plant at Greenville. George R. Gray is president.

Tennessee

NASHVILLE—The Hermitage Portland Cement Co., Chattanooga, has acquired a portion of the Old Hickory plant of the government and is reported to be planning for the construction of a large cement mill on

the site. Present structures will be remodeled and a number of new buildings erected. It is proposed to develop a daily capacity of 2,000 bbl. The new mill will cost in excess of $1,000,000, with machinery. John C. Vance is president.

Texas

CLARKSVILLE—The Texas Petroleum Co., Fort Worth, W. W. Fisher, president, has plans nearing completion for the construction of a new local refinery of two-unit type, with initial capacity of about 500 bbl. a day.

LAREDO—The Texas-Mexican Oil & Refining Co., Milno Bank Bldg., recently organized with a capital of $150,000, will soon commence the construction of the first unit of its proposed plant on local site, with output of 500 bbl. a day, estimated to cost about $90,000, including equipment. J. N. Galbraith is president.

Washington

HILLYARD—The Western Materials Co., Valley, Wash., operating local magnesite properties, is planning for the erection of a new plant at Hillyard for the manufacture of magnesite cement, estimated to cost about $35,000. Negotiations are under way for a site.

New Companies

THE CARRIER CHEMICAL CO., Nitro, W. Va., has been incorporated with a capital of $150,000, to manufacture chemicals and chemical byproducts. The incorporators are C. F. Carrier, Jr., Archibald Krieg and M. T. Davis, Jr., all of Charleston, W. Va.

THE CROW CHEMICAL CO., Irvington, Newark, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are Joseph Walsh and Walter Runge, 17 Stengel Ave., Irvington.

THE GRAND RAPIDS BYPRODUCTS CO., Grand Rapids, Mich., has been incorporated with a capital of $50,000, to manufacture soaps, glue, fertilizer products, etc. The incorporators are William D. Batt, Peter D. Mohrhardt and Victor J. Mollers, all of Grand Rapids.

THE BOSTON PRINTING INK CO., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture inks and kindred products. Zenas R. Taylor is president; and Daniel S. Schneider, 769 Morton St., Mattapan, Mass., is treasurer.

THE EQUITY PETROLEUM CORP., Wilmington, Del., has been incorporated under state laws, with capital of $10,000,000, to manufacture petroleum products. The company is represented by the Delaware Charter Co., Ford Bldg., Wilmington.

THE CAPITOL PRODUCTS CORP., Albany, N. Y., has been incorporated with a capital of $10,000, to manufacture paints, oils, etc. The incorporators are E. H. Brown, P. J. McLure and R. B. Streeter. The company is represented by M. H. Messimer, Albany.

THE STATE PAPER CO., Zanesville, O., has been incorporated with a capital of $100,000, to manufacture paper products. The incorporators are N. B. and William W. Hanlon, Zanesville.

THE U. S. DRYER & MACHINERY CO., York, Pa., has been incorporated with a capital of $150,000, to manufacture double shell driers of the rotary type. William J. Kuntz is general manager.

THE GILL CHEMICAL CO., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are L. S. Kochler, K. L. and Louis E. Graf, 439 Riverside Ave., Newark.

THE HAYS CORP., Seattle, Wash., has been incorporated with a capital of $5,000, to manufacture rubber products. The company is headed by Winfield R. Smith, Alaska Bldg., Seattle.

THE STANDARD FOUNDRY & MFG. CO., Kansas City, Mo., has been incorporated with a capital of $250,000, to manufacture iron and steel and other metal castings. The incorporators are W. H. Simpson, J. B. Harden and H. H. Akers, all of Kansas City.

PULVER & WALDMAN, INC., New York, has been incorporated with a capital of $5,000, to manufacture chinaware specialties. The incorporators are F. and S. Pulver and L. Walman. The company is represented by Max Gelles, 1140 Broadway, New York.

THE DECAMP CONSOLIDATED GLASS CASKET CO., Blackwell, Okla., has been incorporated under Delaware laws, with a capital of $25,000,000, to manufacture glass products. The incorporators are James W. DeCamp, Blackwell; F. H. Butehorn, New York; and Hilbert B. Mattheson, Orange, N. J. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ROBINHOOD FELDSPAR CO., Robinhood, Me., has been chartered under state laws, to operate a plant for the production of commercial feldspar. Paul Nash is president, and S. M. Neff, treasurer, both of Robinhood.

THE VARCOTE CO., 40 East Kinzie St., Chicago, Ill., has been incorporated with a capital of $5,000, to manufacture paints, stains, varnishes, etc. The incorporators are W. J. Rankin, B. Z. Hazlett and George H. Johnston.

THE RED CROSS CHEMICAL CO., Fall River, Mass., has filed notice of organization to manufacture chemical products. Martini Barrette, 91 Oak Grove Ave., Fall River, heads the company.

THE FI-BESTOS CO., New York, N. Y., has been incorporated under Delaware laws, with capital of $100,000, to manufacture asbestos products. The incorporators are Joseph Sandler, David T. Lotwin and Nathan Frankel, New York. The company is represented by Boyce & Magee, Dover, Del.

THE ESSENTIAL OIL CO. OF AMERICA, Tavares, Fla., has been incorporated with a capital of $25,000, to manufacture essential oils. E. S. Burleigh is president; S. C. Colley, vice-president; and B. W. Hunt, secretary, all of Tavares.

THE AMERICAN RUBBER & BRASS CO., 203 West Lake St., Chicago, Ill., has been incorporated with a capital of $20,000, to manufacture brass specialties, rubber goods, etc. The incorporators are E. A. and Charles L. Brower, and Arthur J. Cordell.

THE EMLET-WINEBRENNER CO., Hanover, Pa., has been incorporated with a capital of $30,000, to manufacture chemicals, chemical byproducts, drugs, etc. John M. Emlet, Hanover, is treasurer.

THE NULOID CORP., Wilmington, Del., has been incorporated under state laws, with a capital of $10,500,000, to manufacture celluloid and other composition products. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington.

THE H. P. CHANDLEE SONS CO., 112-14 West Lombard St., Baltimore, Md., has been incorporated with a capital of $200,000, to manufacture chinaware, glass products, etc. The incorporators are George M. and Theodore M. Chandlee, and Jesse Englar.

THE ANACOCO OIL & REFINING CO., Lake Charles, La., has been incorporated with a capital of $200,000, to manufacture refined petroleum products. The incorporators are B. T. Head, Lake Charles; and T. R. Sutherland, Shreveport, La.

THE ELLA SINGER CO., Atlantic City, N. J., has been incorporated with a capital of $125,000, to manufacture chemicals and chemical byproducts. The incorporators are A. C. Chism, William J. Riley and Ella Singer, 143 South Virginia Ave., Atlantic City.

THE CHEMICAL PRODUCTS CO., INC., 837 Equitable Bldg., Baltimore, Md., has been incorporated with a capital of $10,000, to manufacture chemicals and byproducts. The incorporators are Edward C. Hamilton, B. G. Hamilton and Byron R. Webb.

VERNON BROTHERS & CO., Pittsburgh, Pa., are being organized under state laws by Lester B. Vernon and W. R. Cole, to operate a metal smelting and refining plant. Application for a state charter will be made on June 6. The company is represented by George B. Berger, 1737 Oliver Bldg., Pittsburgh.

THE DUNN CONSOLIDATED OIL CORP., Wilmington, Del., has been incorporated under state laws with capital of $6,000,000, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE DONOVAN PACKING & RUBBER CO., Philadelphia, Pa., has been incorporated with a capital of $6,000, to manufacture rubber specialties. S. J. Donovan, 211 Bainbridge St., Philadelphia, is treasurer.

THE TWIN FALLS BINDER BOARD MILLS, INC., Scotch Plains, N. J., has been incorporated with a capital of $10,000, to manufacture paper composition products. The incorporators are David Robinson, Harry S. Sherman and Max Rosenthal, Scotch Plains.

THE OLSTEIN CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture oils, paints, etc. The incorporators are R. and S. Olstein, and M. W. Goodman. The company is represented by Levinson & Felnsod, 277 Broadway, New York.

THE INTERNATIONAL CARBON CORP., Wilmington, Del., has been incorporated under state laws with a capital of $32,500,000, to manufacture carbon products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE SMITH ALSOP-BLOOMINGTON PAINT CO., 110 East Front St., Bloomington, Ill., has been incorporated with a capital of $20,000, to manufacture paints, varnishes, oils, etc. The incorporators are Darrel W. Thompson, Guy W. Frederick and Edward A. White.

THE OWENS PETROLEUM CO., Cameron, Tex., has been incorporated with a capital of $30,000, to manufacture petroleum products. The incorporators are E. L. and J. R. Mays, and J. S. Owens, all of Cameron.

THE WILCOX-WALTER-FURLONG PAPER CO., Philadelphia, Pa., has been incorporated with a capital of $75,000, to manufacture paper products. E. T. Walter, Jr., 4701 Wayne Ave., Philadelphia, is treasurer.

THE TUC TOR METAL CORP., New York, N. Y., has been incorporated with a capital of $200,000, to manufacture metals and metal alloys. The incorporators are E. H. Foster, H. E. Brown and W. M. Smith. The company is represented by Van Vorst, Marshall & Smith, 25 Broad St., New York.

THE NATIONAL FLOOR TILE CO., Mobile, Ala., has been chartered with a capital of $144,000, to manufacture ceramic floor and wall tile. The company is headed by W. D. Dellingrath, Mobile.

THE EXCELSIOR PAPER CO., Room 911, 11 South LaSalle St., Chicago, Ill., has been incorporated with a capital of $150,000, to manufacture paper products. The incorporators are L. D. Green, David Alexander and S. Rubin.

THE PENNSYLVANIA OIL CORP., Pittsburgh, Pa., has been incorporated under Delaware laws, with a capital of $100,000, to manufacture petroleum products. The incorporators are George J. Young, C. E. Arnold and William Devlin. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE TIDEWATER FOUNDRIES CORP., Jersey City, N. J., has been incorporated with a capital of $10,000, to manufacture iron, steel and other metal castings. The incorporators are E. Mead Whipple, Franklin L. Whitney and Purley C. Butterfield, 170 1st St., Jersey City.

THE PITTSBURGH ABRASIVE CORP., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of $600,000, to manufacture abrasive products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE HARBOR OIL CORP., Eldorado, Ark., has been incorporated under Delaware laws with capital of $1,000,000, to manufacture petroleum products. The incorporators are S. Williams, L. T. Langston and O. J. Lockhart. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE TRINITY PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of $10,000, to manufacture stainless steel. The incorporators are R. F. Heiles, J. Pfaff and M. T. Quinn. The company is represented by C. M. Davis, 2 Rector St.

Capital Increases, etc.

THE NATIONAL ROSIN, OIL & SIZE CO., 155 North Clark St., Chicago, Ill., has filed notice of increase in capital from $50,000 to $100,000.

JOHN W. MASURY & SON, 50 Jay St., Brooklyn, N. Y., manufacturers of paint, etc., have filed notice of increase in capital from $150,000 to $250,000.

THE VIRGINIA-CAROLINA CHEMICAL CO., Richmond, Va., has disposed of a bond issue of $22,500,000, a portion of the proceeds to be used for expansion, additions to working capital, etc. C. G. Wilson is president.

THE CLAY BRICK CO., Grand Rapids, Mich., has filed notice of dissolution under state laws.

THE GORDON PETROLEUM CO., Eastland, Tex., has filed notice of increase in capital from $75,000 to $120,000.

THE SHOPE CONCRETE BRICK CO., Las Cruces, N. M., has filed notice of organization to operate in Texas, with capital of $30,000, and headquarters at El Paso. The company is represented by J. M. Ireland, El Paso.

THE AETNA POWDER CO., Gary, Ind., has filed notice of dissolution under state laws.

THE COLUMBIA SUGAR CO., Bay City, Mich., operating branch refineries at Mount Pleasant, Mich., and Paulding, O., is disposing of a bond issue of $1,750,000, the proceeds to be used for expansion, general operations, etc. John C. Ross is president.

THE GIBSON OIL CO., Vincennes, Ind., has

filed notice of increase in capital from $250,000 to $500,000.

THE JACK DALTON OIL CO., Mineral Wells, Tex., has filed notice of increase in capital to $1,000,000 for expansion.

THE CLARK PAPER CO., 541 Ridge St., Newark, N. J., has filed notice of dissolution under state laws.

THE COPLAY CEMENT MFG. CO., Coplay, Pa., has called a special meeting of stockholders on June 15, to vote on an increase in capital from $500,000 to $1,250,000.

THE W. R. HOLLINGSHEAD CHEMICAL CO., Utica, N. Y., has filed an involuntary petition in bankruptcy, with liabilities stated at $80,000.

THE MATHIESON ALKALI WORKS, 25 West 43rd St., New York, N. Y., with plant at Providence, R. I., has acquired the plant and business of the Commonwealth Chemical Corp., Newark, N. Y., and will merge the property with its organization.

The plant and property of the STRONGCORD TIRE & RUBBER CO., Oak Hill Road, Evansville, Ind., will be sold by Henry B. Walker, receiver.

THE JOHN B. LOVE CHEMICAL CO., Wilmington, Del., has been incorporated under state laws with a capital of $250,000, to manufacture chemicals and chemical byproducts. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

Industrial Developments

GLASS—The Graham Glass Co., manufacturer of bottles and hollowware, is arranging for the immediate resumption of production at its plant at Loogootee, Ind., following a shutdown for more than a year past. Employment will be given to more than 150 operatives.

The Potomac Glass Co., Cumberland, Md., started operations, May 22, in the new addition to its local blown-glass works, giving employment to about 200 workers as well as a number of apprentices, making a total of over 450 operatives at the entire plant. The addition represents an investment of $125,000. A new etching plant is being completed and will be placed in service at an early date. The plant is now running full.

Blown-glass plants at Millville, N. J., and vicinity are contemplating an increase in working hours from 8 to 9 hours a day.

LEATHER—The American Hide & Leather Co. has adopted full-time operations at its Sheboygan, Wis., tanning plant, working on heavy upper leather. The Ballston Spa, N. Y., tannery of the company is running at 100 per cent on patent leather and colored side leathers. At Chicago, Ill., operations have been increased at the local tannery to about 80 per cent of capacity for side and calf leathers. The Lowell, Mass., works are now operating at about 50 per cent of normal, recently resuming operations after a shut down.

The Central Leather Co., New York, N. Y., is increasing operations at its plants.

The Foucar Leather Co., Woburn, Mass., is advancing production from 1,000 to 1,400 sides of patent leather daily.

RUBBER—The B. F. Goodrich Co., Akron, O., has advanced production about 25 per cent since the first of May, increasing the operating schedule to a full 5-day week. Additional men will be employed.

The Seiberling Tire & Rubber Co. is increasing operations at its plants at New Castle, Pa., and Barberton, Ohio.

PAPER—The Riordan Co. is increasing operations at its pulp mill at Ticonderoga, N. Y., while the lumber mill of the company at Calumet, Mich., is running full under day and night shifts. The Kipawa paper mill of the company has increased production and is now operating on a basis of 150 tons a day, or close to capacity. The Hawkesbury mill is running on a basis of 100 tons a day, against a full capacity rating of 125 tons.

The Tonawanda Board & Paper Co., North Tonawanda, N. Y., is planning for the early resumption of operations, following a shut down for about a year past.

IRON AND STEEL—The Carnegie Steel Co. has resumed operations at its Farrell Works, Sharon, Pa., with blast furnace and thirteen open-hearth mills, following a shutdown from March, 1921. The last units of the plant at Mingo, O., have been placed in operation, making all mills of the company on the producing list with the exception of those at Columbus and Bellaire, O. The plants are developing 80 per cent of the productive capacity of the company for the first time in more than a year.

The Woodstock Operating Corp., Anniston, Ala., has blown in its blast furnace at La Follette, Tenn., following a shutdown for nearly two years. The company is reported to be arranging for the early resumption of production at its furnace at Anniston.

The American Rolling Mill Co., Middletown, O., is arranging for the early operation of two additional sheet mills at its plant, making twenty-nine such mills on the producing list, as compared with seventeen mills just before the depression in 1921. About 300 men have been added to the working force during the past three weeks.

The Struthers Furnace Co., Youngstown, O., will blow in its 500-ton blast furnace about the middle of June, following a suspension for 18 months past. The unit is being prepared for lighting.

The Eastern Steel Co. has resumed operations at its open-hearth plant at Pottsville, Pa., after a shutdown for 18 months. It is expected to be running full, giving employment to a normal working force at an early date.

The Shenango Furnace Co., Sharpsville, Pa., has blown in another blast furnace at its local plant.

The United States Steel Corp. has blown in another blast furnace at its Gary, Ind., plant, making eighteen out of twenty-seven furnaces now on the producing list. It is expected to place additional units in service at an early date.

The Midvale Steel & Ordnance Co. is arranging to blow in a second stack at its Coatesville, Pa., works early in June.

The Sloss-Sheffield Steel & Iron Co. has blown in its second blast furnace at North Birmingham, Ala., following a suspension for a number of months. The company plans to blow in its Birmingham city furnace early in June.

The Sharon Steel Hoop Co., Sharon, Pa., has resumed operations at all finishing mills at the local plant.

MISCELLANEOUS—The Davison Chemical Co., Baltimore, Md., is increasing production at its local plant in the sulphuric acid and other departments.

With practically all cement mills in the Lehigh Valley district of Pennsylvania running at capacity, the highest shipment for the year of 50,000 bbl. in one day was recorded on May 19. A large part of the distribution came from the plant of the Lehigh Portland Cement Co., Allentown.

Manufacturers' Catalogs

ADAM HILGER, LTD., 75A Camden Road, London, N. W. 1, England, calls attention to a bulletin illustrating and describing the Hilger chemical spectrometer designed for chemical analysis.

THE SUPERHEATER CO., New York, has just received from the press Bulletin T1, on superheaters for stationary power plants. This bulletin explains in detail the latest features of the Elesco superheater.

THE PACIFIC FOUNDRY CO., San Francisco, Cal., has published a bulletin on Corrosiron which covers the use of this acid-resisting metal for drain pipe and fittings.

THE TABER PUMP CO., Buffalo, N. Y., in Bull. 131 gives some helpful hints on the application of rotary pumps, also a friction table and conversion scale. This bulletin should be an aid to industrial plants interested in rotary pumps.

THE GRIEBEL INSTRUMENT CO., Carbondale, Pa., has issued an attractive catalog, No. 21, listing glassware for laboratory and scientific purposes.

W. S. ROCKWELL CO., New York, calls attention to Bull. 242, on the influence of method of heating and handling on quality and cost of heat-treated products. This bulletin is a supplement to the series of educational papers previously issued and is intended to illustrate the variety of methods of applying the principles of proper heating and handling to different manufacturing requirements and shop conditions. Another bulletin recently issued is No. 243, on stationary and tilting crucible melting furnaces.

THE SANDVIK STEEL, INC., New York City, has issued a 26-page booklet on steel belting. It contains information as to how the steel belt is applied to solving conveying problems, its efficiency, economy, etc. Anyone interested can obtain a copy of this booklet, No. 18-T, by writing to Sandvik Steel, Inc., 233 Broadway, New York City.

THE HARBISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., has issued a leaflet on Thermolith, the all-temperature fire cement.

THE REPEL-ARC FURNACE CO., Indianapolis, Ind., in Bull. 301 gives facts about the Repel-arc furnace.

THE GRISCOM-RUSSELL CO., New York, has published Bull. 904, on the multiwhirl cooler.

THE SPENCER LENS CO., Buffalo, N. Y., has issued a bulletin on a selection of Spencer products for commercial and industrial laboratories. This list has been selected from the company's larger catalog and with special consideration of workers in industrial and chemical laboratories.

THE CUTTER CO., Philadelphia, Pa., has issued a booklet illustrating and describing I-T-E circuit breakers as applied to the protection of electrical and associated machinery in central stations.

THE ESTERLINE-ANGUS CO., Indianapolis, Ind., in Bull. 422, on "Getting Business With Graphics," discusses the possibilities of the use of graphic records in the sale of technical products.

HERMAN A. HOLZ of New York has issued a four-page folder on "Important Progress in the Calorimetry of Gases."

THE INDUSTRIAL AIR ENGINEERING CO., Elyria, O., in an 8-page booklet illustrates and describes the Industrial Air Purifier and Dust Collector.

THE ROLLER-SMITH CO., New York, has issued two new bulletins. No. 820 illustrates and describes PV ammeters and voltmeters and COD indicators and Bull. 560 illustrates and describes inclosed circuit breakers.

CENTURY WOOD PRESERVING CO., Pittsburgh, Pa., has issued a new bulletin on "Adzing and Boring Cross-Ties."

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN ASSOCIATION OF ENGINEERS will hold its eighth annual convention at Salt Lake City, Utah, June 4-6.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Rochester, N. Y., during the week of June 5, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet- at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN OIL CHEMISTS' SOCIETY will hold its annual meeting at the Grunewald Hotel, New Orleans, La., June 5 and 6.

AMERICAN PULP AND PAPER MILL SUPERINTENDENTS ASSOCIATION will meet in Kalamazoo, Mich., June 1, 2 and 3.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NATIONAL LIME ASSOCIATION will hold its annual convention June 14-16 at the Hotel Statler, Cleveland, O.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

The following meeting is scheduled to be held in Rumford Hall, the Chemists' Club, New York: June 9—American Chemical Society, regular meeting.

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J. S. NEGRU
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CHEMICAL & METALLURGICAL ENGINEERING

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The Railroad Wage Decision

THE wage decision announced May 29 by the Railroad Labor Board, signed by the three railroad members and the three public members of the board, states that the new wages will be higher than in other industries for similar work, a margin having been allowed to cover the hazards of employment and other considerations. The dissenting opinion, of the three labor representatives on the board, says that the wages decreed are insufficient to sustain life on the basis of American standards.

Here is a big issue and at the same time a very simple one. It cannot be claimed that the wage rates prescribed are relatively low, for the board had ample basis of fact to warrant the statement that railroad wages will be higher than other wages. The contention of the minority, then, is in essence that all wages in the United States are too low to sustain life on the basis of "American standards."

Now the use for wages is to spend them for commodities and services. The commodities and services must be available or they cannot be bought. Imagine a small island inhabited by a single native possessed of a certain amount of food. Two men are shipwrecked on the island, each with $1,000 in his pocket, and the native is quite willing to sell all the food he has. Each of the shipwrecked men, other things being equal, will get half. If before they started to bargain you had given each man $1,000 more money they would not have got any more food. There would simply be $4,000 passed over instead of $2,000. The food would not be Americanized by that means.

Estimates of the national income of the United States made respectively by counting up individual incomes and by counting up the value of the production substantially agree. The income buys what is offered for sale. If we want more we must produce more. We cannot increase the quantity of material and the amount of service by bidding more dollars.

To carry on industry at all in these days the workers must have tools and direction. The railroad workers could accomplish nothing without cars, locomotives and track, or without managers to direct their work. These things, tools and management, have to be paid for. Approximately speaking, between 20 and 30 per cent of the total national income goes for these purposes, workers for wages and salaries getting the other 70 or 80 per cent. And there is strong reason for holding that the workers are better off when the share for tools and management is 30 per cent than when it is 20 per cent.

There is, then, only one way to bring about a higher standard of living generally, and that is to increase production, by men working harder and more efficiently and with better tools.

Artificial Industrial Conditions In Europe and Germany

HISTORY portrays LOUIS XV as a conspicuous example of the indifference of a monarch to the welfare of the masses and the consequences of his own extravagance. When his advisers remonstrated with him, he is reported to have said, "After me the deluge." The expression typifies the attitude of the then ruling class.

Something of the same spirit is to be observed today among industrial leaders in Europe. In Belgium and France a few powerful leaders and their entourage feed the people with the doctrine that everything will be all right when Germany pays the reparations, but in the meantime the people are burdened with taxes and privations. In Italy speculators in depreciated money exploit the means of production to their own profit. In Switzerland another group buys at depreciated foreign value and sells at home at Swiss currency value with resulting profit to themselves and damage to Swiss production. In Germany industrial and economic conditions are critical to the breaking point. Russia has already disintegrated under the baneful influence of a small but dominant group of leaders. In fact, throughout Europe one can observe artificial industrial and economic conditions created by small groups of leaders whose opinion is dominant for the moment, but whose thinking is unsound. Not only are these things largely responsible for the industrial situation in Europe, but the repercussion of bad business resulting from unsound economics is felt in the United States and affects our own business revival.

In Germany particularly we may observe a curious combination of conditions. Production is at full capacity. There is no unemployment, and yet wages are abnormally low. The bulk of production is exported at prices comparatively lower than for home consumption; but the revenue, instead of finding its way into Germany to ameliorate local conditions, purchase raw materials and repair the wrongs of the war, is invested outside the country as personal insurance of the industrialists against the inevitable ruin that must overtake the unsound business policy at home. It seems inconceivable that industrial leaders can thus selfishly hasten the bankruptcy of their country, but such apparently is the case. After them the deluge!

In order to justify this treatment of the laborer, whereby he gets but a small fraction of the value of his labor, he is fed with the doctrine that exportation is necessary in order to meet the reparations, and that the price must be low in order to meet competition. At the same time the doctrine of hatred for the Allies is being instilled into the worker so that he will the more readily accept the unfair treatment to which he is subjected. The picture is not a happy one, revealing as it does the domination of the country by a compar-

atively small handfuls of industrialists who exploit the people to their own advantage. This domination, we learn, extends also to the press and even affects scientific research, but that is another story. The sad fact is the present domination of one class over a mass of 70,000,000 people.

Another curious phase of the situation seems to be a fear, certainly an unwillingness, on the part of the intellectuals of the country to expose this uneconomic and unfair industrial policy and bring to bear through some medium or other the pressure of opinion that would immediately modify existing conditions. Engineers, scientists, technologists, economists and other trained thinkers in Germany recognize the folly of the present artificial industrial situation, and yet they are evidently without courage to express their opinion or exert their influence. In this country they would have the benefit and co-operation of an independent technical and business press through which to voice their protests.

This leads us to say to the technical press of Germany that it has an unprecedented opportunity for service to its country and the technical industries which have flourished there so highly. If the technical press itself is not also under the domination of German industrial leaders, let it adopt a vigorous editorial policy that will expose the futility of the present industrial system and the disaster to which it must inevitably lead. Let the German intellectuals, whose own independence is threatened by industrial domination, and whose welfare is directly affected by the present situation, express their honest opinions regarding the exportation of German production and the exploitation of the workers by a few leaders who are profiting at the expense of their own national prosperity. If a beginning of this kind could be made, we believe it would grow in volume and influence until it would become a strong factor in rectifying the present uneconomic condition.

A Research and Educational Plan For the Packing Industry

FRANK analysis of the present trend of development in the packing industry, keen appreciation of work being done in other industries to advance the science of efficient and economical production and a sincere desire to have the largest industry in the country keep step with such progressive movements characterize the development plan for the Institute of American Meat Packers prepared by the president, THOMAS E. WILSON. By recent action of the executive committee, the plan has been transmitted to the entire membership for consideration at the next convention.

Since its establishment in 1919 by reorganization of the American Meat Packers' Association, much of the Institute's work has been directed toward the establishment of more cordial relations with the livestock producers on one hand and the retailers and the public on the other. These efforts, as well as others within the industry itself, have been attended with such a measure of success that Mr. WILSON sensed the opportunity for laying out a definite plan of enlarged activity and broader service, to guide and stimulate future growth.

Critical analysis of the methods by which the industry is progressing at present discloses several ways in which the Institute could function for the benefit of the whole industry. Attention was directed particularly to such points in the present system as: Unnecessary duplication of research and development work; the lack of an adequate system for perpetuating and handing down to the next generation in readily available form the results of past experience; lack of organized instruction of employees; no opportunity for executives in one branch of the business to broaden their perspective; no educational feeder of men whose training fits them especially for this industry.

With these points in mind, Mr. WILSON has outlined a plan for the Institute, details of which appear in our news pages of this issue. It contemplates an ambitious program and one which will require detailed study to determine the best method for carrying out each recommendation. For this purpose, Mr. WILSON proposed an Institute plan commission, which has been appointed by the executive committee with instructions to begin functioning at once. In this way no time will have been lost should the proposals of the commission be approved by the convention. This action indicates the presence of a genuine spirit of progressive co-operation in the packing industry, and it is to be hoped that the plan will materialize. It will be a great step forward.

Big Business And the Technical Man

ANOTHER billion dollar merger! Independent steel companies to form a trust which will rival the U. S. Steel Corporation!

So say the newspapers. Adjectives such as immense, colossal, gigantic come to mind. If you have ridden by the properties along the shore of Lake Michigan—a part only of the prodigious scheme—the physical magnitude of the project will begin to dawn on you.

What does such a project do to the technical men in the organization concerned? What of their work, their prospects, their future? A very pertinent comment of STEPHEN LEACOCK may find happy application here. Said he in substance: "A man who has a million dollars may be a good fellow, enjoy golf, play a good game of bridge and tell a good story. A man with five million dollars may still be able to speak graciously to his employees and colleagues, but a man with twenty million is just twenty million." There is something very similar about corporations. A small corporation may be imbued with the kindly spirit of a splendid man. A larger corporation may feel the personality of someone, but to a lesser extent. The larger the corporation becomes the more like a ruthless, inexorable machine it seems. The individual becomes a cog. Whole groups of individuals are lost to view. The great machine grinds on.

Technical men do not suffer as does the untrained man, but it reduces business relationships to its lowest terms. Big business cannot easily ask for loyalty when it reserves the right to eliminate a man or groups of men for mere expediency and not because of individual lack of worth or lack of effort. The problem is large and is ours as well as that of boards of directors. It must be solved by compromise. Loyalty and enthusiasm we give for fair treatment and security. Can big business pay the price? Can billions become human?

The answer is not going to be found in welfare committees, but in a genuine effort in business to regard the individual as a person with ideals and aspirations, with needs and desires and not as a cog—a unit quantity of energy purchased like so much lemon juice while the rind is cast out with the refuse.

Is the Steel Corporation On the Decline?

A MONTH or more ago the United States Steel Corporation held its annual meeting and its twentieth yearly report was presented to stockholders. Judge GARY made, as usual, a felicitous address and any stockholder present had the opportunity to say what he pleased or to ask questions. The meeting proceeded in amity and the chairman of the board, the finance committee, the executives and the directors were justly thanked by the stockholders for their able services and competent administration of the corporation's affairs.

Judge GARY said among other things: "The corporation has made steady, intelligent progress from the time it started. We have fortified our positions, we have become stronger, we have added to our capacity and our wealth. . . . We expect to meet competition, sharp competition. We have no feeling of hostility toward competitors or anyone else. We are going to do our duty as we see it. . . . We are subject to criticism . . . and sometimes it will be unfair. That has no influence upon us except, when we hear or read a criticism which we think is deserved, we try to improve our methods accordingly."

We agree with the stockholders present in believing that the corporation is to be congratulated on its excellent leadership and its frank reports of its conditions—with one reservation. Its leadership is immensely able so far as it leads and its reports are full so far as its property, sales and cash accounts are concerned. The criticism that we make is presented in all good will and from the standpoint of a stockholder of long standing.

Here is the greatest corporation in the world. Its leading occupation is within the field of metallurgy. It produces and sells mainly iron and steel, although its vast dominion includes the production and sale of cement and the operation of gas wells, railways, steamships and a great variety of subsidiary activities. Now in all the report and in the remarks of the chairman and in the comments of the stockholders themselves it would seem as though not only the theory of steel making but the technology itself were but minor features, whereas the number and size of the blast furnaces, the list of mines, quarries, railroads, steamships and above all things of sales, were the features of leading interest. We fail to find any reference to the quality of its products. The statistics have to do principally with tonnage. Of course, it may be said that big tonnage proves quality to be satisfactory, but the blind spot may be found in that very statement! How do we know that the quality of today will be satisfactory tomorrow? Or that the costs of today may not be lowered by research by next year, and with no reference to wages or coal or transportation costs?

In other words, the very heart of the business passes without comment. Steel is the subject of constant research, and improvements in product and in processes are constantly reported by the corporation's competitors. We are familiar with the fact that many of the Steel Corporation's subsidiaries maintain well-equipped research staffs, but whatever they find out is apparently held for internal consumption only, or is directed solely to the solution of operating difficulties appearing under their own special conditions. If any fundamental researches on iron, steel or its alloys is being done, nothing is being said about it. As a matter of fact, we men of today know that to talk of secret research and practice of metallurgy is a delusion.

We do not find on the board of directors or among the leading administrators of the Steel Corporation, as published, a single man of scientific training or of whom it is reasonable to expect that he has the scientific vision. It appears to be operated by the Old American Method under which finance and legal acumen control, while Science punches the time clock and is hired and fired according to the pleasure of the finance committee. We may be wrong in this view, but the report gives the impression. The New American Method is that practiced by the General Electric Company, the Westinghouse Company, the American Telephone & Telegraph Company and a number of other organizations that keep constantly in the forevan of scientific knowledge and understanding because they practice research, welcome theory, resolve it into practice—and then are not ashamed to tell the tale.

With all good will we wish the Steel Corporation would indicate an interest in the scientific side of its great business and change over to the New American Method of administration. It would be a grand thing for this country if it did. We believe it would be following a course of self-preservation as well, for undoubtedly the metallurgical progress of tomorrow is not to come through bigger business or bigger blast furnaces and rolling mills, but through the precise application of science for the production of quality metal.

Judging Coal Prices

HOOVER, with customary courage and vigor, promises to fix on his own personal responsibility a set of fair prices for coal. So long as the present labor disturbance in that industry creates an emergency, he will ask those producers who are able to operate to accept as a fair price no more than the charges which he will name after careful consideration of all factors in the situation. This is a public service of first magnitude. The Secretary quite properly says in this case that a man who is not willing to accept on behalf of the public the burden of large responsibility in time of emergency is not competent for public office. Judged by this measure, and for any other so far as we can observe, no one can gainsay Mr. HOOVER'S full competency as Secretary of Commerce.

But there is another side to the question and another responsibility in the matter which rests upon coal purchasers. Those in the chemical industry who find themselves with unfortunately low coal stock should do their best to avoid competitive bidding in limited markets. It may be that the need for coal will quite justify on a dollar-and-cent basis the payment of exorbitant prices temporarily. But wherever possible the purchaser should avoid any such payments as will tend to undermine the work of the Secretary in fixing fair base prices for bituminous coal.

Whenever it may become necessary to pay a bonus or excess above a "fair price," it is to be hoped that the purchaser will do it under protest. And this protest should not be the only result. Mental note should be made of those producers or dealers who use the emergency situation as an opportunity for large profit. If industry once makes coal profiteering unprofitable, it will promptly disappear. Now is a golden opportunity to accomplish this. A moral standard of action has been set up. The coal user will have full basis for judgment. Let him exercise it.

Readers' Views and Comments

Shipping in Bulk

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial on containers for coconut oil in the April 12 issue is of interest, but I suggest that the objection against the use of oil tankers for this purpose is not an insuperable one. After an experience in coconut plantations and on ships carrying copra in the tropics, I can bear witness to the deteriorated condition in which the dried coconut reaches the oil-expressing plant after a long journey. This we found was due largely to the propagation of what are known as copra bugs—small black beetles; these multiply with amazing rapidity in the humid atmosphere and help to flavor the sickening stench that emanates from the hold of a ship carrying copra in the tropics. It is one of the mysteries of chemistry that an edible and odorless product can be produced from such material, but experience has proved that it can be done with remarkable success.

My point is that if odorless preparations can be made from copra in such a condition, surely it is possible to cleanse tankers so that the degree of contamination of the vegetal oil with petroleum on the return trip would be negligible. The holds of such tankers are, I believe, fitted with steam coils, by which it should be possible to facilitate cleansing. The cost of the operation, in proportion to the enormous saving in freightage and transference, would be insignificant. Much deterioration would be avoided.

One of the heaviest costs in shipping nitrate from Chile is for the jute sacks, which come from India. The nitrate is sacked at the oficina and taken on flat cars to the port. Here it may lie in a warehouse until the individual sacks need be pried apart. Damage also occurs when loading into the lighter, during transference from the lighter to the slings and from the slings to the ship's hold. In many cases the number of intact sacks that have survived the jars and jolts of travel and have escaped being torn apart by the ugly hooks used by the Chilean stevedores is only enough to form four walls to inclose a pile of torn jute and loose nitrate in the center of the hold. Much resacking is done on the lighter and more at the port of arrival, all of which tends to increase greatly the ultimate market price.

It has been maintained that Chilean nitrate cannot be shipped in bulk, on account of its cementing properties. However, it would appear that, if clean and dry, there is no danger of such action. From my experience with this product in Chile I can see no reason why these two conditions could not be obtained at small expense.

To date, in spite of the magnitude of the natural nitrate industry, little attention has been paid to the question of the special freighting of the product. The present methods are not only expensive but unnecessarily wasteful. As soon as Chilean nitrate meets with serious competition with a synthetic product manufactured in the United States it is probable that economies in transportation methods will be adopted that will reduce appreciably the cost of fertilizer to the consumer.

San Francisco, Cal. A. W. ALLEN.

Rapid Determination of Tungsten

To the Editor of Chemical & Metallurgical Engineering

SIR:—The following method for the determination of tungsten should be of interest to chemists who must make preliminary tests on electric furnace heats. For such work time is valuable. With good facilities a tungsten determination by this method can be completed in 35 minutes, and the results are absolutely dependable. It is not applicable for steels containing large amounts of chromium or for high-speed steels, but the writer has been using it very successfully for more than a year on steels containing up to 1.50 per cent carbon and up to 1.50 per cent tungsten. Proceed as follows:

Dissolve 5 grains of drillings in an 8-in. evaporating dish with 90 c.c. of 1:2 nitric acid. After violent action is over, place over a high flame of an Argand burner and boil until action ceases. Add 20 c.c. of potassium permanganate solution (30 grams per liter) and boil for several minutes; add sodium nitrite solution (25 grams per liter) until the manganese dioxide has all been reduced.

At this stage the solution in the dish should be a clear amber color, as all the tungsten will be in solution. If any scale has been weighed up with the steel, it can be seen readily and should be removed, as it will not dissolve later. However, it is better to make sure that the sample contains no oxide, as the result will be vitiated accordingly.

Add a small spoonful of paper pulp and 30 c.c. concentrated hydrochloric acid and continue boiling; then add 100 c.c. of boiling water, next 15 c.c. of cinchonine solution (75 grams per liter of 1:1 HCl) and continue the boiling for 5 minutes. Filter through a 15-cm. Swedish filter No. 0, using suction. Wash thoroughly with a wash made as follows: 900 c.c. water, 35 c.c. concentrated HCl and 15 c.c. cinchonine solution. Use this wash hot. Burn in a weighed platinum crucible and weigh.

The difference in weight calculated in the usual way gives the tungsten, which will be free from silica, and if the operator has been careful it will also be free enough from iron for general technical purposes.

Bridgeville, Pa. FRANK G. ROHM.

The Ignorant Forge Shackles for Progress

To the Editor of Chemical & Metallurgical Engineering

SIR:—Right you are, Brother Parmelee! Whether or not you were directly responsible for the editorial headed "The Ignorant Forge Shackles for Progress," I wish to commend your courage and judgment in printing it.

One of the editors of a Maine newspaper (not our own local) assured me the other day that we need expect no trouble from Bryanism, for the very simple and obvious reason that no thinking man would listen to Bryan; conversely, he (Bryan) and others like him need expect to number among their disciples *only* the unthinking. What a comforting thought for those of us who like to feel that we do, occasionally, think!

At a conference of ministers which I had the pleas-

ure of attending in a lay capacity not long ago, one of the members insistently called attention to this menace to intellectual freedom. The assembly, representing what is usually considered the most liberal and progressive of all the denominations, listened more or less patiently to what he had to say—and turned to other matters of greater importance.

Are we asleep? Do we not realize that the docile sheep are in vast majority; and that once they have been stampeded the independent goats (pardon the implication) may butt and kick and dance and bleat to the limit, and will succeed in nothing but in making a spectacle of themselves?

Do we imagine that the days of Quaker persecution and of the hanging and burning of witches are so far away that they can never come back? Those things happened yesterday, and may happen again tomorrow. My wife's maternal ancestor, Cassandra Southwick, not so very many generations back was cruelly whipped at the cart-tail for refusing to give up her spiritual and intellectual independence at the behest of the fanatics of Salem. It is not pleasant to think that our great-grandchildren may, some time, suffer a like humiliation. Is the picture overdrawn? It is not.

It is for the few—among whom we like to count ourselves—who know how to place a true value upon freedom of thought, to throw off their coats, roll up their shirt-sleeves, and pitch in. *Otium cum dignitate* has been the motto of the scientific thinker too long: let's keep what "dignitate" we may, but throw "otium" into the discard.

FREEMAN F. BURR,
Acting State Geologist.

Augusta, Me.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, ITALY, May 2, 1922.

IT IS altogether appropriate that the Italian chemical industries behaved somewhat like a turtle during April. The Italian lira was undergoing very severe oscillations in value and consequently the foreign values of the lira fell. Many reasons lie behind this variation, the overcrowding of ports with retarded deliveries of coal and raw material, the general excitement created by the International Conference at Genoa and many others.

TRADE ASSOCIATION IN THE ALCOHOL INDUSTRY

A large and comprehensive trade association was organized recently at Brescia for protecting the interests of the distillers of alcohol from grape residues. It is expected that this organization will be able to effect considerable improvement in conditions.

SULPHUR MARKET SLOW

It is quite natural that the sulphur industry should continue at a low ebb owing to the lower quotations of the lira in America and to special local conditions in addition. Several new firms, however, were incorporated for the exploitation of new or neglected sulphur mines in Sicily, one of them with a capital of 100,000 lire. The production in 1921 of brimstone reached 284,000 tons, that of ground sulphur 28,000 tons and of iron barytes 448,000 tons. This represents about one-half of the pre-war figure. A corporation created for assisting the sales of sulphur was able only to dispose of 105,000 tons during 1921, of which 42 per cent was destined to continental Italy. In order to assist the industry, the government has reduced taxes and arbitrated the wages of workers in sulphur fields and also taken action with regard to disputes between agriculturists and other land owners and the sulphur mines. Railway tariff is also under revision.

SULPHATE OF SODA EXTRACTION

Mines near Bompensiere in Sicily are ready to be worked for sulphate of soda. Mineral deposits in these mines consist principally of glauberite (sulphate of lime intermixed with sulphate of soda). Warm water is used to extract the sulphate of soda in the mine shaft and the concentrated solutions are then pumped to the surface and crystallized out. A similar principle of extraction is used in Austria. It is thus possible to use material much poorer in sulphate of soda contents than would ordinarily pay to extract.

ACIDS AND FERTILIZERS

During the past year a great deal of profit was made by Italian fertilizer work and several new firms have been created in spite of the effort of the Montecatini Works, which is trying to absorb all of the Italian production. A new fertilizer has come into prominence, consisting largely of mineral sulphate with concentrated sulphuric acid and a small quantity of cyanamide. Sales of fertilizers, very light early in the spring, have increased now and have already passed the sales of the corresponding period last year. A new process has been developed by the Prodotti & Concimi Chemical Co. for using the waste vapors from the Gill stoves in making sulphuric acid. These until now have been entirely lost and a considerable reduction in the market price of sulphuric acid is to be hoped for as a result of this interesting experimental work.

MINERAL PRODUCTION

Below are listed a number of products used in chemical industries, and the figures which follow them refer to the tons produced in 1921:

Magnesium sulphate, 350; barytes, 13,500; china clay, 13,500; carbonate of lime powder, 6,500; asbestos, 420; graphite, 7,750; boric acid, 2,500; alunite, 1,170; mercury, 1,070; rock salt, 45,400; gold minerals, 80; silver minerals, 9,000; copper minerals, 22,700; lead minerals, 26,500; iron minerals, 274,000; manganese minerals, 4,700; zinc minerals, 69,000.

Recent cable dispatches indicate that business conditions in Italy are improving. The number of business failures is considerably less in April than it was in March, and unemployment is also encouragingly decreased. Government expenditures during the last half of 1921, as recently announced, represent a cut of 25 per cent over the same period in 1920. All of these things indicate a healthy and recuperating condition.

Artificial Silk Manufacture in Italy

There are five mills in Italy, all in the northern section, manufacturing artificial silk. Their total production is about 8,000 kg. (17,637 lb.). One of these factories, situated in Venetia, employs about 1,000 laborers, of whom 800 are women, and produces about 2,000 kg. of artificial silk. This concern is erecting two new mills, one at Naples, the other at Rome, which are expected to be completed in 1923. Most of the artificial silk manufactured in Italy is uncolored. The Italian industry now exports considerable amounts of artificial silk in addition to supplying the domestic demand. In 1921 the total exports amounted to 588,834 kg., of which 173,876 was sent to the United States.

Regional Meeting of Steel Treaters in Pittsburgh

Standardization of Tool Steel Opposed by Dr. Mathews—Fiber in Steel, as Revealed by Macro-Etching, Essential for Tough Metal—A Machine for Measuring Abrasive Resistance Described —Heat-Treatment of Armor Plate and Impact Testing Also Discussed

THREE months ago local organizations of Steel Treaters near by New York met with their national officers in the first regional meeting. Last week (May 25 and 26) Pittsburgh entertained similarly. And a very successful meeting it was; somewhat more pretentious than its predecessor, it carried technical sessions over two days, and included a rapid excursion through the Edgar Thompson plant of the Carnegie Steel Co. and the extensive Westinghouse works at East Pittsburgh.

Friday evening a banquet was served to about 200 members at the University Club. Dr. John A. Mathews, president of the Crucible Steel Co., was the principal speaker, and as usual drew upon his rich experience and knowledge of the manufacture and properties of fine steels to present some wholesome advice to the younger men.

Recalling that in his brief life he had witnessed, or had participated in, almost every new application of science to the testing and heat-treatment of tool steels, he predicted that the advances of the last 20 years would be surpassed in the next decade. Therefore it was necessary for the ambitious men to keep their minds open to general science, read widely, and build up a mental card index of references to practices in allied industries and sciences. Such references can often be put to use by their owner in the most surprising manner.

Furthermore, he warned against shackling progress by too much standardization. A standard is useful in many ways, but it is tacitly assumed to be the best, not only the best that has come before, but the best that will come after. Once a standard is fixed, every effort is made to suppress variations; yet only through the study of variations can progress be made! While he had every reason to sympathize and co-operate with a progressive works which had fixed upon a certain kind of tool steel for a certain operation, and was determined that those tools be made as nearly alike as possible of exactly the same material, he was opposed to any body of men insisting that the same steel and the same tool should be used for all shops doing that kind of work. Even tool steels were not well enough known to permit such rules being followed, although tool steels had been made since steel was invented, and many manufacturing operations had been agreed upon as best practice long before science had for good reasons approved those same operations.

Fiber in Steel

Prof. F. F. McIntosh of Carnegie Institute of Technology gave an address before the technical session on "Fiber in Steel and Iron." His lecture noted that metallurgists seldom considered fiber of importance. It was therefore a little-studied subject—in fact so little was known about it that there was no precise and accepted nomenclature which could be used to describe the known facts. Yet it would often be impossible to produce tough forgings of intricate shape without careful attention to fiber.

Fiber was often studied with the aid of deep etching reagents, suitable for revealing macrostructure. If such etching developed in a forged piece a well-defined, parallel structure similar to a bundle of very fine wires, which "wires" suffered no abrupt change in directions or foldings back upon themselves, then the piece under overpowering load would be expected to tear apart slowly and exhibit a fibrous fracture, and it was said to possess "fiber." If these conditions were not met, fractures would favor the folds in the macrostructure, often under low loads, they would occur almost instantaneously, as in brittle material, and the fracture would be crystalline. Prof. McIntosh exhibited a series of macro-etchings to support his contention that this fiber could be traced back through all the manufacturing processes into a characteristic dendritic structure in the ingot. It appeared to be absolutely independent of the chemical analysis, as ordinarily performed, and seemed to originate in the way the steel was deoxidized and the conditions during ingot cooling. How the steel making conditions affect dendritic structure is not known with sufficient precision to warrant generalizations, but since selective freezing of iron from melts containing substances of varying solubility is responsible for the cored dendritic structure revealed by deep etching, the same foreign substances—substances which are not iron, even though perfectly normal constituents of commercial steel—are in some way responsible for the production of fiber in the finished piece.

It is important, as E. J. Janitzky, of the Illinois Steel Co., pointed out, to note a line of demarcation between the amount and kind of interdendritic segregates responsible for fiber—if such be accepted as the cause—and that amount or kind which is thought to be responsible for "woody" fractures, so called. Woody fractures are fibrous to the extreme, they occur in steels having extremely low transverse ductility, and are to be avoided altogether. He called attention to a German war specification demanding fibrous structure for crankshafts. It has been contended that an electric furnace which first works up an oxidizing slag, then follows it with a reducing slag, will produce metal with fiber, whereas one which makes up two reducing slags only will produce steels markedly deficient in this elusive property.

W. B. Crowe, of the Carnegie Steel Co., agreed that fiber, laid in a proper direction, was an essential to steel which must pass a ballistic test. He confessed that he was much mystified by the subject, even after many years' study. Two armor plates of the same chemical composition, manufacture and heat-treatment—at least as near as may be in practice—might differ markedly in fiber, even though the one lacking fiber might have superior tensile strength and 65 per cent reduction in area. Furthermore, size of specimen would have much

to do with it. One steel might exhibit fiber in specimens as large as it was possible to break under a press, yet another exhibit fiber only in relatively small pieces. Certainly foreign matter (often called sonims) has much to do with the problem.

Armor plates which fail under the ballistic tests will often be found to contain dirt accumulated along definite, continuous laminations, or on the other hand may be found to be very clean steel. Best results seem to be had when the sonims are uniformly distributed in tiny particles with no continuity of arrangement.

Heat-Treatment of Large Masses of Steel

Continuing on the peculiarities shown in the way large blocks of metal respond to heat-treatment, Mr. Crowe said that the chemical composition had a great deal to do with it. For instance, chromium-vanadium, nickel-chromium and nickel-chromium-molybdenum steels containing 0.45 per cent C in big slabs, 12 in. thick, might be quenched in water from a correct temperature, would exhibit a fine porcelanic fracture for a depth of 3 to 4 in., with the interior semi-porcelanic, and be unmachinable throughout. If these same steels were air-cooled from above Ac_3, they were still unmachinable, and when drawn to give 20 per cent elongation would have quite superior physical properties. On the other hand, similar slabs of a 0.55 plain carbon steel and a 0.40 C chromium-molybdenum steel, when water-quenched from temperatures which in 1-in. test-bars would give the same results as 1-in. test-bars from the other alloys, gave a fine granular fracture at the surface, gradually coarsening to a medium fine grain at the center, and were machinable throughout. In particular, the 0.40 C chromium-molybdenum steel, quenched as a 1-in. bar from 820 deg. C., gave Brinell hardness corresponding to a strength of 300.000 to 325,000 lb. per sq.in. A similar bar cut from a quenched slab gave 140,000 lb. per sq.in. at the surface and 130,000 lb. per sq.in. at the center. If the slab were quenched from 875 deg. C. or 1,050 deg. C., there was no distinguishable difference in fracture, and the uniformity in strength surface to center (as indicated by the Brinell machine) was remarkably constant.

These notes were given as specific instances that laboratory experiments were a poor guide when selecting the temperatures for heat-treatment of large masses. Usually the metallurgist had the opportunity of using one steel which would give the required physical properites after a simple drastic treatment, or another which would require a complex, mild treatment. In general, the former is preferable, if it will produce a high percentage of acceptances, and leaves the unacceptable pieces sound and in shape for a re-treatment. On the other hand, if many pieces are ruined, it would be well to go over to the complex treatment. In any case, uniformity in practice should be the aim.

Quenching by water sprays may be hazardous from many causes, and may be superseded by a different steel quenched in oil, air, or hot water. Laminations and welded blowholes appear to be particularly active causes of quenching cracks; they seem to prevent the uniform conduction of heat through the steel. Sometimes such materials can be handled by quenching to just below color.

It is especially necessary to heat cold slabs very carefully and slowly up to 350 deg. C. in order that they may pass through the brittle range without spontaneous fracture. Complete saturation at high temperatures is quite essential; a good rule for slabs is to allow 1 hour per inch of thickness to heat, and then 40 minutes per inch to soak. Bars take only half this, cubes and balls one-third. This lag in heat, surface to center, is especially vexatious in quenching operations. Often it may be taken care of by quenching from a considerable temperature above the critical; then the lag occurs before the transformation range is reached, and it is then crossed at sufficient speed to produce the hardening effect. This practice may coarsen the grain size, and require an extremely long refining heat just above Ac_3. Recrystallization may be speeded up by reheating 100 to 125 deg. C. higher. If this grain is still too large, the next refining may be 50 deg. C. lower; the crystal grain is thus "stepped down." Ordinarily the piece should be quenched only after the last heat.

Impact Testing

J. M. Lessels, of the Westinghouse company's research staff, read a paper on impact tests, in which he remarked that their laboratory was making satisfactory use of the Izod machine. It appeared to be quite sensitive to changes in quality in the metal, and in hardened alloy steels seemed to vary as some function of the reduction of area. He was careful to emphasize that the Izod test was a measure of notch brittleness, and should not be used to measure the endurance under repeated and alternating stresses.

Much discussion was forthcoming on this paper, mostly from those who were uncertain as to just how to interpret impact tests. Some speakers objected to testing steel in a notched condition, when designers carefully avoid notching their material. Others alluded to the difficulty in getting notches precisely alike, and in eliminating other sources of instrumental error. Attention was called to recent work on Sulphur in Rivet Steel[1] which demonstrated that Charpy and Izod tests would not give consistent results on very uniform steel, and these notched bar tests were totally at variance with impact shear on unnotched specimens. The Stanton repeated impact test was recommended by R. J. Allen, of the Rolls-Royce Co., and was described as a method which in his experience had been successful in picking out steels which in severe service actually gave superior results.

Abrasion Resistance

Preliminary results obtained from a machine designed for the R. D. Nutall Co. to measure abrasion resistance of gear steel was presented by A. M. Cox. It consists of a pair of motor-driven manganese steel rollers 3 in. diameter and 1 in. face set with a little clearance, one geared to run at 300 and the other at 330 r.p.m. In the crotch between these rollers is placed a test roller, 1 in. diameter, which in turn is pressed down by a weighted idler. The effect of the combined rolling and slipping abrasion is noted by weighing the test-piece after a counted number of revolutions. In general, the loss in weight during short runs on a roller varies directly with the number of revolutions. Furthermore, the most abrasive-resisting steel appears to have a medium hardness, although runs on different samples, in what are thought to be identical condition, do not check one another as well as might be desired. A first result of these tests has been the selection of a particular type of steel for gears to follow manganese steel pinions, a selection which has turned out to give extremely good results in heavy machinery.

[1] Reviewed last week in Chem. & Met., p. 1019.

The Business Side of Chemical Manufacturing

Article Four of This Series—The Study of Marketing Completed With a Study of the Following Departments: Sales Research, Credit, Traffic, Collection, Sales Service — A Discussion of the Theory and Practice of Those Departments

By CHARLES WADSWORTH, 3d.

MARKETING is not finished with Advertising and Sales. There are five other functions which deserve at least a brief consideration. If you will recall the diagrammatic analysis of Marketing appearing in the second article of this series, we differentiated the following functions:

1. Locate the market.....Sales research.
2. Interest it in the product.....Advertising.
3. Classify prospects .....Credit.
4. Consummate sales .....Sales.
5. Deliver the product.....Traffic.
6. Collect the bill.....Collection.
7. Keep customer satisfied.....Sales service.

The two most important units—Advertising and Sales—have already been discussed in Articles II and III of this series, and this article will complete the study of marketing by taking up the five minor departments in the order mentioned.

Before actually discussing any of the departments, it is extremely important for us to remember our general attitude on the whole subject of organization. Of necessity, we talk of these units and sub-units of organization as departments, but in many properly organized manufacturing companies they may not be departments at all. The work which such a department would undertake may actually be done for some particular company by one man who is a clerk in another department. It is, therefore, not the actual unit of organization which we are discussing, nor yet the actual creation of such a unit of organization. It may be entirely unnecessary. What is necessary and vital is that the functions which the department or sub-department carries out shall not be neglected in any organization. The company with which you are connected may have no credit department whatever, but the sales manager may have given all the thought that is necessary to the credit problem. You would find, if you examined the bills which the company sends out, stated terms, and you would also find that the company dealt with no one who was not actually known to the sales manager. Such a condition would eliminate the necessity of a credit department, but the idea behind the credit department has been entirely taken care of within that particular organization. Illustrations such as this could be multiplied ad infinitum. The point to bear in mind in all this work is this: Do not think, when credit department is discussed, or any other department for that matter, that it is necessary for your company to have a small room with "Credit Department" lettered on the door and a credit man inside. What is necessary, if your company is balanced and healthy, is that the functions of the credit department shall have been considered by somebody in the organization, and a definite policy established. This applies to all the various departments that are differentiated, and it is important only to emphasize it and reiterate it here because we are about to discuss departments which are frequently of minor or of negligible importance in chemical manufacturing businesses. No generalization of the subject is warranted or safe, except that the functions represented by each department named should have been taken care of. This much and no more!

Sales Research or Sales Engineering

Perhaps the difference between the marketing problems of the firm which manufactures for the ultimate consumer and those of the firm which manufactures for industry consumption is most apparent in this particular work of locating the market. In the case of the former, the location of the market can be undertaken by the advertising department or the advertising agency. The problem is one of consumer advertising and its solution needs no technical assistance. Expert advertising experience must be focused on the appeal to John Jones, average citizen. The market is known. The sales research problem is the study of the product and the psychology of its consumption. It is an integral part of planning the advertising campaign.

Not so with industry consumption. Sales research is not part of the advertising work. The problem may be one of two, to find uses or new uses for a product, or to develop prospects who would be interested in a product. These problems need technical training for their solution. And in fact sales engineering departments are invariably technical departments.

For administrative purposes these are usually tacked on to the sales department and the head of sales engineering will report to the sales manager. Before we go any further it is necessary to record the sad fact that this department is not widely used. This unfortunately does not mean that it could not be widely used, but rather reflects the conservatism and lack of imagination of manufacturers generally. It is at once apparent that sales engineering would vary over an almost unlimited range.

To take concrete examples of departments which are working on one of the two problems studied by this department. There is first the company which produces, for example, a metal. The sales engineering department of such a company will list possible uses of the metal as they are discovered. The metal might be used in lining equipment such as stills, pipe, valves, etc., or it might be used to make the whole still or valve. There might be a possible outlet in lining cans, in making laboratory or kitchen ware, as a wire for screens, in shingles or spouting for houses. The technical difficulties of each particular use are then studied, the limitations and advantages, the relative cost and the extent of the market. In addition, of course, trade prejudices and sales difficulties must also be evaluated.

Thus the sales research department is or should be in a position to recommend a logical market for the product.

Another company manufactures a machine for a specific purpose—a mill, perhaps, for grinding materials. The sales engineers in this company must locate new industries or firms which could advantageously use this equipment. Can their mill accomplish the results desired in that process? Is it applicable to ore or pigments or to both or to neither? A distinctly different kind of problem from the first type.

Technical Brains and Sales Problems

The point is this: In chemical industries the need of technical brains on sales problems is imperative. That is practically what sales engineering means. The sales manager may recognize this necessity, but the general average attitude is more nearly represented by the following anecdote. The story is not a single occurrence, but has been confirmed a number of times, so that it represents a composite.

The sales manager of a company was asked if it wouldn't be rather a good idea to market a given product in a different form. "Yes, undoubtedly," he replied, "but we have to sell what the manufacturing department produces." That seemed to settle it until the works manager remarked that it would be a much easier proposition to make that same product in the revised form, but he added, "You know we have to make what the sales department can sell." And there you are!

There are a great many chemical firms which might not need to create the department of sales engineering. They could handle the problem through a technical man in the organization, but there isn't a single firm that can afford to neglect the problem. Perhaps this will make some of them realize that the problem exists.

Credit

Among firms which have credit departments you will find it an unpopular department. The salesmen, who are usually the loudest talkers, are forever claiming that the credit department interferes with their work, that it is foolishly conservative and that it pays no attention to salesmen's recommendations. All of these things may be true, but it is largely a necessary and fundamental difference of point of view.

The credit department functions will vary over a limited range. It differentiates first of all between desirable and undesirable customers—those who pay promptly, those who do not and those who do not pay at all. It frequently has control over the terms of sale and can vary them with the customer. For example, a customer who is slow pay may be requested to pay cash on receipt of bill of lading. Often the department has charge of collecting bills, of which more anon.

In chemical industries the importance of the credit department will depend on the nature of the business. A firm which sells in large quantities to firms with fairly large capital will often find that a single sales clerk is all the credit department it needs. On the other hand, a firm which has thousands of customers buying often in small quantities may find that an alert, active and necessarily large credit department is essential to its very life.

The trouble in the industry has been that not enough attention has been paid to the department or to the point of view that the credit man would have. A good credit man will do more than act as curb—he will indicate desirable customers so that the sales department can turn its sales effort to best advantage.

Sources of Information

It does seem rather ironical that, after all the effort of producing and marketing, a firm has to be careful of the customers to whom it distributes. But experience, the oldest teacher in the world, has created the credit man and demonstrated his usefulness, and experience trains him in his work. There are many sources of information open to the credit man, but unless he is able to read the story behind letters, figures and opinions, many a sale will be lost through overconservatism or a large "bad debt" item will accumulate through lack of proper conservatism.

A comparatively large number of business men and even technical men are familiar with the almost miraculous compilations known as Bradstreet's and Dun's. These companies furnish an annually revised list of business houses with an easily interpreted credit rating, expressed in terms of capital and promptness in paying bills. In addition they stand ready to report on the credit rating of any firm to their subscribers.

Trade associations to which the manufacturer belongs may in some cases be able to furnish credit information about a consumer of that industry's material. The National Association of Credit Men is another source of information, while perhaps the most valuable of all, though necessarily limited, is the bank with which the firm is a depositor. Bankers are more and more coming to realize that such service is most desirable from their standpoint. Bad debts contracted by a depositor weaken one of their units. Good accounts correspondingly strengthen them. Bankers obtain this information by co-operating with correspondents in other cities.

Finally, salesmen often are extremely serviceable in obtaining opinions and forwarding their own estimates of credit reliability.

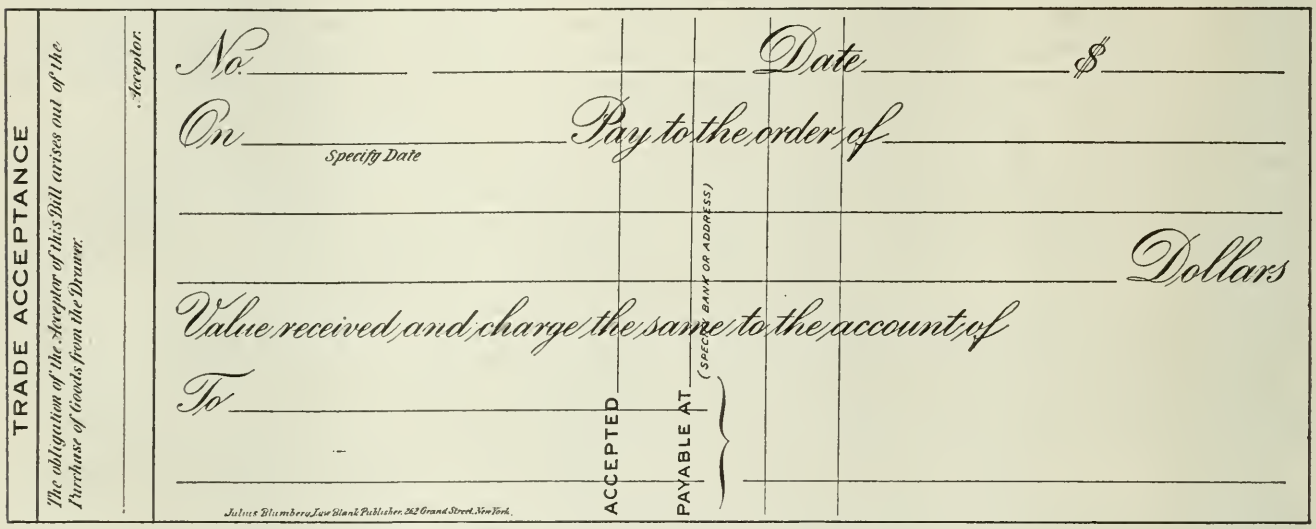
So information comes in and accumulates. As the firm (and the credit department) grows in age its own experience with customers translates itself into invaluable credit data. It should be recorded—and often isn't. A card catalog constantly revised as new data are obtained is the most convenient record for this material. Such a catalog, usually classified geographically (as Bradstreet's is also), should contain all relevant information such as capitalization, credit rating in Bradstreet's and Dun's, all other credit ratings, salesmen's estimates and finally the detailed experience of specific negotiations with the customer. Date of sale, amount of sale, terms, date account was due, date paid, history of collection follow up if necessary. Frequently elaborate data are not thought necessary, and no generalization is wise in this connection.

Terms of Sale

Fortunate is the firm, wisely financed and successfully managed, which is able to discount its bills. Under our present system American business houses run what is known as an open account with their customers. A sale of material is made and the purchasing firm is billed for the amount of the sale in accordance with certain somewhat arbitrary terms. It is nearly a universal practice to allow a discount of 1 or 2 per cent for cash within 10 days (or some definite short period of

time). To take advantage of this is to "discount a bill." The bill becomes due at its full value within 30 or 60 days and such terms are expressed as 2/10/30 or 2/10/60, which means 2 per cent off for cash within 10 days, net cash due in 30 or 60 days respectively. These terms are generally not rigidly enforced. In fact the laxity of enforcement is notorious. Cash discounts are taken without protest at 15, 20 or 30 days where 10 days is allowed. Accounts due in 30 days run on 60 and 90 days without more notice than a monthly statement. This laxity is a subtle and bad influence on general business. Nothing is more quickly demoralizing than slackness in financial matters. It is rather a mistaken idea that it is a favor to the customer to let the time dates on which bills are due slide by unnoticed. As a matter of fact, it works the other way, and a company which demands fulfillment of terms in a friendly but definite way will usually command the respect of the customer. Leaders in finance have frequently given this subject attention, and it is one of the concomitant acceptance is issued by the firm selling the goods and is "accepted" by the buyer, who then designates the bank where it will be paid. The form is then returned to the seller, who can keep it until maturity or, if he needs cash, take it to his bank and have it discounted. This means that he will receive the face value of the trade acceptance less the small discount permitted by the Federal Reserve act. Under our present system of commercial banking, when funds are necessary, a firm goes to a bank and asks for a short term loan. If the firm's standing is good and if the bank has money to spare for commercial loans and if the money market is not tight, the loan is made. Now, if trade acceptances were used, it would remove the arbitrariness of the present system.

There is another very good influence which trade acceptances would have on business in general. Under the lax collection system of open accounts a firm is very apt to overbuy. With trade acceptances, however, the fact that the money is due on a definite date and must be paid when the bank presents the note would compel



FAC-SIMILE OF A TYPICAL TRADE ACCEPTANCE

blessings of the trade acceptance system, made possible by the Federal Reserve Banks, that a higher standard of financial responsibility is certain.

The Trade Acceptance

This section is, I unblushingly confess, propaganda. Aside from the distinct financial advantage to the individual firm which uses trade acceptances, the general economic advantage to the nation is great enough to make it an almost patriotic duty to present the subject forcibly. The trade acceptance became a commercial possibility in this country when the Federal Reserve banking act was passed. This provided for minimum rate of discount on trade acceptances. In order to become eligible for this low rate of discount under the Federal Reserve act, "the bills must be the result of commercial transactions" and the proceeds must be "used for agricultural, industrial or commercial purposes." This wording was intended specifically to exclude the possibility of using the proceeds from trade acceptances in speculation.

If you will examine the fac-simile of a typical trade acceptance on the accompanying cut, you will see that it amounts to a promise to pay on a certain time, usually 60 or 90 days distant from the date of issue. The clearer and more intelligent thinking on commercial problems and a firm would not overbuy on the chance that it could let its open accounts ride along until money came in to cover them. This has proved fatal so often that it would be very desirable to supply the ounce of prevention against overbuying and other lax practices. There would be no advantage gained by offering cash discounts under the trade acceptance system, and hence the illogical cash discounts would disappear. Cash discounts at best are a very lukewarm plea for prompt payment, while trade acceptances provide a 100 per cent efficient mechanism for the same purpose. Banks are unwilling to risk loans to small firms in anything like the same proportion as they will to large firms. This, of course, is not unnatural, but it frequently works great hardship on the smaller firm. This hardship completely disappears if the trade acceptance is adopted, for a trade acceptance is as easily marketed by the small firm as by the large.

In addition to helping the individual firm, it is also of great assistance to the commercial bank. A very great many failures in commercial banking circles have been due to the fact that commercial loans were not sufficiently liquid and in times of financial stringency collections on maturing loans could not be made. This

situation would be greatly relieved by the use of the easily negotiable trade acceptance. It is, of course, perfectly obvious that when a firm asks for a loan from a bank it would ask for a fairly large amount. Trade acceptances, on the other hand, would spread this amount over a number of smaller units. In this way, the assets of the bank are very much easier to liquidate than they could possibly be under the loan system. If you multiply this by the number of banks, you will see how infinitely more flexible the credit machinery of a country becomes. Financial stringency under a trade acceptance system would be almost unbelievable.

Traffic

It is a wise plan to avoid generalizations if possible. It is wise because it is very easy to drift into a habit of loose generalization which is inaccurate and misleading. After due consideration, however, it is safe to say that the traffic work of most companies can be handled by one man in part of his time. It is also safe to say that this work is neglected by many firms to their own disadvantage. The traffic department varies somewhat in proportion to the size of the freight bills. It will thus be obvious that a heavy chemical plant is more apt to have a large traffic department than a fine chemical plant. If finally the company owns and operates its own tank car service, the traffic department becomes a major department in every sense of the word.

The department is occupied with three questions: The first one is, what is the cheapest way of routing material to its destination; the second, locating and tracing of shipments to and from the plant; and the third, the collecting of claims against the railroad or transportation companies.

The work of the department is largely routine after the system has been worked out, even in companies which have large traffic departments. In fact, the very success of the department depends on the rigid following of routine. This statement goes double in case any exporting is done. Then routine is verily canonized, and necessarily so. That subject is far too intricate for casual consideration.

Railroad Rates

There is one thing which rather impresses a man who takes up traffic somewhat seriously, and that is the work of the Interstate Commerce Commission. Our railroad rate system is rather a peculiar jumble. Before there was an Interstate Commerce Commission railroad rates were not standardized. They varied to different shippers and preferential rebates were common. Gradually some order has come out of chaos, as much order as could come from a system which has been produced by expediency. At risk of developing a point which may be familiar to many, let this serve as an illustration of what is meant. Assume a flat rate per mile of transportation, and then have clear sailing and a progressively increasing rate from New York to St. Louis, Kansas City, Denver, Salt Lake City and San Francisco. But in transporting to San Francisco the railroads encounter water competition. If they are to stay in business they must meet water transportation rates. This means a substantial diminution in the New York-San Francisco tariff. It therefore becomes cheaper to ship from New York to San Francisco by rail or boat and then reship from San Francisco perhaps even as far as Salt Lake City. In other words, the freight rate from New York to Salt Lake City may actually be more than that from New York to San Francisco plus that from San Francisco to Salt Lake City. It is at once obvious that the Interstate Commerce Commission would have a nice question to decide as to whether or not this would be equitable. This is one of the many kinds of complications which arise. The decisions of the I.C.C. have been impressive for their thorough and detailed study of difficult problems. It is easy to criticize. It would have been nearly impossible for the system to develop otherwise than it did.

Need of Discretion by Traffic Man

Naturally in a traffic department some familiarity with freight tariff and with general methods of transacting railroad business is necessary, but it is not an unmixed blessing. In one case an overpowering desire to avoid demurrage charges cost the company a good deal of money. Cars were unloaded in order to clear them from the yard and the material had in some cases to be transported to a consumption point within 3 days. A small demurrage charge would have avoided the large charge for transferring the material. So while intimate knowledge of railroad procedure is highly desirable, it should be tempered by some personal or executive restraint. All these problems which the traffic department has in hand deal with railroads principally, except as noted in case of export and except further when it is considered desirable to use motor truck transportation. Frequently a separate clerk, group or executive will have charge of the trucks and be attached to the sales department rather than to the traffic department, which seems somehow to be inseparably and often solely concerned with railroad work.

Collections

The problem which we are about to discuss has very little of vital interest to chemical-manufacturing companies. The reason for this is that most companies do not sell to the individual consumer. Their product goes to firms of relatively high financial standing, and as a general thing, no policy of collection is considered necessary.

There are inevitably bad debts, but the percentage is less than in the case of firms which market to the ultimate consumer, and are more easily avoidable. In other words, the customer who does not pay his bills is easily differentiated, and no more material is sent to him.

There is, however, a valuable point to consider in connection with this work. The normal course of collecting bills involves the sending of statements, at first merely stating the amount due, then perhaps with a "Please remit" stamped on the statement. This is followed later by a polite letter, calling the firm's attention to the fact that the bill is due, and this in turn may be followed by a rather impolite letter, threatening legal action. Finally, it may be necessary to turn the account over to a collection agency, where for a rather large commission the disagreeable task of squeezing the dollar out of the stone is undertaken. This procedure is carried out thoughtlessly and mechanically, and little consideration is given to the individual needs of the case. Not infrequently an unfortunate attitude is developed by a customer due to the rigid application of the system. Consider this from the point of view of an individual. The tactless and needless use of a large "Please remit" stamp has frequently been the cause of a change on the part of a customer. Business houses must remember

that collecting bills must be done tactfully and not mechanically. You are dealing with personal reactions even though they are masked under a firm name. This is one of the points of contact mentioned in the discussion of advertising which must be watched carefully to avoid any bad reactions from firm policy.

Sales Service or Trouble Department

The exact point at which the sales research department ceases to function and the trouble department begins is somewhat difficult to decide, but the functions are definite and distinct except on the border line. The process of locating a customer may involve and frequently does involve the confident knowledge that he will be satisfied with the product. In that sense, therefore, the sales research department is not dissimilar from sales service. Both, furthermore, are technical departments which must be operated by technical men and both represent the opinion of technical men with regard to the sales department, though, to be sure, the attention is focused on different points.

Trouble Work Should Be Under the Direction of the Sales Department

The inception of a sales service or trouble department can be rather easily described. A complaint comes in to a manufacturing concern. Some material was not satisfactory. "Why not?" asks the general manager. "Well," suggests the sales manager defensively, "the operating department really knows more about the product than I do. I suggest that they be asked to find out." This sounds logical, and the general manager therefore usually calls in an operating man, who is given this specific job of settling the complaint. In a large organization these complaints are not infrequent and therefore it may be that one of the operating men will work into trouble work. Of course it is a wrong theory for the sales department to shunt it off on the operating department. The work should be done under the direction of the sales department and in chemical firms particularly this is frequently not the case. The operating department has no sales background. It is difficult or practically impossible for the technical man to sense and reflect the policy of the sales department toward that particular customer unless co-operation is close, which it usually is not. The result is that wires frequently get crossed and wrong attitudes are developed by the customer, all of which might be avoided if the sales department were not usually so anxious to get rid of a distasteful job. This last phrase is put in advisedly and after careful thought and lengthy observation. The trouble department is so frequently not included under the jurisdiction of the sales manager and so frequently the distaste of the sales manager for this kind of work is evident that the statement represents an existing condition.

Too Few Chemical Concerns Have Trouble Departments

We have been talking about firms which actually have trouble departments and unfortunately we are talking about a relatively small percentage of chemical manufactures. Trouble departments are almost as unknown as sales research departments. There have come personally to my attention not a few firms large enough so that many complaints are received, yet without anyone to take an interest in this work. The inevitable result has been that many a customer has turned to competing firms when a little sales service work would have kept him in a friendly frame of mind and ironed out the particular technical difficulties.

There is the whole crux of the value of sales service. Technical difficulties are frequently encountered by the consuming industry and these difficulties can be overcome oftentimes by co-operation between the seller and the buyer.

Naturally the buyer, if he has experienced trouble with a product, is not likely to be enthusiastic about repeating an order. It is therefore a matter of dollars and cents to the seller to make sure that trouble does not arise from his own product and to make the buyer realize it. This logic seems to me to be the most elementary kind of reasoning and yet many sales managers in the chemical field still rely upon a kindly pat on the back and a good cigar to dispel technical troubles for their purchasers. A definite attempt is made to minimize the trouble, to make the purchaser believe that after all he really is not in trouble and if he is, that it can't be the fault of the product. Such an ostrichlike attitude can really not be tolerated in technical manufacturing and a firm is biting off its own nose if it does not see that the information which it obtains itself from trouble work is of the utmost importance in developing better products, more easily marketable and more serviceable to the industry to which it is selling.

Desirability of Technical Work

It is often not easy to point out the desirability of technical work. It has been especially difficult during the last year when firms have been cutting their technical staffs to an absolute minimum, but in the case of the sales service or trouble department, the necessity of undertaking this kind of work is becoming more and more evident, even to the rather conservative industry to which we belong. Very interesting sales service departments are to be found in most of the progressive dyestuff manufacturing companies. An effort is made to have on the sales staff of even small producers of dyestuffs men thoroughly familiar with the dyeing game. Sometimes it has been found necessary to train specialists in such things as the dyeing of paper and other special branches, but in nearly every case you will find a man in the organization who can go out and show a dyer how to use the company's dyestuffs in the plant. If only the rest of the dyestuff industry were as admirable as the sales service departments we should have nothing but praise for them. Heavy chemical manufacturers specifically can take a valuable lesson by studying this particular work. Heavy chemical manufacturers have been notoriously slow to believe that anything like trouble work is essential or desirable and, in fact, there are hardly any manufacturers of this class who make a practice of finding out whether their products fulfill the requirements of the customer. True, when complaints come in, they are frequently taken care of, but there is no systematic effort to find out whether the technical man in the consuming company is satisfied or not. Until this state of efficiency is reached the sales department may be said to be standing on relatively unsubstantial ground.

Note:—This is the last of the series of articles on the Marketing Function. In subsequent issues several articles on Accounting and Cost Finding in chemical manufacturing will be published. They will complete this series on the business side of chemical manufacturing.

The Manufacture of Ammonium Nitrate

Description of Modern Operating Practice and Considerations Affecting Design and Operation of Ammonia Stills, Scrubbers, Condensers, Neutralizing Tubs, Evaporators and Crystallizing Kettles—Use of Ammonium Nitrate in Permissible Explosives

By E. M. SYMMES
Chemical Department, Hercules Powder Co.

THE use of ammonium nitrate in explosives is becoming of more and more importance every year. Approximately 20 per cent of the sum total of the commercial high explosives made in this country each year consists of ammonium nitrate. This amounts to a very substantial figure, and small economies in yields or plant costs in the manufacture of ammonium nitrate are important items when the total is considered.

At the present time there are two sources of supply of ammonium nitrate available—one the synthetic product from Norway and Germany, the other a product made by neutralizing ammonia gas derived from coke ovens with nitric acid made from Chilean saltpeter. Synthetic ammonium nitrate shows a purity of 99 per cent or better on the dry basis and usually contains about 0.10 to 0.15 per cent of moisture. It is received in large casks, usually solidified. It is treated by breaking it out of the casks and subjecting it to a coarse grinding in a swing hammer mill, followed by heating and agitation in a steam-jacketed crystallizing kettle to reduce the moisture to 0.05 per cent or less and simultaneously to wear down the crystal structure until a fine meal is obtained, suitable for direct use as an ingredient of dynamite and gelatin.

The ammonium nitrate made from ammonia gas and nitric acid is obviously a product of the following reaction:

$$NH_3 + HNO_3 = NH_4NO_3$$

which expresses the essential features, although water is present on both sides of the equation as a diluent for the sake of convenience in manufacture.

Effect of Impurities in Ammonia on Yield

Most grades of ammonia liquor from coke-oven plants contain a number of impurities, the amount depending upon the purification to which it has been subjected. The usual impurities are:

Ammonium sulphide $(NH_4)_2S$.

Tarry bodies, both soluble and insoluble, containing small amounts of pyridine and light oils.

Fixed ammonia salts, such as sulphate, sulphite, thiosulphate, thiocarbonate, chloride, thiocyanate, ferrocyanide and carbonate.

In the direct neutralization processes practically all of these compounds are retained in the neutralized liquor in some form or other. The ammonium sulphide probably reacts as follows:

$$(NH_4)_2S + 2HNO_3 = 2NH_4NO_3 + H_2S$$
$$3H_2S + 2HNO_3 = 4H_2O + 3S + 2NO$$
$$2NO + O_2 = 2NO_2$$
$$2NH_3 + H_2O + NO + NO_2 = 2NH_4NO_2$$
$$2NH_4NO_2 = 2N_2 + 4H_2O$$

showing what a far-reaching effect sulphur has upon the reaction. The losses may be calculated on the basis of the above reactions as follows:

$2HNO_3 = 126$ molecular weight
$3S = 96$ " "
$2NH_3 = 34$ " "

therefore 1 lb. sulphur represents a loss of 1.312 lb. HNO_3
and 1 lb. sulphur represents a loss of 0.3541 lb. NH_3

One hundred pounds of ammonia liquor containing about 25 per cent NH_3 is worth about $2.75. If it contains 1 per cent of sulphur, then the

HNO_3 lost = 1.312 lb. at 6c. = 7.872c.
NH_3 lost = 0.3541 lb. at 11c. = 3.895c.
Total loss per 100 lb. = 11.767c.

$$\frac{275}{11.767 \times 100} = 4.28$$ per cent reduction in value of the ammonia liquor by 1 per cent of sulphur.

The harmful effects of the above impurities are felt throughout the system. The tarry bodies collect in black clots which float on the liquor during neutralization and evaporation, decomposing and frequently igniting and burning. Free sulphur, with the cyanogen compounds, settles out during storage of the neutralized liquor, and if not removed is a source of fires if drawn into the evaporation process. The reaction is probably as follows:

$$2S + 8NH_4NO_3 = 2SO_2 + 2NO_2 + 16H_2O + 7N_2$$

and

$$S + 2NH_4NO_3 = (NH_4)_2SO_4 + 2NO$$
$$2NO + \text{air} = N_2O_3$$

Economies of Direct Neutralization

At the present time ammonia liquor can in many cases be obtained with the tar and sulphur content as low as 0.01 and 0.05 per cent respectively. Under these conditions it can be neutralized directly by weak nitric acid without trouble from the small amounts of impurities. When liquor of less purity is used, it must be subjected to distillation to hold back the impurities and drive out the pure ammonia gas from both the free and the combined ammonia.

In direct neutralization all the water of the ammonia liquor enters the neutralized solution, and it must be evaporated finally. When using the distillation process, on the contrary, all of the water is retained by a reflux condenser and only the ammonia gas passes into the nitric acid used for neutralization. Consequently, the water of the ammonia liquor does not have to be evaporated in the end. At first glance this would seem to be a substantial economy, but further reflection will show that large quantities of steam, compressed air and cooling water are required for the operation of the ammonia still, which will offset the apparent economies mentioned above. To distill a lot of ammonia liquor of 4,000 to 10,000 lb. will require about 6 hours. To neutralize the same quantity by the direct process without distillation will require from 1 hour to 2 hours.

There is thus a very considerable saving in labor, as well as in steam and air for the still. The over-all economy of the two methods is something which must be determined by local conditions at each plant.

Effect of Impurities in Nitric Acid on Yield

The nitric acid used is usually obtained from two sources—that recovered from denitration of spent acids and that made as the weak portion from nitric acid stills. This weak portion includes both the last runnings and the tower acid. As used for neutralizing ammonia liquor it has a strength of about 45 to 50 per cent. Stronger acids will permit the temperature of the neutralization process to rise high enough to cause decomposition of the ammonium nitrate.

The usual impurities in nitric acid are hydrochloric acid, sulphuric acid and nitrogen peroxide. The hydrochloric acid is derived from the salt (NaCl) contained in the Chilean saltpeter. The ammonium chloride formed from it causes no particular trouble unless present in large amounts, in which case it reduces the strength of the ammonium nitrate as an explosive. The same is true of the ammonium sulphate formed from the sulphuric acid in the nitric acid. The nitrogen peroxide reacts as follows:

$$2NO_2 + 2NH_3 + H_2O = NH_4NO_3 + NH_4NO_2$$
$$NH_4NO_2 = 2H_2O + 2N$$

from which it will be seen that one-half of both the NH_3 and the NO_2 which enter into the reaction is lost. It is therefore desirable that the nitrogen peroxide content of both kinds of the nitric acid used be as low as possible.

All the material used is weighed carefully, and yield statements are made out at the close of each month. On account of the corrosive nature of the vapors in the house the scales used require close attention. The bases are sealed in oil, and when properly constructed will remain accurate for a long period. Frequent and regular checking is necessary if beams and weights corrode. In unheated houses it is necessary to use coal oil for the oil seal, or some low-freezing, thin lubricating oil, to prevent freezing with consequent loss of accuracy.

For the sake of economy the two operations of distillation and neutralization are conducted in the same house, so that one operator can attend to both. In starting the operation the charge of ammonia liquor is drawn into a blow-case from the elevated outside storage, and weighed accurately. This blow-tank has a vent discharging either into the neutralizing tank or into acid-absorption towers to catch the ammonia gas which would otherwise be lost. The same acid-absorption towers serve to catch the ammonia gas from the vents of the large outside storage tanks. The weigh tank has a small sampling valve near the bottom, through which a sample of every weighing is taken. This sample, when composited and analyzed, serves to determine the quantity of ammonia gas charged against the operation.

Purification of Ammonia

Since in distillation it is necessary to break up the fixed ammonia salts, lime is added to the still. The proper amount may be calculated either from an analysis of the ammonia liquor or by tests applied from time to time during the operation to see if a sufficient quantity is present. On the assumption that calcium sulphide is formed by the reaction between calcium hydroxide and ammonium sulphide, as in the following reaction:

$$Ca(OH)_2 + (NH_4)_2S = CaS + 2NH_3 + 2H_2O$$

and with dry CaO = 71.4 per cent Ca, 28.6 per cent O
and with CaS = 55.6 per cent Ca, 44.4 per cent S
1 lb. CaO is equivalent to 0.5704 lb. sulphur.
1 lb. $Ca(OH)_2$ is equivalent to 0.4326 lb. sulphur.

1 lb. Sulphur is equivalent to $\frac{1}{0.5704} = 1.753$ lb. CaO.

Example:

12,000 lb. charge of ammonia liquor containing 0.5 per cent sulphur.
$12{,}000 \times 0.005 = 60$ lb. sulphur in the liquor.
$60 \times 1.75 = 105$ lb. CaO.
Allowing approximately 25 per cent excess
$105 + 25 = 130$ lb. CaO.
Assuming slaked lime contains 75 per cent CaO

$$130 \times \frac{1}{0.75} = 173 \text{ lb. slaked lime required.}$$

A check on the proper quantity of lime to use lies in the color or the residue from the still. If white, too much lime is being used, and the excess is wasted. If a light blue, conditions are about right, only a small quantity of the ferrocyanides being left unattacked. If very dark and with an odor of hydrogen sulphide, there is a deficiency of lime and the sulphur and cyanogen compounds are not completely destroyed. Hydrated lime, although commanding a higher price, often makes a saving by reducing the labor of preparation.

The ammonia gas is driven out of the liquor in the still by heating with steam coils and agitating with air, passing the gas first through a reflux condenser to remove the water and return it to the still, and then through a scrubber where it bubbles through a solution of sodium carbonate. From the scrubber the gas goes down to the bottom of a neutralizing tub in which there is at first a shallow layer of weak nitric acid, where it reacts, forming nitrate of ammonia.

Since the lime used in the still cakes on the steam

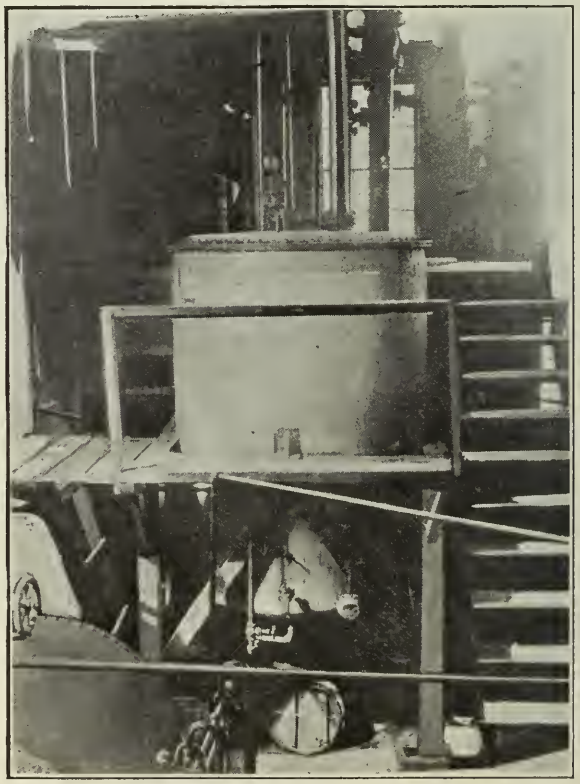


FIG. 1—AMMONIA STILL

coils, reducing the heating efficiency seriously, it is sometimes economical to substitute soda ash, which does not give this trouble.

Operation of Ammonia Stills

The still is always provided with a long manometer made of 1-in. pipe long enough to permit the still to blow out through this manometer at 10 lb. pressure, since if the discharge pipe lines were to become plugged a dangerous pressure would otherwise be built up in the still. If the latter were to burst when filled with ammonia liquor, the conditions can better be imagined than described.

The heat must be applied gradually at first, since the depth of the nitric acid originally in the neutralizing tub is slight, and a rapid evolution of ammonia gas will blow through this layer without being neutralized and will be lost up the stack. For this reason two neutralizing tubs to one still are sometimes provided.

Between temperatures in the still of 130 to 180 deg. F. there will be a so-called "prime," or very rapid evolution of the gas. As the temperature approaches this point the steam must be cut off and the rate of addition of nitric acid to the tub increased so that no ammonia gas will blow through the neutralizing tub and be lost. After the "prime" has passed the amount of air agitation in the still must be increased to carry out the remaining quantities of gas, but too much air will so dilute the gases that difficulty will be experienced in absorbtion.

Operation of Ammonia Condensers and Scrubbers

It sometimes happens that the odor of pyridine present in the still residue masks the odor of ammonia when the latter is present only in small amounts. The sense of smell should not be relied upon. The best method is to hold a strip of moistened phenolphthalein paper over the sample of hot still-residue. A slight purple tinge around the edge of the paper will indicate very small amounts of NH_3.

FIG. 2—NEUTRALIZING TUB, SHOWING FUME STACK

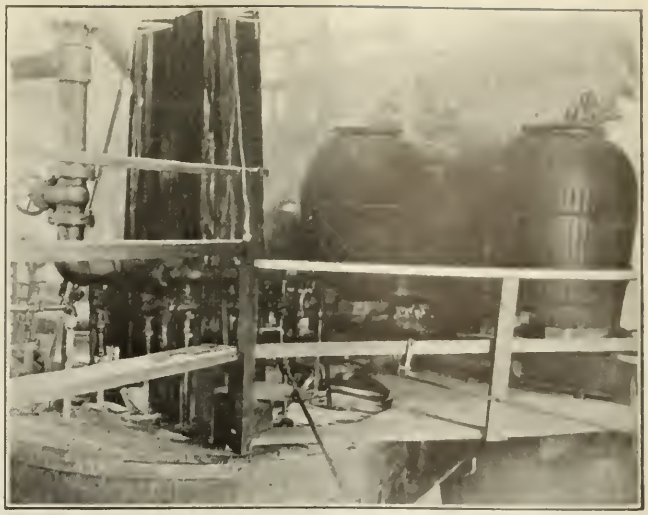


FIG. 3—TOP OF NEUTRALIZING TUB, SHOWING NITRIC ACID SCALE POTS

A condenser, properly operated, should reduce the temperature of the gases to about 120 deg. F., although this will vary somewhat with the temperature of the cooling water used. If temperatures much above this are permitted, the scrubber will fill up with condensate and require renewing.

Unless the condenser is frequently tested for leaks, losses in yields will be experienced, which are almost invariably blamed on other parts of the operation. On account of the large amount of cooling water used, the escape of ammonia gas will not be evident from examination of the water. The condensers should be tested frequently when empty by using a small water pressure.

The scrubber serves to remove any sulphur or tarry bodies which may have passed over. This, theoretically, should not happen, and the scrubber should act only as a flexible unit from which to draw a small amount of ammonia gas to finish the neutralization after all the ammonia gas has been removed from the still. As a matter of fact the scrubber does retain considerable quantities of sulphur.

The solution used in the scrubber is an 8-deg. Bé. solution of soda ash. It should not be stronger, as nothing will be gained and there will be increased opportunity for crystallizing on chilling, which will plug up the perforated distributor pipes in the bottom.

Construction of Neutralizing Tubs

Past experience has shown that hot solutions of ammonium nitrate wear out wooden tanks very rapidly either by permeating the wooden staves or by forcing the staves apart by crystallization in the cracks. To avoid this the tubs are lined with a dense, acid-proof brick set in some acid-proof cement such as Pecora, Fireite, Duro, or something similar.

Formerly tanks were installed with their tops flush with the floor. This had the disadvantage of not showing leaks as they developed, and rendering repairs, tightening of the bands, etc., impossible without dismantling. The old tubs were double—i.e., with an inner, brick-lined wooden tank set inside of an exterior and larger wooden tank, the space between the two being filled with a high-melting pitch. Tanks con-

structed recently are set above the floor level and have no exterior tank, but have small streams of water playing over the staves to keep them wet and swelled, since the heat developed during neutralization will dry the staves very rapidly otherwise. When installing such tanks it is necessary to subject the interior brick lining to a wash of weak acid to set the cement before actual use, since otherwise the cement will not become hardened sufficiently to resist the hydrostatic pressure and heat of operation during the first run.

Many types of gas distributors for these neutralizing tanks have been tried, including long glass tubes with small perforations on the bottom, chemical-ware hub-and-spoke, and Duriron, Tantiron and Corrosiron hub-and-spoke types. In tests of these comparisons have been made to determine life, yields obtained and relative costs both of construction and upkeep. The acid-resistant alloys have proved to be the best and are practically indestructible.

Operation of Neutralizing House

It is important to have as deep a "heel" as possible in the neutralizing tank to start with, and this should be calculated as the maximum allowable without overflowing the tank at the end of the run. Allowance must be made for the differences in volume of the various strengths of acid used. While tests have shown that very high yields can be obtained with comparatively strong acids, their use requires much more care, since the temperature in the neutralizing tub rises more readily in this case and high temperatures are, in general, conducive of low yields. The temperature should never be permitted to rise above 195 deg. F., since above this point a violent frothing occurs with evolution of nitrous oxide and loss in yield.

Each crock of weak nitric acid is carefully weighed and sampled before use, and at the end of the day the various samples are composited according to weights, and analyzed, so that a yield can be calculated monthly not only on the ammonia but also the acid efficiency.

The top of the neutralizing tub is covered, except for a small window for the operator to watch operations and dip out samples to test for neutrality. During the run, methyl orange test papers are used to determine whether a sample removed is acid or alkaline, but at the close of the run the exact end-point is found by taking a known quantity in a pipette, which is neutralized by a tenth-normal acid or alkali solution from a burette, with methyl orange solution as indicator, since this determination is much more delicate than the test papers. After a very short experience the operator can almost entirely dispense with the test papers, since the color of the solution in the tub is indicative of acidity or alkalinity. If a lemon color, the charge is acid, and if a chocolate-brown, it is alkaline. These colors are due to the small amount of iron present, the change being very delicate.

Occasionally during neutralization severe foaming occurs, which, if the tubs are being operated at capacity, may cause them to overflow. A small amount of petrolatum thrown into the tub will float on the top and obviate this trouble.

Recently, advantage has been taken of the fact that the principle of the heat exchanger can be applied to this operation just as easily as it has already been applied to others. If two stills are used, the gases from the one in operation are passed through the idle one, the latter acting as a condenser and also absorbing the heat from the gases which would otherwise be wasted in the cooling water of the condenser.

At the close of the neutralization, the tub is emptied by an acid-resisting cast-iron standpipe connected to a centrifugal pump which delivers the neutral liquor to storage tanks. Formerly the latter were made of wood, but more recently have been constructed of boiler plate, since the latter have the longer life, in spite of considerable rusting being experienced. The small amount of iron rust carried through the neutral liquors is of no disadvantage. In fact, it is a positive advantage in preventing the development of acidity during evaporation, as will be explained later. For this reason agitators consisting of air pipes are installed in these storage tanks to stir up the iron rust sludge and carry it through.

Evaporating Equipment

Experience in evaporation of neutral ammonium nitrate involves a variety of styles of evaporating pans, methods of heating, and theories regarding losses involved. Many shapes of pans have been used, both direct-fired and steam-heated. Steam coils with rust joints inside the pan, through-and-through coils of wrought iron, cast iron and steel, even Spellerized steel

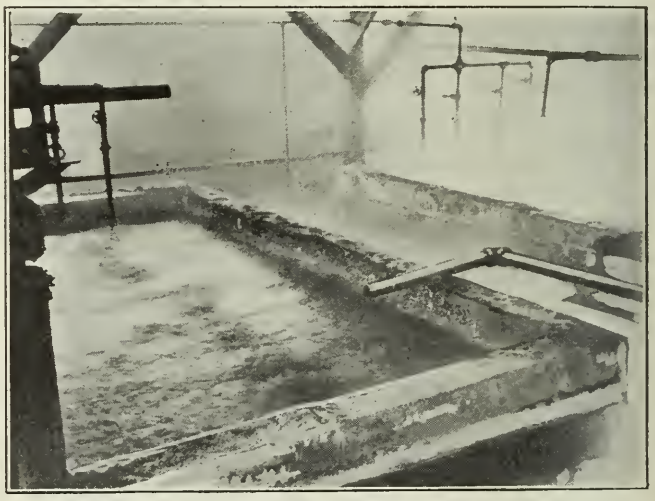


FIG. 4—EVAPORATING PANS

and aluminum, have been used. Experience has shown that in general liquors containing a considerable quantity of ammonium chloride act severely on wrought iron and steel, sometimes corroding through in one evaporation, while cast iron will stand this service. The latter are difficult to obtain in such lengths, and two shorter lengths have been carefully threaded and joined in the center. The air agitation should never be directed against a steam pipe, since the blast of air will cut through a steam pipe in this service in the course of a few hours. While no work has ever been done to prove the point, it is assumed that the air in the hot solution assists in the hydrolysis of the ammonium nitrate, carrying off the ammonia gas and leaving behind the nitric acid, which rapidly corrodes the metal.

One theory of this corrosion of the steam pipes is that the entire pan operates as a huge galvanic cell, the two elements being the dissimilar metals, steel and cast iron, the electrolyte being the ammonium nitrate solution. Insulation of the steam pipes from the pan

and measurement of the potential differences show an appreciable voltage, which supports this contention. Nevertheless, the corrosion does not take place in the absence of ammonium chloride.

Evaporating pans of the size in use at present contain about 8,000 lb. of a solution of about 50 per cent concentration. The steam pipes were formerly one continuous through-and-through coil, which had the disadvantage that a leak in the coil at any point stopped operations. At present there is a steam header at each end and each steam pipe in the pan is fed from this header by a small valve, so that a failure of any one pipe permits cutting this particular pipe out of service without interrupting the operation.

Operating Considerations in Evaporation

At elevated temperatures experience has shown that the loss in yield is directly proportional to the time the solution is held at the high temperature. Evaporation is therefore carried off as rapidly as possible.

The use of air agitation is required during evaporation on account of the severe foaming experienced without it. A slight current of air bubbling through the liquor from perforated air pipes breaks up this froth very effectively. A large air receiver is placed in the air line near the operation to separate the water always carried by compressed air. This reservoir prevents freezing of the air lines in cold weather, as well as insuring a supply of air for some time in case of failure of the main supply. Calculations will show that it is cheaper to install a small low-pressure rotary blower to furnish this air for agitation rather than to use high-pressure air and throttle down to the low pressure required.

It was formerly the custom to add small amounts of chalk or zinc oxide to the charge during evaporation to reduce the acidity developed and so protect the pan from corrosion. On account of the alkaline nature of these substances, ammonia gas was driven off with consequent loss in yields. It has been found that ferric hydroxide normally present in these solutions exerts the same effect without driving off ammonia gas, and therefore additional iron is now added in case insufficient is present.

To illustrate the extent to which losses may occur in evaporation during long periods of time we give below figures obtained experimentally by heating nitrate of ammonia in a constant temperature bath for 2 hours:

Temperature in Deg. F.	Per Cent Loss
330	3.53
320	2.65
315	1.66
300	1.14
290	1.00
280	0.53
270	0.40
250	0.21
230	0.10
210	0.00

On account of the hydrolysis mentioned above, charges can develop acidity during evaporation, but this change can always be recognized by the color of the charge. A lemon-yellow color indicates acidity, which can be confirmed by tests with methyl orange papers if any doubt exists. This acidity during evaporation may be corrected by the addition of the minimum quantities of chalk or zinc oxide necessary, bearing in mind that any excess drives off ammonia gas. The presence of small quantities of iron oxide or hydroxide in suspension will prevent this development of acidity and so protect the pan and steam pipes from corrosion. Small quantities of iron may be added to the neutralizing tub to furnish this hydroxide.

Operation of Crystallizing Kettles

The solution of ammonium nitrate is evaporated to a predetermined point and then drawn off into a water-jacketed crystallizing kettle having revolving arms and scraper blades so that the salt may be agitated during cooling, to produce the size of crystal desired. The determination of the proper temperature to which the solution in the evaporating pan must be carried is actually the determination of the freezing point of the charge. In actual practice some of the solution is removed in a dipper, a thermometer placed in it, and the material stirred by the thermometer while cooling. As the temperature falls, a point is reached where it remains practically stationary for a time as the liquor becomes thick and slushy. This pause in cooling is due to the heat developed by crystal formation. This point, and not the maximum temperature of the solution of ammonium nitrate, is taken as the criterion for the finish of the evaporation. Three factors influence the final size of the crystals obtained, (*a*) the temperature of crystallization, (*b*) the rate of cooling, and (*c*) the amount of ammonium chloride present.

FIG. 5—CRYSTALLIZING KETTLES

Two grades of ammonium nitrate are used in explosives—one a very coarse, sandy material, the other a rather fine powder. The former is made by carrying the evaporation to a higher point and permitting the liquid to run into crystallizing kettles heated by steam in the jacket. After the entire charge is in the kettle the steam is shut off and the charge permitted to cool naturally without the use of cooling water. This gives a slow rate of cooling with consequent formation of large, rounded crystals. When the fine product is desired the evaporation is not carried so high, and the charge is run into a warm kettle, which is then immediately chilled with cold water in the jackets, inducing sudden crystallization and consequently fine crystals. On cooling down to room temperatures the crystals, in forming, will give off sufficient heat to drive off all but about 0.05 per cent of moisture. This removal of moisture is important, since its presence in the finished ammonium nitrate would cause the latter to cake to a solid mass before

use, as well as causing difficulties in the dynamite made from it.

To diminish the tendency of ammonium nitrate to absorb moisture, 1 or 2 per cent of petrolatum is added while the material is still warm and before removal from the kettle, so that there will be a coating of grease over each crystal. To lessen the tendency to "cake" during storage, 1 or 2 per cent of kieselguhr may be added at the same point of the process. Before removal from the kettle 1 per cent of chalk is added as an antacid, but it should not be added until the charge has cooled down to about 120 deg. F., since otherwise a reaction will take place driving off ammonia gas with consequent low yields.

The finished product is stored in barrels lined with waxed paper, or in canvas bags, in a heated storeroom. Heat is necessary to prevent absorption of moisture by the deliquescent material. From this storehouse it is taken to the dope house of the dynamite line, where it is mixed with other ingredients, screened and incorporated with nitroglycerine to form "ammonia dynamites."

The above description does not cover the so-called "direct neutralization," a process which eliminates the use of the ammonia still. If sufficiently pure ammonia liquor is available there is no necessity for distilling, and the ammonia liquor can be run directly into the neutralizing tub. The process of evaporation remains the same as described above and the relative merits of the two methods have already been discussed.

Use of Ammonium Nitrate in Explosives

In recent years conditions abroad, especially as regards financial exchange, have become such that synthetic ammonium nitrate can compete with the same compound manufactured as described above. Synthetic ammonium nitrate is received in this country from Europe and is treated to prepare it for use in commercial high explosives as described in the first part of this article. Very recently a small amount of some material has been added to the synthetic ammonium nitrate when made which prevents solidification during storage and shipment, so that it can be readily dumped out of the cask when received. In this case it is only necessary to agitate in a warm crystallizing kettle to remove the moisture and wear down the crystals to obtain a fine product ready for use in explosives.

Not only does the use of ammonium nitrate effect a very considerable saving in the cost of the explosive but it renders such an explosive much more suitable for many operations by reducing the velocity of detonation to a marked degree, reducing thus the shattering and increasing the "heaving" effect, performing more useful work per pound of explosive used than would be the case without the ammonium nitrate present.

While under ordinary conditions ammonium nitrate cannot be detonated, in combination with nitroglycerine or other similar high explosive it actually does detonate, and with a strength apparently equivalent to about seven-tenths the strength of nitroglycerine. Many of the permissible explosives used in enormous quantities in coal mines contain as much as 80 per cent of ammonium nitrate because of the fact that the latter reduces the amount of flash produced on explosion and therefore reduces the tendency of the gas and coal dust to fire and ignite the mine.

Wilmington, Del.

Commercial Preparation and Use of Fullers Earth

By T. Poole Maynard and L. E. Mallory
Geological and Industrial Engineers

FULLERS EARTH can be defined as a highly siliceous clay, usually indurated, which has the property of adsorbing certain organic coloring matters from vegetable and mineral oils. This property, which defines the earth and is indicative of its value, can be determined only by actually filtering the oil in the laboratory.

The American earths have been found more desirable for the refining of petroleum, while the English earth has been regarded as better adapted for the bleaching of edible oils. American earths have been found of distinctly superior bleaching power to English earth with the vegetable oils as well, but they have failed to displace the English earth on account of the dependable uniformity of the imported earth, thus assuring the refiner a standard of bleach, uniform filtering and reliably low oil retention properties.

Very little has been published regarding the treatment and preparation of the English earth, but it has recently been determined by the writers that certain of the American earths can be commercially prepared, so that the bleaching properties, filtering and oil adsorption are equally as dependable and these qualities found more desirable than those of the English earth.

Occurrence, Origin and Physical Character

Fullers earth is found in this country in seventeen states, but has been developed only in Florida, Georgia, Arkansas, Texas, California, Alabama and Massachusetts. Florida leads in production, with Georgia second. The Florida earth is used largely in the refining of mineral oils on account of the high specific volume of the earth.

Recent investigation by the authors has revealed extensive commercial deposits of superior bleach to any other known earths.

Fullers earth deposits are found in the more recent geologic formations, being Post-Paleozoic. The deposits represent originally calcareous clays of marine origin which have since their deposition been elevated into land areas and subjected to compression, alteration and erosion. The consolidation of the deposits under pressure and the leaching out of the lime has been followed by secondary enrichment of the silica, largely as colloidal silica and colloidal aluminum silicates.

Fullers earth is characterized by its light weight, due to the proportion and nature of the pore space. Sand in varying amounts is usually present as well as some mica and in places calcium carbonate in the form of fragments of shells. The earth is conchoidal in fracture, usually indurated and does not slake in water. It is brittle and not plastic until ground. The earth varies in color from gray to blue, and brown to greenish and yellow. The yellow earth has passed through extreme processes of oxidation and in some areas the yellow oxidized earth proves to be of superior bleach.

Although fullers earth has a true specific gravity about equal to that of other clays, it is so porous in nature that when thoroughly dry most samples will float in water, showing the presence of more than 50 per cent voids.

Chemical analyses have never been regarded as of ıy particular value in arriving at an interpretation the possible value of the earth for commercial use. n ultimate analysis, beyond showing the quantity of ɔssibly objectionable impurities as lime and pyrite, is ithout much meaning. A determination of hydrous lica and of the aluminum silicates, which would in fect constitute the colloidal content, often may be of rect value.

The total silica in different earths may vary from ss than 50 per cent to even more than 80 per cent; ıe alumina is always low, usually from 5 to 20 per ent; the combined water, from 5 to 12 per cent, is ɔout that of the more siliceous clays. These are the ore important constituents and any others may be ɔnsidered as adulterants, sometimes harmful. Lime ıd magnesia are nearly always present and the iron ɔntent is usually evidence of secondary enrichment. he alkalis in many of the commercial earths do not tal more than 1 per cent. The mechanically carried ater (moisture) is high, even more so than in most ays, and there is the same tendency to absorb mois-ıre in storage.

Bleaching Power

The bleaching power of fullers earth is the basis of s commercial use. Several theories have been put ɔrward to explain this action. Like many other colloid ecularities, it is due to a combination of mechanical ıd electrical properties, with chemical action elimi-ated from consideration only by nice differentiation. is a combination of adsorption and mechanical filtra-on, accompanied by some chemical disintegration due selective adsorption.

The active constituents of the earth are probably ydrous silica and hydrous aluminum silicates. The ɔrous nature of the earth, due to the fact that it is uilt up of grains approaching colloidal size, offers a rge active surface.

The driving off of the combined water does not irectly affect the bleaching properties of the earth, but ıis may require temperatures that will destroy a por-on of this power by a reduction in surface as the inkering stage is reached. Coarsely ground earths sed in the bleaching of petroleum oils are not affected their bleaching properties when the water of com-ination is driven off, while the very finely divided arths used in the bleaching of vegetable oils have their each more materially injured by driving off the com-ined water.

Use in Petroleum Oil Bleaching

A few earths can be used for bleaching both mineral ıd vegetable oils, while most of the earths are by ature limited to one field or the other. In the bleach-ıg of mineral oils an earth of high specific volume is ore in demand, while in the refining of vegetable oils arths of lower specific volume are more desirable.

The methods of preparation of earth for the bleach-ıg of mineral oils and vegetable oils are quite differ-ıt. The preparation of the earth for the bleaching mineral oils is much nearer standardization.

The earth is graded for bleaching mineral oils ccording to the nature of the oil to be treated. The ore common gradings are 30 to 60 and 60 to 80 esh, while there is some demand for 15 to 30 and inus 80 mesh. The earth is burned at a low heat to emove moisture and combined water and then placed in large cylindrical containers. The oil is percolated through under pressure, if necessary. When the oil runs too dark, the earth is washed as free of oil as practicable and burned in rotary kilns. The number of times an earth may be re-used depends mostly upon the resistance that it shows to breaking down in burning and handling; with 25 to 30 per cent loss the earth is re-used as much as ten times. The quantity of oil bleached by a ton of earth of course varies widely; with medium oils a total of 250 bbl. per ton of earth is good practice.

Bleaching Vegetable Oils

In the refining of vegetable oils, the crude oil is heated and treated with an alkali to remove the fatty acids and convert the coloring matter to the basic form. The oil is usually bleached at approaching the boiling point of water by stirring in from 1 to 5 per cent of the earth. Moisture, either in the earth or in the oil, interferes with the process. The hot oil, with the fullers earth in suspension, is then forced through a filter press. Following this, the oil is put through a deodorizing process. The refining then varies depending on the use to which the oil is to be put and upon the particular process of manufacture. Some processes include a second bleaching with a mixture of fullers earth and carbon black. The oil usually starts the bleach with slightly alkaline reaction and finishes the process somewhat acid.

The amount of earth used, from 1 to 5 per cent, is determined by laboratory control for the bleach required. The filter cake is usually washed with steam, hot water, air or various combinations of these. The cake is then wasted with any retained oil. As the earth tends to oxidize the oil, the cake must regularly and carefully be disposed of. Some earths cannot be used, as they oxidize the oil so rapidly that it takes fire in the presses.

The earth is prepared by drying and grinding 70 to 100 per cent through 200 mesh for the vegetable oil bleach. This fineness of grinding depends or should depend upon the producer's understanding of the individual characteristics of his earth. A finely porous earth requires less grinding to develop the necessary bleaching surface. The grinding is further limited by the behavior of the earth in the bleaching kettles, in the pumps and in the filter presses. Furthermore, each earth possesses a natural limit in bleach beyond which it requires much more than a relative increase in bleaching surface, whether by finer grinding or an increased percentage of earth, to obtain another point or two in bleach. A little calculation makes this understandable. One pound of commercial fullers earth offers a bleaching surface of several hundred square feet. Six per cent of this earth thoroughly stirred through the oil gives an oil film thin enough to compare closely with recently determined films of lubricating oils. The effectiveness of the earth at this concentration should be rapidly approaching a limit.

Losses of Material During Use

Fullers earth found its first commercial use in removing oil from woolen cloth. This property of absorbing oil is inherent in the earth.

In the refining of vegetable oils in 1921 nearly $2,000,000 worth of cottonseed oil was thrown on the waste dumps in filter cake. These oil losses run from 15 per cent of the weight of the earth used to more

than 30 per cent. At the lower figure they exceed in cost the value of the fullers earth. The refiner endeavors to reduce the losses of oil by scouring the cake and experimenting to find commercial means of recovery. The producer can bring his brand of earth into favor by lowering the oil losses with his earth as much as is practicable.

These losses may be divided into three more or less determinate parts.

1. Loss in oil film.
2. Loss by absorption in the pores of the earth.
3. Loss in small and inaccessible voids between the particles.

In a well-washed cake the loss in oil film should not amount to more than 10 per cent of the total loss; the loss by absorption of pores in the earth is a property of the individual earth, though it can often be lessened by proper grinding; the third and often largest factor can be regulated more directly, although a separate problem for each type of earth. The use of the best-adapted system of grinding or the proper combination of two or more systems of grinding makes possible the grading of particles that will reduce these inaccessible voids in the cake to a minimum, while in no way interfering with the filtering properties of the earth.

The authors have recently put through a wide series of commercial tests on certain earths with oil losses markedly lower than with other earths and with bleaching properties superior to those of the standard English earth.

Extent of Market and Possible Developments

The consumption of fullers earth in this country has had a very rapid growth during the past 6 or 7 years and now amounts to more than 150,000 tons annually, of which less than one-fifth is imported. While there are extensive deposits of earth, particularly in the Southern States, and some comparatively large developments have been made, the demands of industry have kept in advance and have resulted in a steady increase in price. Under this stimulus production will grow until it will be another incident in "the survival of the fittest" with the superior earths or superior processes controlling the market.

There is a possibility of a widening market in making cheap "clay pigments" due to the property of fullers earth of strongly adsorbing basic dyes. The property of adsorbing bases gives it a real value as a commercial and simple water "softener." The earth when freed of sand and properly ground is in good standing as a filler, particularly in the rubber trade. The "fines" now wasted in the preparation of the earths for the mineral oil trades may be utilized, by further preparation, for the uses above mentioned.

Carbon blacks, calcined bauxite, prepared lignite and infusorial earth are also used in the refining of oils and sirups. It is possible that fullers earth under modifications of present processes, where necessary and practical, may replace some of these materials.

Summary

Fullers earths are widely distributed in this country, particularly in the Southern States.

In arriving at the possible value of an undeveloped earth a geological interpretation of its origin is of primary importance. Determination by chemical analysis of hydrous silica and aluminum silicates may have scientific value in predicting bleaching quality.

A relative determination of bleaching surface due to porosity may be made by comparing the bleaching power of an earth at different finenesses. This may be used as a base to determine nature of grinding required not only to develop bleach but also to control oil absorption.

Commercially feasible developments are dependant on location with respect to transportation; inherent superior qualities of the earth; preparation that develops these natural advantages for a particular market, and then technical control of the product. Only by a combination of these essentials can a reliable, uniform, dependable, superior commercial earth be prepared.

Our investigations show that while American earths of superior bleach to standard English earth are on the market, yet the excessive oil retention of these earths resulting from a lack of proper grinding and technical control have prevented them from occupying the position they should have.

Earths of dependable uniformity are available and eminently satisfactory to the mineral oil refineries. However, the large amount of "fines" resulting from grinding and which cannot be used by this trade and which materials are now largely wasted can be utilized and established in other trades by their proper preparation, at values equal to the earth shipped to the oil refineries. The present losses are wasteful and inexcusable.

While the markets and the value of fullers earth have been growing rapidly, the producer for the mineral oil on the one hand has paid little attention to his byproduct in the way of "fines" and the producer of the vegetable oil bleach on the other hand has not developed the all-around desirable earth that his market demands.

With the growing knowledge of the needs of the industries, technical control of production is the next step in development and will lead to markets otherwise beyond attainment or even conception.

Atlanta, Ga.

Recent Hydro-Electric Development in Canada

The Canadian Department of the Interior has been analyzing the waterpower resources of the dominion for the past two years.

Last year was one of substantial progress, there having been brought into operation new installation to the extent of 300,000 hp. The installed waterwheel capacity now totals to 2,763,000 hp.

The 2,763,000 hp. thus far installed throughout the dominion is apportioned to the following uses: 2,013,000 hp. in central electric stations for general distribution purposes, such as operation of street railways, operation of mines, operation of electrochemical and electrometallurgical industries, operation of pulp and paper mills and for general industrial and domestic uses; 476,000 hp. installed in pulp and paper mills. In addition there is used in the pulp and paper industry 161,000 hp., purchased from the central electric stations installation; 274,000 hp. installed in industries other than central electric stations and pulp and paper mills. The total installation for the dominion averages 315 hp. per thousand of population, a figure which places Canada second only to Norway in the per capita utilization of water power among the countries of the world.

Selective Case-Carburizing

A Review of the Various Methods of Producing Local Cases—In General, Electrodeposited Copper Has Furnished the Best Protection—A Non-Metallic Coating Whose Application and Removal Present No Great Difficulties Is Described

By W. P. WOOD* and O. W. McMULLAN

ON A GREAT many occasions it is desirable to obtain surfaces of varying hardness upon the same piece of steel. A camshaft is a good example of this, inasmuch as it is desirable to have the surface of the cams hard and resistant and the intervening bearings, etc., much less hard. This object is usually accomplished by case-hardening the surfaces of the cams, leaving the bearings without the carburization. Such a procedure may be termed selective case-carburizing.

Selective case-carburization is due to:

1. Desire to leave some parts soft for riveting or fixing purposes.
2. Desire to leave parts soft that are to be subsequently machined, and which are adjacent to case-carburized parts.
3. Desire to produce hard wearing surfaces alternating with softer surfaces.
4. Desire to maintain the interior of tapped holes in a soft condition.
5. Desire to leave axle shafts or spindles soft in the middle so as to straighten or set them after hardening.
6. Desire to maintain threads true and soft. As a rule, when a threaded part is case-hardened, it becomes warped and thrown out of center with the ground surface of the rest of the piece.

The advent of the motor car industry has brought about great changes in the old methods of case-carburizing and it is in this industry where the desire to obtain localization of case-carburizing is most frequent. This of course means that there was but little occasion for securing selective case-carburizing until the last few years. If much experimental work has been done, it has not been published, for very little is to be found in the literature concerning it, and apparently no résumé of the entire subject has been heretofore attempted.

The requirements for the production of localized cases are essentially simple. It is well known that carburization is brought about through a cycle of reactions in which carbon monoxide acts as the carbon carrier. In order then that no case be formed, it is only necessary to produce a coating upon the surface of the steel which is impervious to carbon monoxide. The difficulty arises in producing a coating which is unaffected by the high temperature of carburization and one which is reasonably easy to remove.

Classification of Methods

Methods may be divided into a few general classes according to the nature of the "resist" used in obtaining the desired soft spots:

I. Metallic coatings.
   1. Thin plate of copper produced by dipping in or rubbing with $CuSO_4$ or $CuCl_2$.
   2. Thin plate of copper produced by electrolysis.
   3. Thin plate of nickel produced by electrolysis.
   4. Thin plate of tin produced by electrolysis.
   5. Coatings of metals produced by Schoop spray process.
   6. Coating of steel, produced by shrinking on a thin steel sleeve.

II. Non-metallic coatings.
   1. Clay, loam, asbestos wrappings.
   2. Fire paints enamel.
   3. Mixtures of clays and other inert substances.
   4. Mixtures of sodium silicate with clays, calcium hydrate, sand, and others.
   5. Putty.

III. Leaving parts oversize, and grinding off case.

IV. Packing pieces in contact at desired soft surfaces.

Metallic Coatings

A thin copper plate produced by dipping or rubbing with $CuSO_4$ has not in general proved suitable. It was originally developed from the work of de Dion-Bouton.[1] Brearley,[2] and Guillet and Bernard[3] make rather unfavorable mention of this method.

A most generally used and successful method of producing local cases is by a copper coating deposited electrolytically from a cyanide bath. (A bath of $CuSO_4$ is recommended by some.) Probably the most extensive work upon electrolytic copper coatings has been done by Guillet and Bernard.[3,4,5] They state[3] that a thickness of 0.01 mm. is sufficient for carburization at 850 deg. C. but 0.02-0.03 mm. is required at 1,000 deg. C. There is some danger of diffusion of the copper under some circumstances,[4] but this is not of much importance. Giolitti[1] states that the use of copper coatings can be successful only below 950 deg. C.; Lothrop[6] states that a thickness of 0.0005 in. is required; Harbee[7] mentions a thickness of 0.001 in. as preventing the action of the most vigorous carburizers; Keachie[8] is of the opinion that a thickness of 0.002 in. is required, while Zimmerli[9] maintains that a thickness of only 0.0004 in. is necessary. Other writers who discuss the utility of copper coatings are Brearley,[2] Giolitti,[10] Tiemann,[11] E. F. Houghton Co.[12] Jones,[13] Gleason,[14] Paxton,[15] Grant,[16] Edwards[17] and Van Deventer.[18]

Coatings of nickel and tin have not been generally successful.[2,3,4,10,13] Guillet and Bernard[5] state that carbon monoxide will pass through any nickel coating and that tin is unsatisfactory unless on a horizontal surface where it will not run off. Paxton[15] mentions nickel plating as a satisfactory means of preventing case-carburizing.

The application of the Schoop spray process in applying coatings is discussed by Guillet and Bernard.[3,5] The apparatus is rather expensive and a thicker coating is required.

Giolitti,[1] Brearley[2] and Grant[16] describe the method

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of producing local carburization by means of a soft steel sleeve. This sleeve must be thin so that it will be brittle after the carburizing operation and may be broken off by tapping with a hammer.

Requirements of Non-Metallic Coatings

Non-metallic coatings usually include mixtures of clays, sodium silicate, sand, calcium hydrate and many other substances. Clays or sodium silicate alone are not successful, but some of the mixtures using sodium silicate as a base have been partly successful. Nearly all the writers have gone more or less at length into their use. Giolitti[1] quotes Grenet to the effect that putty is useful in preventing carburization.

A non-metallic coating should fulfill the following requirements:

1. Easily applied through painting on with a brush or as a paste.
2. Will not shrink or crack.
3. Will not melt or peel off when heated.
4. Will not become porous and permit passage of carbon monoxide at high temperatures.
5. Easily removed after carburizing treatment is finished.
6. Material and operating cost low.

Experiments on Coatings

The attempt to discover such a coating was of a rather routine nature involving intelligent selection of material and a large number of trial runs. The same carburizer was used throughout, being the so-called rapid mixture produced by the Parke Chemical Co. of Detroit.

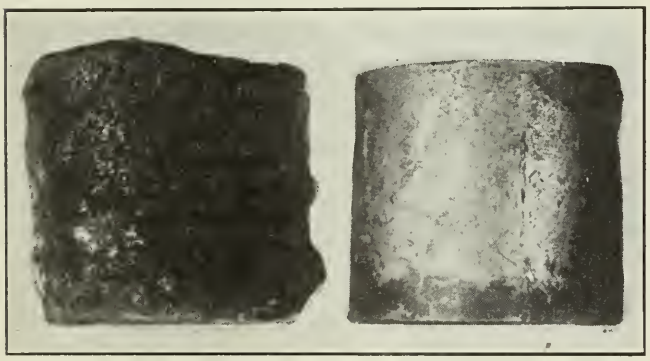

FIG. 1—SAMPLE AS REMOVED FROM FURNACE, AND AFTER DIPPING IN MOLTEN SODIUM HYDROXIDE

Samples were heated in an electric furnace, pyrometrically controlled, usually at 1,700 deg. F., which might be considered as an average case-carburizing temperature. The time ranged from 2½ to 24 hours at the above temperatures, as indicated in the table of results. Samples were of plain 0.11 carbon steel in the form of a cylinder ¾ in. diameter and about 1 in. long, coated to various depths about half way round with the mixtures. Fig. 1 shows a sample with its coating. These samples were placed in a threaded steel tube, 2 in. in diameter and 6 in. long, closed by screwing a cap on each end. Usually more than one sample was placed in the tube at a time, in which case they were separated from one another by the carburizer with which the tube was filled. The closed tube was then placed in the furnace. Fresh case-hardening compound was used for each run. Before applying the coating some of the samples were polished on a fine grinding wheel, while others were not, but this did not seem to affect the adherent or protective properties of the mixture. After removal from the furnace the samples were permitted to cool in the tubes, after which they were removed, cut, polished, etched and examined under the microscope.

Table I contains a summary of the results. Various thicknesses of the same material were tried. In making the mixtures all dry substances were finely ground and then mixed with the base, either sodium silicate or clay. Water was then added until a good smooth paste

TABLE I—SUMMARY OF CARBURIZING EXPERIMENTS

Thickness of Coating, Mm.	Coating Material	Time, Hrs.	Temp., Deg. F.	Results
0.3	Sodium silicate	3½	1,700	Protected
0.5	Sodium silicate	3½	1,700	Protected
1	Sodium silicate	3½	1,700	Protected
2	Sodium silicate	3½	1,700	Protected
2	1 Flint clay:3 sodium silicate	4	1,700	Protected in spots only
2	1 Flint clay:1 sodium silicate	4	1,700	Thin case formed
2	3 Flint clay:1 sodium silicate	4	1,700	Not much protection
1.5	Flint clay	4	1,700	Not much protection
2	1 Flint clay: 3 sodium silicate	6	1,700	Protected in spots only
0.3	MgO+sodium silicate	6	1,700	Protected
0.3	Sodium silicate	6	1,700	Protected except where coating scaled off.
0.3	Sodium silicate	6	1,700	
0.3	Sodium silicate	8	1,700	Thin case formed
0.5	Sodium silicate	8	1,700	Cased in spots
3	Portland cement + sodium silicate	8	1,700	Not much protection
1	Sodium silicate	6	1,700	Protected
2	Calcined flint clay	6	1,700	Cased
1	MgO + sodium silicate	6	1,700	Results not good
2	1 Flint clay:3 sodium silicate	6	1,700	Protected except one spot
1.5	*1 MgO:3 sodium silicate	6	1,700	Cracked. Not protected
1	1 MgO:20 sodium silicate	6	1,700	Protected, but tends to crack
2	1 calcined flint clay:1 sodium silicate	6	1,700	Gives a case
2	3 Calcined flint clay:1sodium silicate	6	1,700	Gives a case
1	1 Asbestos:5 sodium silicate	6	1,700	Mostly protected. Asbestos was too coarse
2	1 Al_2O_3:2 sodium silicate	6	1,700	Protected
0.3	1 Silex:2 sodium silicate	6	1,700	Cased. Layer too thin
1.5	A commercial selective carburizing compound	6	1,700	Cased in two or three spots
1	1 Pb_2O_3:2 sodium silicate	6	1,700	Cased in spots
0.5	1 ZnO:2 sodium silicate	6	1,700	Slightly cased. Layer too thin
1.5	1 Plastic clay:1 Al_2O_3:1 sodium silicate	6	1,700	Cased in spots
3	A commercial selective case carburizing compound	6	1,700	Thin case formed
1	1 Asbestos:3 sodium silicate	6	1,700	Good protection
1	1 Silex:2 sodium silicate	6	1,700	Cased in spots
0.2	1 Al_2O_3:2 sodium silicate	6	1,700	Cased in two small spots
1.5	1 Al_2O_3:1 plastic clay:2 sodium silicate	6	1,700	Cased in spots
2.5	1 Al_2O_3:1 sodium silicate	6	1,700	Thin case formed
2	1 ZnO:2 sodium silicate	6	1,700	Cased
2	3 Plastic clay:1 sodium silicate with outer layer of sodium silicate	6	1,700	Peeled off in furnace
1.5	1 Plastic clay:1 sodium silicate	6	1,700	Cased
0.5	1 Asbestos:3 sodium silicate	6	1,700	Good protection
1.5	1 Plastic clay:1 sodium silicate with outer layer of sodium silicate	6	1,700	No case. Sticks on
1	1 Plastic clay:2 sodium silicate	6	1,700	Cased in spots
0.3	1 Al_2O_3:3 sodium silicate	6	1,700	Cased in spots. Layer too thin
1	1 Asbestos:3 sodium silicate	6	1,760	Good protection
1	1 Kaolin:2 sodium silicate	6	1,760	Cased
0.7	1 Asbestos:2 sodium silicate	6	1,760	Protected
1.5	1 Asbestos:3 sodium silicate	8	1,825	Protected
0.5	1 Asbestos:2 sodium silicate	8	1,825	Protected
2	3 Calcined flint clay:1 sodium silicate with thin outer layer of sodium silicate	6	1,760	No case. Sticks on
1	1 Kaolin:1 sodium silicate	8	1,825	Slightly cased
1	1 Al_2O_3:3 sodium silicate	8	1,825	Protected
0.7	1 Asbestos:1 sodium silicate	6	1,700	Slightly cased
1	1 Asbestos:5 sodium silicate	6	1,700	Protected
1	2 Asbestos:1 sodium silicate	6	1,700	Slightly cased
1	1 Asbestos:10 sodium silicate	6	1,700	Protected
1	1 Asbestos:2 sodium silicate	24	1,750	Protected
1	1 Asbestos:2 sodium silicate	24	1,750	Protected
1	1 Al_2O_3:2 sodium silicate	24	1,750	Slightly cased in spots
1	1 Al_2O_3:3 sodium silicate	24	1,750	Slightly cased in spots
1	1 Kaolin:1 sodium silicate	8	1,700	Badly cased
1	1 Kaolin:3 sodium silicate	8	1,700	Cased in spots
1.5	1 Al_2O_3:3 sodium silicate	8	1,700	Protected
3	1 Asbestos:3 sodium silicate	24	1,750	Good protection
3	1 Asbestos:3 sodium silicate	24	1,750	Good protection
3	1 Al_2O_3:3 sodium silicate	24	1,750	Good protection
2	1 Na_2CO_3:3 sodium silicate	2	1,700	Cracked off when drying
2	1 Ca $(OH)_2$:3 sodium silicate			Disintegrated while drying
1.5	1 Borax:3 sodium silicate	8	1,700	Cased in spots
2	Putty	7	1,700	Cased
2	Plasteline	7	1,700	Cased

* 1 MgO:5 sodium silicate also tried but coating shrank and peeled off.

FIGS. 2 TO 4—MICROSTRUCTURE OF VARIOUS SAMPLES ETCHED WITH 5 PER CENT HNO_3

Fig. 2—Case after 8 hr. at 1,700 deg. F. in unprotected sample.

Fig. 3—Protected by 1 asbestos plus 3 sodium silicate; after 8 hr. at 1,700 deg. F.

Fig. 4—Protected by 1 alumina plus 3 sodium silicate; after 24 hr. at 1,750 deg. F.

was obtained. The coatings were permitted to dry in the air until hard enough to prevent being pushed out of place when handling. Too rapid heating will leave the dried coating full of bubbles, which permit the passage of carbon-carrying gases.

First layers of various thickness of pure sodium silicate were tried. When the water solution of sodium silicate was thin enough so that it could be readily applied, surface tension forces pulled the silicate into drops, making an even coating difficult to obtain. When the solution was made thicker, it also became very viscous. Pure silicate offered good protection against carburizing except when the pieces were in the furnace for a long time, when it would scale off in small spots, there permitting carbon penetration. Ordinary clay is porous and permits the penetration of gas at high temperatures and also tends to shrink, crack and peel off.

Adulterant for Sodium Silicate or Clay

The problem at this stage was narrowed down to finding something to mix with sodium silicate to make it more rigid and prevent surface tension action, or to mix something with clay which would fill up the pores and prevent the passage of gas.

Of those substances mentioned in the literature, the following were found to be unsatisfactory if any good degree of protection is desired: Clay and its various mixtures, mixtures of kaolin and sodium silicate, putty, hydrated lime and sodium silicate, sodium carbonate and sodium silicate, sodium borate and sodium silicate.

Tests with a commercial local carburizer were made, the directions being carefully followed. All experiments showed more or less carburization. This particular method also required a good deal of time and care in mixing, applying and drying the coating. No test was made on the mixture of 50 per cent sodium silicate, 25 per cent china clay, 18¾ per cent amorphous silica and 6¼ per cent fine silver sand specified in Whyte's patent, it being considered that this mixture was unnecessarily complicated and because of the fact that no mixture was found to give perfect protection when the amount of sodium silicate was as low as 50 per cent. Copper plating produced both by dipping in copper sulphate and electroplating from a cyanide bath were tried. Dipping was found to give a porous, loosely adhering layer which did not give good protection. Electrodeposited copper plate gave good protection, as has been abundantly demonstrated by many workers.

Of these mixtures tried only two were found to be satisfactory. Finely ground asbestos and sodium silicate gave perfect protection whenever the percentage of sodium silicate was 67 or more. Aluminum oxide and sodium silicate mixtures give about equally good protection, but the coating needs to be thicker than that for the asbestos mixture. The method of preparing and applying these coatings has been mentioned previously. Different percentages of asbestos and sodium silicate were tried in order to ascertain between what limits protection was to be had. It was found that when the amount of asbestos became greater than one part in three by weight, the protection became imperfect, while the lower limit becomes one of viscosity—that is, the mixture is not plastic enough and does not stick.

Twenty-four-hour tests were made, showing that 1 mm. of the asbestos-sodium silicate mixture gives protection at 1,750 deg. F., while it requires a thicker layer of the aluminum oxide-sodium silicate mixture to give equally good protection. Tests carried out at a temperature of 1,825 deg. F. showed that these coatings also afforded good protection at this higher temperature.

Experiments made on practically carbonless ingot iron showed the protection with 1.5 mm. asbestos-sodium silicate mixture to be as complete as that with a coating of electrically deposited copper, the two samples being in the same container for 10 hours at 1,700 deg. F., and therefore under exactly the same conditions.

Removal of Protective Coating

It was found that all coatings that gave any good degree of protection adhered firmly to the piece after carburizing and if it were desired to have the surface of the carburized piece absolutely smooth and clean the coating could not be removed satisfactorily by pounding with a hammer. This was to be expected, since if the coating did not adhere firmly, it would probably permit the passage of gas between it and the steel, which would result in carburization. An attempt was made to put on first a layer of material such as clay (which would come off readily after carburizing) and after permitting this to dry somewhat, put on a second layer which would be impervious to the carburizing gases. Where the inner coating was such that it would come off readily, the compound coat was also liable to crack and peel off. The process also took much longer because of the extra coat, so was not very satisfactory when viewed from any angle.

The best method for removing asbestos- or alumina-sodium silicate coatings is to dip in molten sodium hydroxide. A sample which had one etched surface before being immersed still showed the crystal grains under the microscope, showing the sodium hydroxide to have practically no corrosive action on the steel. Fig. 1 shows two samples, one with a coating and one from which the coating has been removed by this means.

Another method is to quench the piece in water. If one quenching does not remove the coating completely, it can be given a second quench, or the small remaining portion can be quickly dissolved off in sodium hydroxide. Heating in molten calcium chloride so softens and disintegrates the coating that it can be removed by quenching once in water directly from the bath or by mere immersion when cold. The above methods were carried out with the coatings of alumina-sodium silicate and asbestos-sodium silicate mixtures.

Preventing Decarburization

The effectiveness of the mixtures in preventing decarburization of high-carbon steel and white cast iron was tested. The first samples were placed in the electric furnace without any material surrounding them. Under these conditions the coating tends to soften and run to a certain extent, making it rather thin in places. Thinking that some surrounding material would prevent this, samples were placed in one of the tubes mentioned above, used in carburizing, and packed in gravel so that the conditions would approach those of the samples when carburizing. Even under these circumstances the coatings fused to a certain extent and decarburization was again not entirely prevented.

Summary and Conclusions

1. A review of the literature establishes the fact that an electrolytically deposited plate of copper furnishes the most satisfactory metallic coating to produce localized case-carburizing. Under many circumstances and conditions this method is the most satisfactory one to use.

2. Non-metallic coatings have not heretofore proved generally successful under all conditions and experimental work with various mixtures which have been recommended in the literature has shown that they are not uniformly successful.

3. A non-metallic coating consisting of definite mixtures of sodium silicate with either finely ground asbestos or alumina furnishes good protection from carburizing conditions. It is easily painted on the metal and may be removed by immersion in molten sodium hydroxide or by quenchings in water. Calcium chloride in the molten state is also useful in loosening these coatings.

It is not felt that these coatings have universal application, but it is believed that there may be many times when their use may not only be possible but also profitable in heat-treating shops.

4. The coatings mentioned above are not as efficient in preventing decarburization as they are in preventing carburization.

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Ann Arbor, Mich.

Legal Notes

By Wellington Gustin

Damages Awarded Where Injunction Against Discharge of Waste Was Denied to Aid War

In the case of E. G. Temple vs. E. I. du Pont de Nemours & Co. the complainant brought suit to restrain the defendant company from discharging its waste material into Bailey's Creek, which ran along his premises for about a mile, situated in Prince George County, Virginia. In 1915 the company established on the opposite side of the creek from complainant's lands a guncotton plant which employed at times as many as 25,000 men and used daily about 90,000,000 gal. of water.

The waste products of this operation, consisting in part of refuse cotton and other substances impregnated with poisonous chemicals, were carried into the creek, and it was claimed the navigability of the stream was greatly impaired and its waters polluted. Complainant sought to enjoin the du Pont company against discharging its waste material into the stream and to require it to clean out the creek and restore the waters to their natural state.

After the suit was begun war with Germany was declared and while the United States District Court at Richmond, Va., held the suit was properly instituted, it refused an injunction in view of the probable consequences of closing down the plant in face of the war and considering the public interest involved. Instead of the restraining orders demanded by the plaintiff, the court awarded damages to complainant in the sum of $8,500, and this decision was later upheld and affirmed by the United States Circuit Court of Appeals. (272 Federal, 456.)

Froth Flotation Tests on Bituminous Coking Coal

A Study of the Applicability of Froth Flotation to the Treatment of Fine Sizes of Bituminous Coal From Wilkeson, Wash., Including Various Experimental Arrangements of Roughing and Cleaning Operations for Best Ash Removal

By OLIVER C. RALSTON* and GAICHI YAMADA†

THIS research is the second undertaken in connection with a study of the applicability of froth flotation to the treatment of the fine sizes of coals of the Pacific Northwest. It forms a part of the coal-washing program of the Northwest Experiment Station of the Bureau of Mines in co-operation with the University of Washington, at Seattle. The first paper, by A. P. Wichmann and Oliver C. Ralston,[1] reviewed the past work on the flotation of coal and reported a number of experiments made to test the applicability of the process to the coals of the Pacific Northwest.

This paper reports the results of tests made to ascertain why the tests in the first research gave such poor results when finely ground coal was treated. It is naturally to be expected that fine grinding should better liberate the ash from the pure coal substance, yet flotation of the finely ground coal gave "dirtier" concentrate than flotation of relatively coarse coal.

The experiments consisted of a series of sink-and-float tests on the raw coal to ascertain the fineness of crushing necessary to liberate the maximum amount of ash and to provide a standard of permissible ash in the coal concentrate to be made by flotation; a series of tests on flotation of coal ground very fine under water in a pebble mill to test a number of oils and to determine the efficiency of flotation in removing the ash of this coal under the most extreme conditions; a series of tests on dry-crushed coal to compare with the wet-crushed material and also to determine the effect of size of crushing; and, finally, a number of tests operating on a definite flow sheet with roughing and cleaning operations in various combinations to see if a clean finished product would be made.

The sample of coal used for these tests came from, the No. 3 bed of the Wilkeson mine at Wilkeson, Wash. It consisted of the material passing a $\frac{3}{8}$-in. screen in a large screen test of the raw coal from this mine. The coal of this mine is normally crushed and washed before passing to beehive coke ovens.

Sink-and-Float Tests

A 20-kg. sample was crushed in rolls, removing oversize with a 35-mesh screen and returning to the rolls, and recrushing till all the sample passed through the screen. One kilogram of this material was used for a screen test (Tyler Ro-Tap) and each of the sizes was treated by the sink-and-float test commonly used in connection with coal washing, using a solution of zinc chloride of 1.34 sp.gr. to float the clean coal and allow the ash to sink. Previous work on coarser sizes of this coal had shown that the coal was somewhat "bony" and the cleanest particles contained about 7 to 9 per cent ash. Had the coal been cleaner, a zinc chloride solution of 1.30 sp.gr. would have been used.

Ten grams of each size of coal was placed in a 200-c.c. capacity separatory funnel and about 100 c.c. of zinc chloride solution of 1.34 sp.gr. was poured into the funnel. After 1 minute of shaking in order to mix and wet the sample the funnel was allowed to stand 12 hours in order to permit the heavier particles to sink to the bottom and the lighter materials to rise to the surface. Manipulation of the stop-cock then permitted separate collection of the sink product and of the float product. These were thoroughly washed with slightly acidulated wash water until no trace of zinc was found in the filtrate. The sample was then dried in an electric oven at 70 deg. C., weighed and analyzed. The screen analysis and the sink-and-float tests on this material are shown in Tables I and II, all figures being calculated on a moisture-free basis. The assumption was made that the material consisted of pure coal, ash and moisture. The latter two were determined and the pure coal was then calculated by difference.

TABLE I—SCREEN ANALYSIS OF WILKESON BED NO. 3 COAL, CALCULATED ON MOISTURE-FREE BASIS

Size—Meshes Per In.	Average Diameter, Mm.	Weight, Per Cent	Ash, Per Cent
Original—35	...	100.00	23.35
On 48	0.356	19.9	24.95
On 65	0.252	20.1	24.74
On 80	0.184	10.3	23.63
On 100	0.153	11.1	23.37
On 150	0.126	4.7	23.52
On 200	0.087	22.2	23.05
Through 200	0.074	10.7	23.48

TABLE II—SINK AND FLOAT TESTS, MOISTURE-FREE BASIS

	Float in ZnC_2 Solution, Sp. Gr. 1.34			Sink in $ZnCl_2$ Solution—		
Size, Mesh	Weight, Per Cent	Ash, Per Cent	Recovery Per Cent	Weight, Per Cent	Ash, Per Cent	Elimination of Ash, Per Cent
On 48	56.86	9.41	69.16	43.14	46.65	78.9
On 65	60.49	12.43	71.85	39.51	47.40	74.2
On 80	62.65	10.11	72.87	37.35	39.90	72.1
On 100	59.75	8.69	70.38	40.25	42.98	76.9
On 150	61.37	9.66	71.68	38.63	43.20	73.8
On 200	56.12	9.90	64.65	43.88	37.08	74.6
Through 200	49.30	16.12	52.95	50.70	27.52	63.7
On 200	64.18	12.25	62.50	35.82	40.86	65.01
Through 200	63.20	17.84	66.25	36.80	28.09	47.85

From Tables I and II the following conclusions can be drawn: The ash is about equally distributed in all the sizes of the coal, indicating that fine grinding, at least to 200 mesh, liberates little or no more ash than grinding to pass a 35-mesh screen; the cleanest coal contains about 8.69 per cent ash and on an average it is mechanically feasible to obtain 70 per cent of the combustible matter in the form of a 9 to 10 per cent ash product.

High inherent ash is characteristic of the coals of the Pacific Northwest, particularly the lower grade ones. Just why the more lignitic coals should have higher ash

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[1]Oliver C. Ralston and Arthur P. Wichmann, "The Froth Flotation of Coal," CHEM. & MET. ENG., vol. 26, No. 11, March 15, 1922, p. 500.

than the anthracitic ones, even in the same field where part of the field has been altered into anthracite by local metamorphism, is not easy to understand. The true lignites of Nevada, California and Oregon are all very high in ash, so that they have frequently been considered of no value whatever and have been more or less neglected and are consequently not well charted nor described in the literature. The inherent ash in these coals is quite evidently too finely disseminated to be liberated by any ordinary commercial type of grinding. This has been revealed by both the sink-and-float tests we have carried out and by the froth flotation tests reported later in this paper.

Tests Under Reduced Pressure

The ash content of the float fractions of the material which passes a 200-mesh screen in the tests reported in Table II shows that the ordinary sink-and-float test is not adapted to the treatment of these fine sizes. Evidently the fine dust is buoyed up so that it floats, or else it is entrained in floccules of clean coal. To test the hypothesis that possibly the fine coal was full of gas bubbles which gave it too low an apparent specific gravity, two tests were carried out by applying reduced pressure to the surface of the zinc chloride solution in which the finely ground coal was suspended. A similar test with zinc chloride solution of lower specific gravity than those shown in the table had given no float, so we found it necessary to use denser solutions. The data on these tests are given in Table III.

TABLE III—SINK-AND-FLOAT TESTS UNDER REDUCED PRESSURE ON DRY GROUND COAL (−200 MESH) SOAKED IN $ZnCl_2$ SOLUTION FOR 2 HOURS UNDER REDUCED PRESSURE

		Float			Sink	
Sp. Gr. of $ZnCl_2$	Pressure, Atm.	Weight, Per Cent	Ash, Per Cent	Recovery, Per Cent	Weight, Per Cent	Ash, Per Cent
1.37	0.1	7.7	10.48	8.90	92.3	23.77
1.48	0.1	87.8	16.98	93.20	12.5	55.80

While these tests failed to give us clean float products, they are quite interesting in that treating the coal under a reduced pressure evidently removed gases from the pores of the coal, so that its apparent specific gravity was increased. However, to assure ourselves, since the above tests had been run with dry-ground coal, we prepared a sample by wet grinding in a pebble mill, grinding till it all passed a 200-mesh sieve. This material was then subjected to sink-and-float tests in zinc chloride solutions of varying specific gravities, the data of which are given in Table IV.

TABLE IV—SINK-AND-FLOAT TESTS ON WET GROUND MATERIAL (−200 MESH)

		Float		Sink	
Sp. Gr. of $ZnCl_2$ Soln.	Pressure, Atm.	Weight, Per Cent	Ash, Per Cent	Weight, Per Cent	Ash, Per Cent
1.61	1.0	98.9	22.68	1.1	....
1.56	1.0	98.7	22.93	1.3	....
1.52	1.0	98.8	22.34	1.2	....
1.45	1.0	99.1	21.48	0.9	....
1.40	1.0	0.1		99.9	....
1.34	1.0	0.0		100.0	....
1.45	0.1	84.7	19.87	15.3	31.27

Under full atmospheric pressure this coal tended to all float or all sink, according to the specific gravity of the $ZnCl_2$ solution, and had an apparent specific gravity between 1.40 and 1.45. On treating a sample with 1.45 sp.gr. solution at one-tenth atmospheric pressure, in order if possible to remove the gas bubbles from some of the ash material and permit it to sink, there was a separation of high-ash material and the float coal was cleaner, but the separation was not clean.

We are not reporting all the various sink-and-float tests made by us, but the above illustrates the fact that this method of studying the ash in the coal is not applicable to the fine sizes and hence is not available for controlling the work in a froth flotation study.

Effect of Mesh on Gravity

The anomalous results obtained in this study can be explained by the following hypothesis: Coal is a porous substance with long cells, more or less resembling compressed charcoal. The true specific gravity of amorphous carbon has been determined by various experimenters to be about 1.88 and the apparent specific gravity of clean coal, 1.30, is evidently due to the porous nature of the coal, the pores being filled with moisture and gases. With the coarse lumps of coal ordinarily dealt with in the sink-and-float tests, the greater portion of the pores is buried and cannot be filled by the zinc chloride solution, even on long soaking or even boiling. Soaking is necessary to get consistent results even with coarse coal due to the necessity of displacing all easily displaced air in pores that are open to the outside. Boiling temperatures during soaking also assist in getting the samples properly saturated with solution. When fine sizes of coal are treated by the sink-and-float test, a much greater proportion of the pores is open to the outside and hence, by applying reduced pressure during the application of the test, it is possible to displace a greater proportion of the gases from the pores and substitute zinc chloride solution in these pores. This results in an increased apparent specific gravity. In the case of the Wilkeson coal the increase was from 1.34 for coal in lumps coarser than 100 mesh to approximately 1.43 when it was reground to pass a 200-mesh screen.

Froth Flotation Tests of Slimed Coal

Due to uncertainty of previous work on slimed coal we felt it best to repeat some of the work, particularly a series of tests with different types of flotation oils, to see if we could find one that had more marked selective properties. Not a great deal of true slime is formed in breaking the coal for coal washing, but that which is formed is thrown away. We therefore decided that if suitable conditions could be found for flotation of clean coal the work would be justified.

The sample tested was ground very fine in a porcelain pebble mill to pass a 200-mesh screen. It was stored in a tub under water and for each test the pulp was stirred up and approximately the same volume dipped into the flotation test machine.

The machine used was the Ruth junior laboratory machine. It was run at a constant speed of 1,200 r.p.m. and the aëration varied by restricting the air that went down the hollow spindle. Seattle city water was used in all tests. This water is very pure, being frequently used in place of distilled water for filling storage batteries. The pulp dilution was varied from 1:9 to 1:15. When flotation oil was added, the opening in the spindle was closed to prevent formation of a froth until the oil had been well stirred into the pulp. Tests were carried out slowly, adding a small quantity of oil at a time, as it was thought previous work had suffered from overoiling of the pulp. The concentrate was removed in three portions to ascertain if there was any variation in the flotability of different constituents of

TABLE V—SUMMARY OF FLOTATION TESTS ON COAL SLIME, CALCULATED ON MOISTURE-FREE BASIS

Sample: Wet ground coal in pebble mill under 200 mesh
Assay of the sample: 23.35 per cent ash
Machine: Ruth laboratory flotation machine, junior
Speed: 1,200 r.p.m.
Water used: 3,500 c.c. at room temperature, 15 to 22 deg. C.
Duration: 1st concentration, 30 min.; 2nd conc., 30 to 15 min.; 3rd conc., 15 to 10 min.

		1st Concentrate				2nd Concentrate					3rd. Concentrate					Tailing		
Test No.	Kind of Oil Used	Weight, Per Cent	Ash, Per Cent	Oil Lb. Per Ton	Recovery, Per Cent of Pure Coal	Weight, Per Cent	Ash, Per Cent	Cumulative Amount of Oil, Lb. Per Ton	Cumulative Recovery, Pure Coal	Average Per Cent Ash	Weight, Per Cent	Ash, Per Cent	Cumulative Amount of Oil, Lb. Per Ton	Cumulative Recovery of Pure Coal	Average Per Cent Ash	Weight, Per Cent	Ash, Per Cent	Elimination of Ash, Per Cent
1	Pine oil	26.26	14.53	0.17	30.6	37.26	13.59	0.34	74.5	13.74	24.70	34.15	0.51	96.7	19.46	11.78	78.70	35.5
2	8 pt. kerosene 2 pt. pine oil	29.66	12.67	0.27	32.4	35.50	12.82	0.38	71.9	12.77	26.65	27.92	0.65	97.9	17.16	8.19	80.60	29.6
3	X-cake-xylidine	29.80	11.15	0.36	32.6	50.00	11.79	0.79	86.7	11.57	11.80	24.50	1.11	97.7	13.22	8.40	76.70	34.8
4	Coal-tar creosote	59.40	13.50	0.21	67.0	....	....	....	....	....	29.20	24.62	0.42	95.8	17.17	11.40	71.60	34.9
5	Carbolic creosote	34.80	13.94	0.09	39.1	25.98	13.87	0.34	68.3	13.92	28.22	23.63	0.60	96.4	17.00	11.00	74.60	35.2
6	Phenol 5 per cent aq. sol.	37.35	13.92	0.17	41.8	17.45	14.46	0.84	61.3	14.08	....	....	....	....	....	45.00	34.25	66.7
7	Cresylic acid	35.30	14.55	0.08	39.3	41.11	14.05	0.33	85.3	14.27	14.31	34.20	0.58	97.5	17.42	9.28	79.10	31.8
8	Crude wood turpentine	18.48	11.68	0.13	20.9	36.22	11.26	0.38	62.7	11.41	34.42	22.70	0.77	96.8	15.75	10.87	76.90	38.2
9	1 pt. xylidine 4 pt. Calol D4	17.52	11.87	0.13	19.7	28.45	11.28	0.39	51.9	11.52	37.60	16.98	0.64	91.8	13.75	16.43	60.70	46.1
10	1 pt. pine oil 4 pt. Calol D4	18.21	11.43	0.16	20.4	44.90	11.80	0.47	70.6	11.68	29.33	26.40	0.78	91.9	16.37	7.56	78.20	28.1
11	4 pt. pine tar oil 1 pt. kerosene	30.57	13.58	0.28	34.2	....	....	....	....	....	55.49	16.73	0.96	94.1	15.59	13.94	67.40	41.2
12	1 pt. gas-house tar 4 pt. pine oil	15.28	13.90	0.11	17.2	23.58	12.57	0.21	44.2	13.08	50.42	20.60	0.42	96.7	17.32	10.72	76.30	34.6
13	4 pt. gas-house tar 1 pt. pine oil	35.55	12.57	0.14	40.8	39.30	15.05	0.28	84.5	13.88	15.09	35.75	0.43	97.2	17.52	10.06	79.50	33.7
14	Hardwood creosote	17.47	16.28	0.24	19.4	18.59	13.67	0.48	40.8	14.93	53.52	20.32	1.08	97.5	18.33	10.42	81.30	34.2
15	Kerosene	11.52	15.53	0.47	12.7	23.04	14.28	0.93	38.4	14.55	51.60	17.08	1.07	94.1	16.75	13.84	67.50	40.3
16	4 pt. gas-house tar 1 pt. pine oil	26.44	18.80	0.28	28.0	45.75	16.42	0.40	77.9	17.29	19.18	23.81	0.46	96.9	18.67	8.63	72.90	27.0
17	Ditto	41.45	16.37	0.23	46.9	32.99	25.10	0.35	80.2	20.24	14.31	20.78	0.46	95.6	20.30	11.25	71.00	30.7

the coal. The last concentrate was taken off 30 minutes to 1 hour after beginning the test, and flotation was continued till no more froth would form. The residual pulp in the machine was of a chocolate color and analysis showed that it was usually nearly all ash.

The data on these tests are contained in Table V.

In this table are given the amount of oil used in making each concentrate, the percentage of ash in the concentrate and the recovery of pure coal or combustible matter. In the columns dealing with the second concentrate are also given the cumulative recovery of combustible (concentrates Nos. 1 and 2 together) and the average percentage of ash in the first two concentrates. Similar figures are given for the third concentrate.

Appearance of the Froth

The first froth was of a brown color, while the last one was very black. We expected that the brown froth would contain a high percentage of ash, but found that it was the cleanest. The brown color was evidently due to greater subdivision of the coal. Since screen analyses could not be made on this very fine material, we had to be content with microscopic examination. We were able to see qualitatively that the first froth contained much very fine ground coal and the last froth was the coarsest coal. This might have been expected, as it is well known that the finer sizes of other minerals are likewise the most easily floated.

In fact, the fine sizes could be floated from the pulp to some extent without the addition of any oil. A froth made in this manner contained 9.5 per cent of ash. If too much oil was added at any time, a very bulky froth formed quickly and overflowed all sides of the machine. On that account the oil should be very well mixed into the pulp before any froth is permitted to form.

Oils

Referring to the tables, it will be seen that the best results were obtained with a mixture of six parts of alpha-naphthylamine, usually known as X-cake, and 4 parts xylidine, as it produced the cleanest concentrate and a high percentage of recovery. A mixture of one part xylidine with four parts Calol D4 (a petroleum distillate) also gave good results. Pine oil, aqueous solutions of phenol and hardwood creosote were not good oils, as they gave a very dirty concentrate. In general, rather thin fluid oils seemed to work best. The consumption of the various oils varied from 0.42 to 1.11 lb. per ton of coal.

Discussion of Tests

By referring to test 3, the one with xylidine-X-cake mixture, it can be seen that the total recovery is 97.7 per cent in the form of a concentrate containing 13.22 per cent ash. This result is far better than would be expected from other tests. The first and second concentrates contained 11.15 and 11.79 per cent ash respectively, but the third concentrate contained 24.5 per cent ash. The same general condition is true in the other tests. This suggested that the third concentrate ought not to be combined with the two others but ought to be regarded as a middling product and re-treated. Consequently all the middlings from the first sixteen tests were combined to give enough feed for a re-treatment test. This is test No. 17. Its feed averaged 29.3 per cent ash and it gave a concentrate averaging 20.30 per cent ash with a 95.6 per cent recovery of combustible.

This seemed to indicate that the coal was very easily floated but that clean flotation in one operation was difficult. Re-treatment of all the various products seemed to be in order, and this procedure was later carried out.

Flotation of Coarser Coal

Previous work by A. P. Wichmann indicated that better flotation could be obtained with 35-mesh material, so another lot of coal was crushed dry to pass a 35-mesh sieve. This was part of the sample that had been used in the sink-and-float test. The same machine

TABLE VI—SUMMARY OF FLOTATION TESTS ON DRY-CRUSHED COAL UNDER 35-MESH, CALCULATED ON MOISTURE-FREE BASIS

Sample: Dry-crushed coal under 35-mesh, 500 grams
Assay of the sample: 23.35 per cent ash
Water used: 3,500 c.c.
Machine: Ruth laboratory flotation machine, junior
Speed: 1,200 r.p.m.
Duration of test: 1st conc., 10 minutes; 2nd conc., 10 minutes; 3rd conc., 10 minutes
Temperature of water: 22 deg. C.
Pulp dilution: 1:7.

			1st Concentrate				2nd Concentrate					3rd Concentrate					Tailing		
Test No.	Size in Mesh	Kind of Oil Used	Weight, Per Cent	Ash, Per Cent	Oil, Lb. Per Ton	Per Cent Recovery of Pure Coal	Weight, Per Cent	Ash, Per Cent	Cumulative Amount of Oil, Lb. Per Ton	Cumulative Recovery, Pure Coal, Per Cent	Average, Per Cent Ash	Weight, Per Cent	Ash, Per Cent	Cumulative Amount of Oil, Lb. Per Ton	Cumulative Recovery of Pure Coal, Per Cent	Average Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Elimination Ash, Per Cent
18	On 48	4 pt. gas-house tar....	81.82	18.30	0.18	88.3	.....	.....	....	....	.....	.....	.....	....	....	.....	18.18	57.3	41.0
19	On 48	1 pt. pine oil..... } X-cake..... } Xylidine .... }	7.85	9.52	0.63	9.4	39.02	13.55	1.27	53.8	12.88	44.28	27.92	2.11	95.4	20.18	8.85	64.15	23.1
20	On 48	Coal-tar creosote... ..	14.54	10.05	0.21	17.5	34.15	14.41	0.33	56.7	13.11	45.05	32.09	0.59	97.6	22.24	6.26	72.8	18.0
21	On 65	Coal-tar creosote... ..	13.15	9.42	0.21	15.7	37.80	12.64	0.34	59.4	11.80	40.27	29.48	0.59	96.9	19.61	8.78	73.1	26.4
22	On 80	Coal-tar creosote... ..	37.48	8.94	0.21	43.9	29.52	15.52	0.34	76.0	13.92	25.46	35.73	0.59	97.5	18.40	7.54	75.8	25.6
23	On 100	Coal-tar creosote.....	30.25	7.95	0.20	36.3	33.13	13.78	0.32	73.5	11.01	25.00	32.54	0.50	95.6	17.20	11.62	71.6	35.4
24	On 200	Coal-tar creosote.....	51.96	10.54	0.20	60.4	23.44	20.75	0.32	84.5	13.53	12.30	35.54	0.50	94.9	16.78	12.30	68.3	36.4
25	Through 200	Coal-tar creosote.....	27.80	9.12	0.14	32.4	51.40	16.28	0.56	87.5	13.77	13.20	45.30	0.72	96.8	18.28	7.60	66.1	23.0

was used for testing, but the pulp density was 7:1 and the duration of the test was shortened to 10 minutes.

Effect of Size of Particle

The first tests with this material were on different sizes removed from the crushed sample by screening. The data on these tests are contained in Table VI.

In the tests it was noticed that the finer sizes of coal floated much more easily than the coarser. In test 24 the froth which formed without the addition of any oil was collected as the first half of the first concentrate and was found to contain 9.35 per cent ash and the recovery was 27.6 per cent of the total clean coal. The material used for this test passed a 100-mesh screen and was retained on a 200-mesh screen.

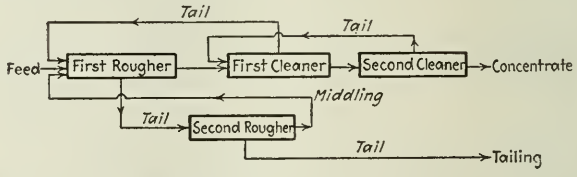
With the exception of the slimed material which passed a 200-mesh screen, the finer the size of material the cleaner the concentrate, other conditions being equal. Evidently the slimed coal is detrimental to the obtaining of clean concentrate. The first concentrate contained only 8 to 10 per cent ash in all the tests, and this suggested that either it was the cleanest coal which floated first or the later froths should be regarded as middling and re-treated.

Again the xylidine-X-cake mixture showed itself superior to other oils in obtaining clean concentrate even with coarse material.

Repeated Froth Flotation

Based on the inferences gained from the above work, we then carried out three series of tests according to definite flow sheets, in which both the tailing and the concentrate of the rougher cell were re-treated and middling returned for re-treatment. The Ruth machine was used and various fractions of the coal from these tests were set aside, each to take its turn in following out the flow sheet, since each operation mentioned in the flow sheet had to be done in the one machine. The water was re-used in each test in order to recover as much of the flotation oil as possible. The complete set of operations in following out such a flow sheet was called a "locked test."

As seen in flow sheet No. 1, the concentrate from the first rougher cell was cleaned and then recleaned, middling from each operation being returned to the next machine ahead. The tailing from the first rougher was treated in a second rougher to recover any coal not floated in the first rougher and return it to the main feed. The coal for this test was crushed dry to pass a 65-mesh screen and the first roughing took place at a pulp dilution of about 1:7. The oil used was the X-cake-xylidine mixture previously found most effective. This locked test involved twenty individual flotation operations on eight samples of coal. The results are summarized in Table VII. A screen analysis was made on the feed and on the concentrate and these analyses are included in the table.



FLOW SHEET OF LOCKED TEST NO. 1

It was disappointing to find such a high percentage of ash in the final concentrate and also to find that the intermediate products all through the system which were being returned for further treatment were so high in ash as to be almost capable of going into the tailing. The original coal contained 23.42 per cent ash and the concentrate of this series of tests contained 17.10 per cent ash, with a recovery of 95.5 per cent of the pure coal. Evidently this is the wrong flow sheet. High oil consumption suggested overoiling and consequent dirty concentrate. It was also thought that too

TABLE VII—SUMMARY OF LOCKED TEST NO. 1

	Oil, Lb. Per Ton	Recovery, Per Cent	Weight, Per Cent	Ash, Per Cent
Concentrate	2.16	95.5	87.85	17.10
Tailing from 2nd cell	....	....	0.38	71.62
Tailing from 1st cell	....	....	0.68	75.55
Middling from 2nd rougher	....	....	3.79	57.60
Tailing	....	....	7.30	77.85
Total elimination of ash			36.5	per cent

Screen Analyses

Screen Mesh	Feed—65-mesh Weight, Per Cent	Feed—65-mesh Ash, Per Cent	Concentrate Weight, Per Cent	Concentrate Ash, Per Cent
On 80	34.90	24.21	16.47	14.59
On 100	4.88	24.38	5.70	15.78
On 150	9.24	23.33	16.38	16.65
On 200	31.37	23.07	45.70	18.07
Through 200	19.61	22.58	15.75	17.89
Total or average	100.00	23.42	100.00	17.10

TABLE VIII—SUMMARY OF LOCKED TEST NO. 2

	Oil, Lb. Per Ton	Recovery, Per Cent	Weight, Per Cent	Ash, Per Cent
Concentrate	0.43	91.5	82.82	15.41
Tailing from 2nd cell	.....	.....	2.61	43.49
Tailing from 1st cell	.....	.....	2.33	54.45
Middling from 2nd rougher	.....	.....	2.61	56.35
Tailing	.....	.....	9.63	70.86
Total elimination of ash				45.6 per cent

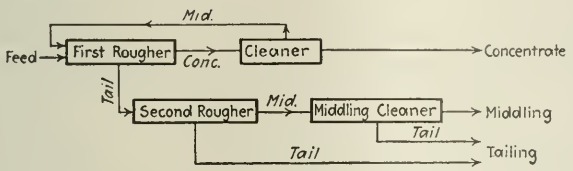
Screen Analyses

Screen Mesh	Feed—20 Mesh Weight, Per Cent	Feed—20 Mesh Ash, Per Cent	Concentrate Weight, Per Cent	Concentrate Ash, Per Cent
On 28	5.38	28.27	0.32	13.50
On 35	22.34	26.70	10.70	12.77
On 48	18.83	25.12	18.85	13.08
On 65	15.07	23.60	16.63	13.77
On 100	11.07	23.85	18.35	17.19
On 200	14.68	23.52	22.48	18.88
Through 200	12.63	23.33	12.67	18.05
Total or average	100.00	23.51	100.00	15.41

much slime was present in the pulp and that coarser crushing would be beneficial. The screen analysis of the concentrate showed more ash in the finer sizes.

Following out this idea, we ran a second series of tests with material crushed to pass only a 20-mesh sieve, following the same flow sheet. Crude wood turpentine was used as an oil, and we were careful to avoid over-oiling. This test, as compared with the first one, involved changing three variables, but these "locked" tests involved so much labor that we thought it best to reason out the best set of conditions as indicated by previous tests and try them immediately rather than to carry out laboriously a whole series of tests, changing only one variable at a time.

The results of this second series of tests are summarized in Table VIII.



FLOW SHEET OF LOCKED TEST NO. 2

The concentrate in this case contained 15.41 per cent ash and a recovery of 91.5 per cent of the pure coal was made. Again the intermediate products were too low grade and showed that they should not be combined with the feed in the way that they were. The concentrate has probably been considerably contaminated by the return of these high-ash products. The ash content of the various sizes in the concentrate seemed to increase distinctly with decrease in size. The screen analyses also show that a good deal of coal is further broken up during the flotation, possibly due to the action of the Ruth impeller.

From these results it seemed best to use a flow sheet in which complete flotation of everything from each cell would leave a tailing which could be discarded immediately. Flow sheet No. 2 meets this condition.

The coal was dry crushed to pass a 20-mesh screen and the head sample contained 23.51 per cent ash. Other tests on this size of material indicated that the concentrate would contain 20 per cent ash if over a 95 per cent combustible recovery was attempted. Screen analyses were made of the feed, concentrate, middling and tailing. The X-cake-xylidine mixture, with sufficient lime water to impart distinct alkalinity to the pulp, was used. All water from the tailing and concentrate was recovered and used in order to economize on oil. The data on this locked test are contained in Table IX. No attempt was made to float all the coal in the first rougher.

This method of operating gave more favorable results, although a much larger middling product was produced. We concluded that the coal must contain particles of various ash contents varying from the almost pure coal, through bony coal, bone and bituminous shale to pure shale or ash. If this be true, and the sink-and-float work seems to bear this out, a flow sheet should be adopted which divides the coal into clean concentrate and bony middling as was done in this test. The concentrate contained only 10.76 per cent ash with a recovery of 63.68 per cent of the pure coal and if the middling is included with the concentrate the ash analysis would be 15.07 per cent with an extraction of 88.88 per cent. The oil consumption was 2.26 lb. per ton of coal.

The screen analyses show that some pulverization of the coal took place in the flotation machine. Also the cleanest sizes were those passing a 35-mesh screen and staying on a 100-mesh screen. The sizes coarser than this are presumably not crushed sufficiently to liberate the ash, while the sizes finer than this are difficult to float clean.

Discussion of Results

In all our tests it was noticed that the first material to float was the very finely divided material and that it required almost no oil for its flotation. When oil was added in any quantity this fine material was "over-oiled" and tended to float in too dirty a concentrate. Microscopic examination did not show differences in appearance between the clean coal and the bone, so we had to rely entirely on the chemical analyses of the various products which we made. However, we formed the idea that the only way to combat the tendency of fine bone coal to float with coarse pure coal is to either deslime the feed and treat the two products separately by flotation, or else treat the various rougher products repeatedly in order further to differentiate them. We chose the latter as the most practical proposal.

We have not been able to prove to ourselves beyond

TABLE IX—SUMMARY OF LOCKED TEST NO. 3

Concentrate				Middling					Tailing		
Weight, Per Cent	Ash, Per Cent	Oil, Lb. Per Ton	Recovery, Per Cent	Weight, Per Cent	Ash, Per Cent	Cumulative Amount of Oil, Lb. Per Ton	Cumulative Per Cent Recovery Pure Coal	Average Ash, Per Cent	Weight, Per Cent	Ash, Per Cent	Per Cent Elimination of Ash
54.5	10.76	0.95	63.68	25.4	24.35	1.49	88.88	15.07	20.1	57.80	49.1

Screen-Analyses of Feed and Products (Moisture-Free Basis)

Screen	Feed—20 mesh Weight, Per Cent	Feed—20 mesh Ash, Per Cent	Concentrate Weight, Per Cent	Concentrate Ash, Per Cent	Middling Weight, Per Cent	Middling Ash, Per Cent	Tailing Weight, Per Cent	Tailing Ash, Per Cent
On 28	5.38	28.27	0.10	13.54	0.10	19.29	0.11	54.70
On 35	22.34	26.70	8.42	10.18	17.32	20.74	17.66	46.07
On 48	18.83	25.12	14.63	8.42	29.03	23.80	12.63	50.60
On 65	15.07	23.60	16.53	8.13	18.52	23.53	19.81	56.40
On 100	11.07	23.85	15.63	9.59	14.51	23.16	16.91	60.85
On 200	14.68	23.52	32.47	12.85	10.81	31.72	21.88	69.80
Through 200	12.63	23.33	12.22	13.56	9.71	37.75	11.00	75.20
Total	100.00	24.87	100.00	10.77	100.00	25.25	100.00	59.57

all shadow of a doubt that the finely ground coal is actually made up of particles of varying specific gravity and of varying ash content, but all data point that way, and if true, our third locked test has come very near the limit in possibility of separation, since the cleanest product shown in the sink-and-float tests contained about 8 per cent ash and the concentrate in our third locked test contained only 10.76 per cent ash. The middling product or bone from this test would probably have to be marketed as such, separately from the clean coal.

Conclusions

1. Tests on a bony coking coal from the Wilkeson mine, at Wilkeson, Wash., have shown that the cleanest coal can be floated first, the bony coal next and the ash last by ordinary froth flotation.

2. Very thin oils or soluble frothing agents work best.

3. The fine sizes of coal float the most easily and the coal in the very fine slime will float to some extent without the use of any flotation oil whatever.

4. Due to the tendency of fine sizes to float so easily, they are probably "overoiled" and produce dirty concentrate when enough oil is added to float the coarser sizes. Screen analyses of the flotation concentrate show increasing percentages of ash in the finer sizes.

5. To take due advantage of the above facts it is necessary to use a flow sheet in which roughing treatment is followed by cleaning of both concentrate and tailing from the roughing cell, discarding as tailing material which will not float in any of the re-treating cells. Re-treatment of middling with original feed is not desirable except for the middling obtained in cleaning the rough concentrate.

6. By this method of treatment a clean concentrate can be obtained, the bony portion of the coal forms a middling which may have a market value, and the tailing is too low in coal to be of any value.

7. Attempts to control the flotation tests by sink-and-float tests with heavy solutions have failed on the fine sizes of coal due to their supposed porosity.

Lead Pigments Marketed in the United States in 1920 and 1921

The following table shows the quantity and value of lead pigments marketed in the United States in 1920 and 1921 as reported by producers to the United States Geological Survey.

LEAD PIGMENTS MARKETED IN THE UNITED STATES, 1920 AND 1921

	1920			1921		
	Short Tons	Value Total	Per Ton	Short Tons	Value Total	Per Ton
Sublimed Lead:*						
White	12,412	$2,083,647	$167.87	11,568	$1,418,403	$122.61
Blue	928	153,657	165.58	463	58,593	126.55
Red lead	21,814	3,410,904	156.36			
Orange mineral	34,431	7,523,089	218.50	379	91,184	240.59
Litharge	62,329	12,386,185	198.72	41,953	5,740,690	136.84
White lead:						
Dry	33,678	6,351,798	188.60	26,695	3,749,851	140.47
In oil	112,017	25,986,100	231.98	143,634	27,713,257	192.94

*Includes basic sulphate lead.

A decrease is shown in the sales of each of these pigments in 1921 as compared with 1920 with the exception of white lead in oil, in which an advance of 28 per cent was made. A decrease is also shown in the average price per ton of each product in 1921 as compared with 1920.

Recent Developments in Low-Temperature Coal Carbonization

AT A RECENT symposium on the low-temperature carbonization of coal held in Cardiff, South Wales, a number of papers were read bearing on the various processes that are being developed in Great Britain at the present time. This subject has aroused considerable interest in Great Britain, as it holds promise of utilizing the non-coking coals and fine slack and dust—a possibility of some economic importance to the country. Several items of interest were brought out during the meeting in connection with recent experimental and development work.

Critical Temperatures of Carbonization

N. H. Freeman gave some interesting facts with regard to what may be called the "critical temperatures" of various stages in the carbonization of coal, and suggested that the essential dividing line between high- and low-temperature carbonization should be taken as 800 deg. F., this being the temperature at which the complex hydrocarbons of the coal substance begin to decompose, forming free carbon and free hydrogen. It was pointed out that the first stage in the carbonization of coal is the separation of water (together with occluded gases), which begins at 212 deg. F. and continues to 500 deg. F. Another critical stage for average coals begins at about 450 deg. F. and may continue to as high as 650 deg. F. In this stage a great portion of the coal substance is transformed into a more or less soluble or semi-soluble condition, and it is only when this stage is completed that oil begins to separate. The oil begins to distill immediately afterward, within a comparatively short range of temperature, up to say 800 deg. F., depending on the constitution of the coal. After this maximum temperature the products coming over are tars, pitches, phenols, anthracenes, etc., the process being then in the nature of high-temperature carbonization. According to Mr. Freeman, coal—because of its low heat conductivity—can be submitted efficiently to low-temperature carbonization only when it is finely divided, in thin layers, and constantly agitated so that every particle is subjected to the same temperature, which must be automatically controlled at the different stages.

Low-Temperature Carbonization Applied to the Mond Process

Some new and interesting information is contained in the paper submitted by the Power Gas Corporation, Ltd., which company has been using the Mond process for the past 30 years. In the original Mond process it was possible, using cheap slack containing 1.3 per cent nitrogen, to recover ammonia to the extent of 65 to 75 per cent of the total nitrogen, equal to 85 to 95 lb. of sulphate of ammonia per ton of coal, with a yield of gas of 135,000 cu.ft. It was necessary, however, to add to the producer a very large amount of steam, about 2½ tons per ton of coal, one-third of this steam being decomposed in the producer, and two-thirds passing away in the gas, which left the producer at about 925 deg. F. About ¾ lb. of the steam is recovered, however, so that a net amount of 1¾ lb. of steam per pound of coal is required. Today this process has no longer the great economic advantages in Great Britain it formerly had, because the price of

labor, coal and sulphuric acid has increased out of all proportion to that of the sulphate of ammonia.

Consequently the Power Gas Corporation, Ltd., has now altered the original Mond process with a view to increasing both the economy and the efficiency, and now combines with it the principle of low-temperature carbonization. This new process, that of Beswick and Rambush, consists in converting as much as possible of the volatile matter of the coal into liquid products according to low-temperature methods, while the residual fuel is entirely converted into producer gas. The transmission of heat to the charge of raw coal in the upper part of the producer is claimed to be achieved in a gradual but effective and rapid manner by the employment of the sensible heat contained in the hot producer gas evolved in the lower part of the producer. That is to say, the raw coal charged into the producer is kept in the upper or primary zone at such a temperature as to get a low-temperature carbonization with the maximum yield of oils, and the residual fuel is then converted into producer gas in the lower or secondary zone. At the same time the very high yield of sulphate of ammonia, 90 lb. per ton of coal, characteristic of the original Mond process is retained, and the whole operation is carried out in one simple plant which is comparatively cheap to erect. The steam required in this new process is only about 1 lb. per pound of coal carbonized. Also, nearly all this steam is decomposed, and the saturated air blast no longer requires to be superheated. The gas evolved has an average composition of 21.0 per cent CO, 20.5 per cent H_2, 8.3 per cent CO_2, 4.9 per cent CH_4, and 45.3 per cent N_2, with a net calorific value of 178 B.t.u. per cu.ft. The yield of gas is 115,000 to 120,000 cu.ft. per ton, and the quality is very nearly as good as the ordinary hot producer gas. The amount of low-temperature tar or oil produced is about 15 to 24 gal. per ton.

Additional advantages claimed for the new process are that, because of the lower temperature in the producer, the pipe lines are smaller, the maintenance costs are reduced and the capital outlay and ground space are both much less because of the elimination of the air and steam superheaters. Also the plant is so arranged that the amount of either tar or ammonia can be easily manipulated, depending on the market.

The Maclaurin Continuous Retort

The method of internal carbonization is particularly characteristic of the "Maclaurin" process, which, in fact, differs from all others in having no external heating at all, not even steam. The continuous retort used resembles an elongated producer or small blast furnace, the height being about 40 ft. and the width at the combustion zone about 8 ft. The raw coal is charged in at the top and passes slowly down the retort, the residual fuel being withdrawn at the bottom. The carbonization is carried out by the heat produced by the combustion of a portion of the charge in the lower part of the retort. The hot products of combustion pass upward, gradually heating the coal in the upper layers, and carrying with them the volatile products given off, which are then condensed by the charge of cold coal entering the top of the retort, the oil and other products being separated by patent oil traps so that they do not trickle back into the hotter regions. The period of carbonization is 20 hours, and it is stated that any size of coal can be used up to pieces that will pass through the bell, which is 8 to 9 in. in diameter.

The residual smokeless fuel in the ordinary method of working has been formed at a temperature of about 1,300 deg. F. and contains about 4 per cent volatile matter. It is black in color and is easily ignited like ordinary coal. The heat losses of the process are said to be small, being confined to the radiation from the plant, the heat lost in the hot coke and the gases leaving the producer.

The oil is of peculiar composition, being similar to low-temperature oil in that it has no naphthalenes and anthracenes, but differs in having no light oils, although there is present a very high percentage of cresols and xylenols, up to 50 per cent of the total oil, and including an exceptional amount of high-boiling phenols. The crude oil can also be used direct as fuel oil.

The composition of the gas is 16.0 per cent CO, 13.0 per cent CH_4, 16.1 per cent H_2, 6.2 per cent CO_2, and 48.1 per cent N_2. No hydrocarbons except methane are present, because the oils are not "cracked" during the process of carbonization. The yield of sulphate of ammonia is 24 lb. per ton, the ammonia liquors being free from ferrocyanides and sulphocyanides, but containing di- and tri-hydroxy phenols.

The further yield by this process from 1 ton of coal (12,300 B.t.u.) with 35 per cent volatile matter and 7.7 per cent water, is 1,096 lb. of residual smokeless fuel, 15.6 gal. of oil and 27,731 cu.ft. of gas at 247 B.t.u., the total loss in the whole process being 11.3 per cent of the coal. It must be pointed out, of course, that in comparison with other processes these figures must be increased by about 15 per cent, since no external producer gas is required.

Pure Coal Briquets

The free-burning properties of low-temperature fuel depend to a considerable extent on the structure of the fuel as well as on the proportion of volatile matter. In discussing the merits of low- and high-temperature carbonization for the production of smokeless fuel, Edgar C. Evans brought out the importance of this consideration, stating that coals which contain little resinic matter and do not fuse or swell during carbonization always give a free-burning coke, because such coke is of quite different structure from the sponge-like substance of ordinary gas or furnace coke, the pores being very much smaller and the whole structure much more granular. Also, this free-burning coke is not impregnated with a film of graphite, which covers ordinary coke and renders it so incombustible.

The "pure coal briquet" (Sutcliffe-Evans) process consists in roughly pulverizing the coal and mixing it with about 20 per cent of pulverized coke breeze or other product from the carbonization of coal. This mixture is then briquetted in a special briquet press at a very high pressure, 10 tons to the square inch, giving perfectly hard briquets without the use of a binder such as pitch. These briquets are now carbonized by means of producer gas at high temperatures, say 1,600 deg. F., the heated inert gas passing through the mass of the briquets in a simple type of retort which is merely a vertical cylinder. These briquets have the remarkable property that they do not expand on carbonizing, so that existing gas-works or coke-oven retorts can be used. Also, although the residual fuel contains only about 2 per cent of volatile matter, it is easily ignited like ordinary raw coal, because of the peculiar fine grain structure which, under the microscope, is seen to resemble charcoal.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Committee Recommends Acceptance of Ford Offer —Inclusion of Gorgas Plant Only Disagreement

Consideration of the disposal of the Muscle Shoals property of the government has been transferred from the Committee on Military Affairs to the House of Representatives proper. A majority of the members of the Military Affairs Committee recommends the acceptance of the Ford offer with the elimination of the steam plant at Gorgas and of the transmission lines connecting it with the No. 2 nitrate plant. The majority also insists on a rewording of the fertilizer guarantee and other amendments of less importance. A minority of the committee will recommend the acceptance of the offer as finally amended on May 31 by Mr. Ford. Every effort will be made to obtain prompt consideration of the matter on the floor of the House.

Revised Fertilizer Provisions

The new fertilizer clause, upon which a majority of the committee insists, reads as follows:

> Since the manufacture, sale and distribution of commercial fertilizer to farmers and other users thereof constitute one of the principal considerations of this offer, the company expressly agrees that, continuously throughout the lease period, except as it may be prevented by reconstruction of the plant itself, or by war, strike, accident, fires or other causes beyond its control, it will manufacture nitrogen and other commercial fertilizers, mixed or unmixed, and with or without filler, according to demand, at Nitrate Plant No. 2 or its equivalent, or at such other plant or plants, adjacent or near thereto as it may construct, using the most economical source of power available. The annual production of these fertilizers shall have a nitrogen content of at least 40,000 tons of fixed nitrogen, which is the present annual capacity of Nitrate Plant No. 2. If during the lease period said Nitrate Plant No. 2 is destroyed or damaged from any cause the company agrees to restore such plant, within a reasonable time, to its former capacity.

Ford Insists on Inclusion of Gorgas Plant

W. B. Mayo, representative of the Detroit manufacturer, declared that he regarded the action of the committee as a decisive victory for Mr. Ford and that a more determined effort than ever before would be made to obtain the properties. He felt that agreement on all points but one—the Gorgas plant—was a distinct achievement.

That Mr. Ford is anxious to have the Gorgas steam plant included in the terms of the lease is evident from a letter which he addressed to the Military Affairs Committee, just prior to the action of that body. He declared in this letter that he would not consider taking over the property unless the Gorgas plant is included. The full text of the letter is as follows:

> I have carefully examined the amendments made by your committee to my proposal dated Jan. 25, 1922, for the lease and purchase of the government's Muscle Shoals properties, and observe with surprise and regret that you have rejected that part of the modified proposal relating to the government's Gorgas steam plant.
>
> The greater portion of the other changes suggested by your committee have been approved and are incorporated in the accompanying corrected proposal. More than a month ago Mr. Mayo presented to me certain clarifications in the proposal of Jan. 25 to which your committee desired my agreement, which was promptly given. Mr. Mayo explained that while some of your committee were unwilling to accept that part of my offer which included the government steam plant at Gorgas, certain other members of the committee had requested him to ascertain if I would agree to accept an assignment and transfer by the United States of everything now owned by the government at Gorgas under its contract of Dec. 1, 1917, with the Alabama Power Co., to which I assented, and Mr. Mayo was instructed to advise your committee that the offer would be revised accordingly. I have been informed that this revision was accepted by your committee, but later, upon reconsideration, you decided to eliminate the Gorgas plant.
>
> I cannot consent to eliminate the Gorgas plant, because it is necessary to the economical operation of the Muscle Shoals properties. If my revised offer for Gorgas is rejected, then I must understand that the acceptance of my offer for Muscle Shoals "as a whole and not in part" is refused.
>
> I am sending a final proposal containing all the amendments suggested by the committee to which I can consistently agree. In doing so, and in view of the fact that my first proposal was signed July 8, 1921, *nearly a year ago*, and in order to bring these negotiations to a close, I ask that your committee consider this proposal as final, and that no further changes should be expected. I further request that your committee send this final offer to the House so that its members may vote for acceptance or rejection. This request is made with the understanding that power to dispose of the plants at Muscle Shoals is vested in the Congress. If the Secretary of War after his negotiations relative to the first offer did not have the power to accept or reject it, you will probably agree that your committee has not the power to accept or reject it. Moreover, I do not believe that your committee or any member of it wishes to assume the responsibility of accepting or rejecting this final proposal, involving as it does a matter of such great national importance.
>
> If Congress votes acceptance of my offer, we will get on the job at Muscle Shoals at once; but if Congress rejects it, that will be but the beginning of a more determined effort on my part to save Muscle Shoals for the benefit of the public.
>
> I wish to thank you and each member of the committee for the courtesies shown my representatives during the negotiations of the past three months.

Appropriation for Completion of Dam Approved

Another important development in Congress affecting Muscle Shoals while the committee was in session was the adoption in the Senate of an amendment to the War Department appropriation bill proposed by Senator Norris, on behalf of the Senate Agricultural Committee, appropriating $7,500,000 for continuing work on Dam No. 2. Senator Norris stated that it would take 3 years to complete the dam and develop power there and that the project would cost about $22,500,000. The War Department appropriation bill with the Muscle Shoals appropriation was passed by the Senate and will go to a conference with the House, which has already passed the bill.

Will Not Interfere With Lease Proposals

In the discussion of the amendment, Senator Jones of Washington asked what effect the amendment would have on the lease proposal of Henry Ford. Senator Norris replied that the construction of the dam would not interfere with any of the lease proposals before the committee and about which there was difference of opinion. Senator Lenroot of Wisconsin stated that he had previously opposed completion of the dam on the ground that the Alabama Power Co. would be the only customer for the power. He is now inclined to favor the construction of the dam, however, as the situation has changed and if the dam is completed he thinks there will be no difficulty in securing a fair price for power, as there will be sufficient demand for it.

Final Program for Niagara Falls Meeting of American Institute of Chemical Engineers

The final program for the fourteenth semi-annual meeting of the American Institute of Chemical Engineers at Niagara Falls, Canada, June 19 to 21, has been distributed to members. The features are arranged exactly as published in CHEM. & MET. of May 3, with the exception of a few additional papers not announced at that time.

Clifford D. Carpenter and Joseph Babor will present a paper at the acid symposium on "Concentrating Dilute Nitric Acid Solutions." S. L. Tyler will discuss the "Absorption of Hydrochloric Acid or Other Gases." The Production of Hydrochloric Acid From Chlorine and Hydrogen" is the subject of a newly scheduled paper by H. K. Moore.

Problems in transportation of acids and corrosive chemicals will receive the attention of the meeting at the Thursday morning session. Contributions to this symposium will be made by J. M. Rowland, who will discuss the transportation of hydrochloric acid in tank cars, and F. C. Zeisberg, who will describe and discuss the "Hard Rubber-Lined Steel Tanks for the Transportation of Hydrochloric Acid." Another paper of interest on this general topic has been prepared by J. L. K. Snyder and H. P. Wells entitled "Transportation of Liquid Chlorine in 15-Ton Tank Cars."

In addition to the strong technical program, arrangements have been made for very delightful entertainment features, particularly for the visiting ladies. Automobile trips, luncheons, teas, theater parties and sightseeing trips will occupy their time during the technical sessions.

Industrial Advertisers in National Conference Will Discuss Marketing to Industries

As a new feature of the annual convention of the Associated Advertising Clubs of the World, which will be held in Milwaukee, Wis., June 11 to 15, a conference on Industrial Advertising is scheduled. It is proposed to make the Industrial Advertising Conference an annual affair, offering opportunity for the discussion of problems arising in connection with the marketing of goods to industry, as contrasted with the marketing of goods from industry to the individual consumer. Keith J. Evans, advertising manager Joseph T. Ryerson & Son, Chicago, is chairman of the conference.

Among the addresses scheduled for the first session, Monday afternoon, June 12 are the following:

"Advertising as a Factor in Interindustrial Marketing," by M. W. Babb, vice-president Allis-Chalmers Manufacturing Co.

"What the U. S. Department of Commerce Is Doing to Aid Interindustrial Marketing," by F. M. Feiker, vice-president of the McGraw-Hill Co. As personal assistant to Mr. Hoover for nine months, Mr. Feiker was engaged in reorganizing the three bureaus of the Department of Commerce which are designed to serve industry. He will describe the new purposes of the department in relation to interindustrial marketing and in addition will bring a personal message from Mr. Hoover to the Industrial Advertising Conference.

"Cutting the Costs of Distribution," by Sydney Anderson, Congressman from Minnesota.

"Advertising in Its Relation to the Four Points of Contact in Industry," by Bennett Chappel, director of publicity, American Rolling Mills.

On June 13 Charles H. Mackintosh, of La Salle Extension University, will talk on "Advertising the Technical Product to the Non-Technical Buyer." J. C. McQuiston, of the Westinghouse Co., will speak on "Selling to the Professional Man in Industry." Mr. McQuiston will discuss the influence of the architect, engineer, chemist and others who have a professional relationship to the buying of industrial products, which presents an important problem in the development of interindustrial markets. H. Colin Campbell, of the Portland Cement Association, will talk on "Expanding the Markets for Raw Materials," and W. Lee, vice-president of Frank D. Chase, Inc., on "Putting Ideas Into Industrial Advertising."

A large and complete exhibit of the best advertising in the country has always been a feature of the conventions of the Associated Advertising Club. This year there will be an exhibit of advertising showing effective methods of mass-selling to interindustrial markets in connection with the Industrial Advertising Conference. The McGraw-Hill Co., Inc., has offered a beautiful silver cup for the best complete campaign and a watch fob for the person who prepared it. Other companies are planning additional prizes which as yet cannot be announced.

Sales and advertising executives and all others interested in industrial marketing are cordially invited to attend the sessions of the Industrial Advertising Conference. It is unnecessary to be a member of any advertising club or organization.

National Fertilizer Association Program for Convention at White Sulphur Springs

The program of the twenty-ninth annual convention of the National Fertilizer Association, which will be held at the Greenbrier, White Sulphur Springs, W. Va., June 12 to 15, inclusive, has been completed. The business sessions promise to be of more than usual interest this year. Reports of standing committees will be presented, and subjects of current importance to the fertilizer industry will be discussed on the floor of the convention. In addition, M. Harcourt Paine and General O. K. Chance, both prominently indentified with the British fertilizer and chemical industries, will be present and address the convention.

The detailed program of the convention follows:

MONDAY, JUNE 12

10 a.m. Subscribers' meeting—Soil improvement committee of the National Fertilizer Association.

12 m.—Committee meeting—Soil improvement committee of the National Fertilizer Association.

3 p.m. Committee meeting—Southern soil improvement committee.

8 p.m.—Meeting of executive committee, Southern Fertilizer Association.

TUESDAY, JUNE 13

10 a.m.—Meeting of Southern Fertilizer Association.

2.30 p.m.—Golf, tennis and quoit tournaments.

4 p.m.—Tea dance at the clubhouse.

8.30 p.m.—Meeting of executive committee, the National Fertilizer Association.

9 p.m.—Informal dance.

WEDNESDAY, JUNE 14

10 a.m.—First business session, the National Fertilizer Association.

Address by Charles H. MacDowell, president of the National Fertilizer Association.

Reports of standing committees.

Address by M. Harcourt Paine, London, England, manager of the Chilean Nitrate Committee. Subject, "The Chilean Nitrate Industry and Its Propaganda."

Discussion of subjects of importance to the fertilizer industry.

12:30 p.m.—Official convention group photograph.

2 p.m.—Golf, tennis and quoit tournaments.

3 p.m.—Ladies' bridge tournament.

9 p.m.—Novelty convention dance.

THURSDAY, JUNE 15

10 a.m.—Second business session, the National Fertilizer Association.

Reports of committees.

Remarks by General O. K. Chance, London, England, first vice-president of the British Cyanides Co., Ltd.

Discussion of subjects of importance to the fertilizer industry.

Election of executive committee.

2.30 p.m.—Golf, tennis and quoit tournaments.

8 p.m.—Organization meeting of the new executive committee of the National Fertilizer Association.

9 p.m.—Informal dance and distribution of golf, tennis, quoit and bridge prizes.

First Section of Dye Tariff Schedule Adopted—Fight Expected on Finished Dyes and Embargo

The first test vote in the controversy over the protection of the American dye and organic chemical industries approved the committee amendments to the tariff bill after a 5-hour fight on the floor of the Senate. The approved amendment proposes a duty of 50 per cent ad valorem and 7 cents a pound on crude coal-tar dye products. The vote was 37 to 20, three Republicans opposing the amendment and one Democrat supporting it. The controversy over the 60 per cent and 7 cents a pound duties proposed on intermediates and the modified dye embargo provisions of the bill went over, as the Senate turned attention to a consideration of the brick schedule immediately after this one vote.

This action was regarded as a forecast of the approval of the other rates on finished dyes, but cannot be interpreted as any indication of what action will be taken on the embargo feature of the controversy. It is expected that action will not be taken on the embargo provision until it is reached in the administrative section of the bill.

King Voices Opposition

As expected, Senator King, armed with a mass of data and documents, opened an attack on both the rates and on the embargo. In a 5-hour speech he reviewed the dye situation, assailing the present control act which, he asserted, was passed during the war "as a result of misrepresentations by Dr. Herty and other propagandists and lobbyists of the dye interests." He asserted that the bill had gone further than the public or the Senate had foreseen when interpreted as covering all compounds of a synthetic organic nature. He assailed the embargo as un-American. "An embargo is not protection," he declared, "it is exclusion. It is the establishment by law of monopoly."

Returning to his disapproval of the rates on coal-tar products, Senator King declared that we are in a position to compete with the world in the production of crudes, intermediates and dyes, yet we are especially gracious to the coal-tar industry. He added that he would later call attention to the corporations, their ramifications, the immense amount of capital and the influence they command, which would profit by protective legislation.

Frelinghuysen Champions Protection

Senator Frelinghuysen, of New Jersey, answered by saying that even if we have the immense amount of coal referred to by the Utah Senator, the byproducts are of no value if intermediates and finished dyes are not protected. Lack of protection of these, he said, makes the products of the coke ovens valueless.

Senator Frelinghuysen in a very brief statement declared that the rates of 50 per cent on intermediates and 60 per cent on finished dyes, which are coupled with a 7-cent specific, are sufficient only to meet the difference in the cost of production here and some of the prices on imported dyes. He added that the Tariff Commission has declared that no ad valorem nor specific rate could be provided that would afford the protection needed by the industry.

The New Jersey Senator gave a brief history of the coal-tar industry. He stated that it is now in a position that makes the United States independent of the world as to dyes, but unless there is a restricted license which will permit the chemists to continue their research and experiments, the industry cannot live.

Expect Further Opposition From King

It is expected that Senator King will continue his fight for a reduction in the dyes tariff. It is probable that the Utah Senator will propose an amendment reducing the 7-cent specific duty to 3½ cents per pound on all dyes and intermediates selling at 10 cents a pound or less.

Another feature against which he is understood to be preparing an attack is that which calls upon the Secretary of the Treasury to prescribe standards of strength for dyes brought into the United States to be used as a basis for the levying of the specific rate of duty. He points out that certain dyes have come into the United States in 20 per cent strength, although perhaps the usual importations are of 60 per cent strength. Under the terms of the provision, he declares, it will be incumbent upon the Treasury Secretary to adopt the lower figures, whereupon the product of greater strength will have to pay triple rates by reason of being three times the strength of the minimum, or 21 cents per pound.

Chemical Glassware Rates Adopted

Considerable time was devoted to discussion of the rates on chemical, metallurgical and other glassware. Senator Frelinghuysen made an extended speech explaining the need for proper duties to protect the American industry from foreign competition, exhibiting samples of products of both foreign and American production. He spoke particularly of glassware used in the chemical industry. He declared that this glassware industry was one of the most important in the country, and read a letter from C. L. Parsons, secretary of the American Chemical Society, urging proper duties on glassware used in the chemical industry. Among the glassware samples submitted by the New Jersey Senator were some which he said cost 12 cents to manufacture in the United States, while the German product was selling in New York at 7.3 cents. A graduated cylinder costs 32 cents to manufacture in this country, while the German product sold for 17 cents in New York, he said.

That any effort to place chemical glassware on the free list is foredoomed to failure is indicated by the vote on an amendment by Senator Jones of New Mexico, attempting to reduce the duty from 75 to 45 per cent ad valorem, which was rejected by the decisive vote of 40 to 26.

Cyanide Put on Free List

For the first time since the tariff bill has been under discussion the Senate overrode the Finance Committee when it voted 46 to 14 to restore cyanide to the free list. Chairman McCumber of the Finance Committee, actively assisted by Senator Frelinghuysen of New Jersey, made a hard fight to hold in the bill 10 per cent ad valorem duty on "potassium cyanide, sodium cyanide, all cyanide salts and cyanide mixtures, combinations and compounds containing cyanide."

The amendment transferring cyanide from the dutiable schedule to the free list was introduced by Senator Oddie of Nevada, who contended that the gold-mining industry is entitled to free cyanide. Senator Frelinghuysen in opposing the amendment established beyond fear of contravention the fact that the officers and employees of the Roessler & Hasslacher Chemical Co. were entirely loyal throughout the war. Senator Sterling of South Dakota did not question the loyalty of the company during the war, but stated that, in addition to its being the only producer of cyanide in the United States, it has intimate connection with the interests which control cyanide production in Germany and in England.

Senator Pittman declared that, regardless of opinions one way or another about the Roessler & Hasslacher company, certain facts are uncontroverted. The control of the stock now is in the hands of the Alien Property Custodian; the company was organized by two men sent to the United States by the German syndicate; the company has had no competition in the manufacture of cyanide since its establishment in 1885; the concern always has been and now is the exclusive manufacturer of cyanide in this country; it is the sole distributor of imported cyanide; it "manufactures at this end of the line when it pays to manufacture here and sells here the German stuff when it pays better."

Chemical Porcelain and Stoneware

The 60 per cent ad valorem duty on chemical porcelain ware and chemical stoneware was adopted after amendments of Senator Jones of New Mexico to reduce the duty to 50 or 55 per cent were defeated.

Paragraph 47 was also adopted, covering 2½ cents a pound on magnesium carbonate precipitated; ½ cent a pound on chloride; ¾ cent a pound on oxide or calcined magnesia not suitable for medicinal use.

Technical Photographic and Microscopical Society to Meet at Luncheon, June 14

The first regular meeting of the Technical Photographic and Microscopical Society will be held in the Hotel Astor, New York, on June 14. Two previous meetings of representatives of various industries interested in the application of photography and microscopy to technology resulted in the organization of this society. Since its official organization, a great deal of interest has been evidenced by individuals and firms in varied branches of the chemical and allied industries. The membership already includes representatives of the following industries: paper, explosives, heavy chemicals, fertilizer, zinc, nickel, lead, leather and rubber.

An interesting program has been arranged for the meeting on June 14. Luncheon will be served at 1 p.m., after which several brief addresses are scheduled. Suggestions will be received from members and visitors as to the future policies and program of the society.

Federated American Engineering Societies Board Opposes Licensing of Mining Engineers

A council meeting, attended by all but one or two members, of the Federation of American Engineers was held in Pittsburgh, May 26 and 27.

One of the most important acts of the board was the adoption of the report of the committee on registration of engineers, of which Colonel Arthur S. Dwight of New York is chairman. The report as adopted contains the statement "that the reasons which justify the registration of engineers responsible for public work do not apply to mining engineers."

The general sentiment of the committee is summarized in the paragraph of the report which follows:

> The registration of licensing of engineers with consequent elimination from practice of all not registered. can be supported upon only two grounds:
> (*a*) The benefit of the profession.
> (*b*) The good of the public.
> Your committee has grave doubts whether licensing can benefit the profession enough to justify the cost and annoyance of the proposed measure. Further, your committee holds it should be beneath the dignity of engineers to fence themselves against qualified competition by the artificial barrier of a statute.

The committee recommends to the societies an expression of opinion that such legislation may properly cover engineers and architects charged with responsibility for public works. The committee agreed that the reasons which justify the registration of engineers responsible for public works do not apply to mining engineers, but was unable to agree as to the wisdom or unwisdom or registration of engineers engaged in other classes of work.

Other Timely Problems Discussed

The board announced plans proposing the solution of the national problems of water power and forestry, upon which "the industrial development of the nation and the standard of living of future generations largely depends." The resolution adopted by the executive board directs the council's committee on water power, of which Colonel J. H. Pinney of Washington is chairman, to place before President Harding the facts of the situation with regard to water power development in this country. The board's action at this time, it was stated, was prompted by "the federal Water Power Commission's lack of effective and permanent personnel."

Progress in a national survey of the two-shift day in American industries was reported by the council's committeee on work periods in continuous industries. This survey, called the most extensive of its kind ever made, has been in progress for more than a year, and purposes an exposition of industrial conditions which shall form a basis for establishing the relative merits of three shifts of eight hours each and two shifts of twelve hours each. Dr. H. E. Hower of the National Research Council, Washington, is chairman of the committee.

A report from the patents committee of the council, headed by Edwin J. Prindle of New York, voiced opposition to the Stanley and Ladd bills as detrimental to American invention and industry.

Reforestation, jurisdictional awards in labor, an International Engineering Congress, aërial research, engineering representation on the Civil Service Commission, foreign relations, waste in agriculture and plans for more intensive engineering organization, as proposed by Herbert Hoover, were other topics before the council.

Thirty societies are now supporting the federation, with individual members numbering about 60,000. The Canadian Institute of Engineers has taken steps to join, and much interest in the progress of the federation is being taken by societies on other continents.

Ambitious Program of Activities Outlined for Institute of American Meat Packers

Plans for the extension of the activities of the Institute of American Meat Packers have been submitted to its membership by the executive committee. The plans were drawn up by Thomas E. Wilson, president of the Institute, and are of interest to all technical and trade associations as an example of broad vision and scientific management in industry. At the next convention of the Institute the plans will be considered and steps taken to further their consummation, provided the members concur in their adoption.

Mr. Wilson summarizes his conception of the function of the Institute in the statement that he believes the Institute ultimately should become an organization which shall be a combined trade association, industrial museum, research institute and educational institution. Elaborating on this idea, he has outlined the scope of the Institute in each of its four functions.

As an Educational Institution

As an educational institution it should do at least three things:

1. Provide for specialized collegiate education for young men tending to enter the packing industry, just as the Colorado School of Mines provides training for young men expecting to begin their work in the mining industry.
2. Furnish special training to intermediate sub-executives of promise, already engaged in the industry.
3. Conduct a continuation school for plant employees and junior office help.

As a Research Institution

As a research institution it should:

1. Develop and systematize a body of scientific and technical data for the service of the whole industry.
2. Carry on agreed researches into new scientific and technical processes common to all packers without infringing on research along individual lines being done by specific companies.
3. Conduct experiments on the extension of products and reclamation of materials, except where experiments would infringe on orginal work done by some individual company.
4. Collate and disseminate information concerning discoveries and developments having relation to the packing industry without invading material developed by particular companies.
5. Conduct merchandising surveys and commercial research work.
6. Discover waste and study means of eliminating it.
7. Test material and equipment offered to the industry.

As a Trade Association and Industrial Museum

As a trade association it should continue to do what the Institute is now doing in this direction.

As an industrial museum it should provide space for permanent exhibits of models showing modern packing-house operation, specimens and processes, and it should rent out space for exhibits of materials of industrial value and for a permanent exhibit of packing-house machinery and supplies —a sort of scientific museum and centralized market place, a gigantic permanent show window, conveniently located where packers from all parts of the country may come and view samples before making purchases and installations.

Chemical Uses of Lime to Be Discussed by Convention of National Lime Association

The chemical industry will find matters of more than ordinary interest in the program for the forthcoming annual convention of the National Lime Association, which is to be held in Cleveland, Ohio, June 13 to 16. The first day of the technical sessions will be devoted to a symposium on lime for chemical industries, taking up the problems of chemical users of lime. Special consideration will be given to the alkali, glass, soda and sulphate paper pulp, soap and textile industries.

The final program for the convention has not been distributed, but it will be practically identical with the following advance schedule:

TUESDAY, JUNE 13

Joint meetings of staff, central office and regional bureaus.

WEDNESDAY, JUNE 14

10 a.m. Assembly and presidential address.

10: 30 a.m. "Lime Burning in Rotary Kilns," by Irving Warner.

Forum. Limekiln efficiency.

11: 30 a.m. Symposium on "Lime for Chemical Industries."

Papers:

"Alkali Industry," by R. C. Snowden, Hooker Electro Chemical Co.

"Glass Industry," by R. R. Shively, Monongahela Glass Co.

"Soda and Sulphate Paper Pulp Industry," by G. K. Spence, New York & Pennsylvania Paper Co.

"Soap Industry."

"Water Softening," by S. C. Hadden, Editor, *Municipal and County Engineering*."

"Textile Industry," by E. R. Darling, James Milliken University.

"Sulphite Paper Industry," by P. A. Paulson.

3: 30 p.m. "Observations on the Lime Industry in Europe," by John Kling and Colonel C. W. S. Cobb.

3: 45 p.m. "Mechanical Handling of Lime," by H. D. Pratt.

4: 30 p.m. "New Idea in Lime Barrels," by T. E. McNamara.

"What the Bureau of Mines Is Doing on Quarry Problems," by Oliver W. Bowles.

THURSDAY, JUNE 15

9: 30 a.m. Symposium. Lime in Construction.

11: 30 a.m. Lime in Agriculture.

Thursday afternoon will be devoted to a clambake and general good time on the lake shore.

FRIDAY, JUNE 16

9: 30 a.m. "Work of the Chemical Department," by M. E. Holmes.

10 a.m. "What I Have Found Out About Lime," by F. C. Mathers, professor of inorganic chemistry at the University of Indiana.

10: 45 a.m. "The Value of Research to Industrial Associations," by E. R. Weidlein.

11:30 a.m. "The Lime Association," by C. Warner.

12: 30 p.m. Some New Angles on the Use of Lime in Agriculture," by J. A. Slipher.

12: 45 p.m. "High Points in the Construction Department Program of Lime Promotion," by W. A. Freret.

2: 30 p.m. Business session.

Newton D. Baker, former Secretary of War, will address the members at the complimentary luncheon on Wednesday.

Senate Committee Raises C.W.S. Appropriation

An increase of $250,000 over the amount allowed by the House is given for general expenses of the Chemical Warfare Service next year by the Senate Appropriations Committee in reporting the War Department bill. An appropriation is also made of $262,000 for general construction at the Chemical Warfare Service station at Edgewood Arsenal.

Civil Service Openings for Chemists

The United States Civil Service Commission announces open competitive examinations for the following positions: Chemical engineer, $3,600 to $5,000 a year; associate chemical engineer, $2,500 to $3,600 a year; associate chemist, $2,500 to $3,600 a year; assistant chemist, $1,800 to $2,500 a year. Appointees at annual compensation of $2,500 or less may be allowed the increase granted by Congress of $20 a month.

Program Announced for Canadian Meeting of American Leather Chemists' Association

An ideal combination of business and vacation is offered the members of the American Leather Chemists' Association by the program for their ninetenth annual meeting. No more beautiful location could have been selected than Lake of Bays, Ontario, Canada, where the meeting will be held, and no more interesting topics to leather chemists could have been chosen than those which make up the program. The sessions will occupy all day Wednesday, June 21, and continue through Friday noon, leaving the weekend free for the visiting members to enjoy the natural attractions of the Lake of Bays region. The detailed program follows in part:

WEDNESDAY MORNING, JUNE 21

Committee reports on: "Determination of Moisture in Leather," "Determination of Epsom Salts in Leather," "Synthetic Tanning Materials."

"Influence of Atmospheric Humidity on the Strength and Stretch of Leather," by F. P. Veitch, R. W. Frey and L. R. Leinbach.

"Comparative Observations of the Tanning Properties of Vegetable Tanning Materials, Sorbanol, and Mixtures of the Two," by S. Kohn.

WEDNESDAY AFTERNOON

Committee report on the "Determination of Oils and Greases in Leather."

"Preservation Effect of Oils and Greases in Leather," by F. P. Veitch, R. W. Frey and L. R. Leinbach.

"Distribution of Grease in Leather," by L. Balderston.

"The Mode of Occurrence of Tanning in the Living Cell," by F. E. Floyd.

"The Bacteriology of the Fresh Steer Hide," by G. D. McLaughlin and G. E. Rockwell.

"A Layman in Research," by F. M. Moffat.

THURSDAY MORNING, JUNE 22

Committee reports on: "Rapid Washing of Chromed Hide Powder" and "Determination of the Water Soluble of Leather."

"Some Observations on the Histology of Bating Skins," by C. S. Hollander.

"Progress in the Physical Chemistry of Gelatine," by C. R. Smith.

"Non-Tannins," by F. H. Yocum.

THURSDAY AFTERNOON. TANNERS' SESSION

Committee report on the "Direct Measurement of the Plumping Power of Tan Liquors."

"Time Reduction in the Tanning Process," by R. O. Phillips.

"The Practice of Curing Heavy Hides," by G. D. McLaughlin and E. R. Theis.

"The Science of Curing Heavy Hides," by G. D. McLaughlin and E. R. Theis.

"The Versatility of a Plumping Method," by H. C. Reed.

"The Plumping Power of Acids," by J. S. Rodgers.

"The Importance of Finish in the Cutting and Marketing of Sole Leather," by H. B. Smith.

FRIDAY MORNING, JUNE 23

Committee reports on "Determination of Sugar in Leather," "Determination of Sugar in Extracts," "Comparative Analyisis," "Chrome Leather Analysis" and "Color Measurement of Vegetable Tanning Solutions."

"Modern Problems in Chrome Tanning," by D. Burton.

National Public Conference on Muscle Shoals Strongly Favors Acceptance of Ford Offer

The national conference of the Southern Commercial Congress, which held a three-day session at Muscle Shoals last week, is committed to fight to the end for the disposal of the government nitrate plants and waterpower projects to Henry Ford. The conference unanimously adopted memorials calling upon President Harding and Congress to end unprofitable delay in action on the Ford offer. According to Dr. Clarence J. Owens, director-general of the Southern Commercial Congress, "every resource and method at our disposal will be used to secure immediate action and disposal of this huge project of Henry Ford."

A committee on general information, empowered and instructed to "educate the American public on the national importance of the Muscle Shoals projects and the necessity of their immediate completion" was appointed during the convention. A legislative committee, empowered to further the program adopted at the conference, was also chosen.

The memorial to the President and Congress declares that the Muscle Shoals issue is national and not local, being of vital concern to the whole country. It is set forth that Mr. Ford's offer was the only one which provides for full development of all the power possibilities of the Tennessee River and for the utilizing of the natural resources of the Tennessee Valley, including the adequate improvement of navigation. It is declared that Ford was the only bidder for the projects who gave a guarantee of cheap fertilizers on a scale which offers substantial encouragement to millions of American farmers. Adoption of the memorial came unexpectedly at the final session of the conference, which was held in Tuscumbia, one of the three Muscle Shoals cities.

Hail Ford as Public Benefactor

Chester H. Gary of Missouri, chairman of the Muscle Shoals committee of the American Farm Bureau Federation, declared that Ford's proposed development of power sites along the Tennessee River would mean "a modernized and humanized agriculture." The American farmer is interested in Muscle Shoals primarily as a potential producer of fertilizer, he declared, "but agriculturists everywhere realize the possible advantages in opening the Tennessee River to navigation and in the application generally of electrochemistry to agriculture.

"Muscle Shoals means to the farmers of America cheaper farm machinery, cheaper transportation, cheaper automobiles and more conveniences for the womenfolk to be secured by the general use of electricity and aluminum."

Mr. Gary asserted that an example should be set at Muscle Shoals of what can be done with hydro-electricity "when applied to the common good," and predicted that other projects would follow in development.

In a message to the conference from Emmett O'Neal, president of the Muscle Shoals Association of Alabama, who was absent on account of illness, it was predicted that the "overpowering sentiment which now demands acceptance of the Ford offer will, with the weight of a mighty juggernaut, crush to powder any selfish corporation or individual who may attempt to check its triumphant march toward final victory."

Personal

J. Cavalier, president of the University of Toulouse, sailed for France, June 1, after concluding a series of lectures in America.

F. G. Cottrell, formerly director of the United States Bureau of Mines and until recently head of the division of chemistry and chemical technology of the National Research Council, has been selected for the directorship of the Fixed Nitrogen Research Laboratory of the Department of Agriculture. He will succeed Richard C. Tolman, who has resigned to become professor of physical chemistry and mathematical physics at the California Institute of Technology at Pasadena. No decision has been made as to the exact date on which Dr. Tolman will turn over the work to Dr. Cottrell. It probably will be late in the summer.

J. G. Detwilder, chief chemist of the Texas Co., Houston, Tex., gave an interesting lecture on the "Manufacture of Lubricating Oils" before the members of the lectureship course at the Agricultural and Mechanical College of Texas, College Station, May 19, forming the last of a series of instructive addresses, conducted under the auspices of the Mid-Continent Oil and Gas Association.

C. R. Downs, chief chemist of The Barrett Company's research laboratory at Edgewater, N. J., will take up work at Buffalo, N. Y., in the near future, for the National Aniline & Chemical Co.

A. A. French, Forest City, Ark., temporary vice-president and state vice-president from Arkansas of the National Oil Mill Superintendents' Association, was elected president of the organization by a unanimous vote at the twenty-ninth annual convention at Dallas, Tex., recently closed. D. B. Denny, Greenville, Tex., retires as president, after having served in such capacity for two years past.

Bennett Grotta, of the Atlas Powder Co. research staff at Emporium, Pa., is to make a tour of the company's Western plants this month.

Ellwood Hendrick, consulting editor of Chem. & Met., will sail on June 10 on the Royal Main Steamer Oripesa, arriving at Southampton June 19. He will attend the meeting of the Society of Chemical Industry in Glasgow early in July and will spend several weeks in England and Scotland, returning to the United States in August.

John S. Lowman, first vice-president of the Philadelphia Rubber Works, Philadelphia, Pa., is making a tour through Europe, including France, Italy and Germany. He is expected to return late in the present month.

F. F. Renwick has been appointed director of the Redpath Laboratory of E. I. du Pont de Nemours & Co. Mr. Renwick arrived from England last month to take charge of the work on photographic emulsions.

Howard M. Raymond has been appointed president of Armour Institute of Technology. Dr. Raymond has been dean of engineering since 1903 and acting president since the death of Dr. Frank W. Gunsaulus.

John T. Wood, East Liverpool, Ohio, has been elected president of the National Brotherhood of Operative Potters, as a result of a referendum election of officers of the association, in which 8,000 potters throughout the United States and Canada participated.

Obituary

Noah Bryant, one of the founders of the Bryant Paper Co., Kalamazoo, Mich., and for half a century a leader among the paper manufacturers of the Kalamazoo Valley, died on Thursday, May 4, at the home of his daughter, Mrs. Frank H. Milham, in Kalamazoo, at the age of 83 years.

Charles Ordway, inventor of many improvements in the design of the Yaryan evaporator, died on Saturday, April 29. He was born in Massillon, Ohio, on Feb. 8, 1858, and was thus in the sixty-fifth year of his age when he passed away. Mr. Ordway had been connected with the evaporator business for thirty years. Shortly after graduating from Wittenberg College, Springfield, Ohio, in 1877, he became associated with Homer T. Yaryan, inventor of the Yaryan evaporator, and was consulting engineer for the Yaryan company, which concern he succeeded in 1916.

Ernest Solvay, prominent in invention and industry through his originating the Solvay process for the manufacture of soda, died on May 27. M. Solvay was an octogenarian, having recently celebrated his eighty-fourth birthday, and was frequently styled "the Carnegie of Belgium."

Frank J. Parry, of Patchogue, L. I., secretary of the John H. Parry Tile Co., New York, died on May 23, as a result of a fall.

Market Conditions

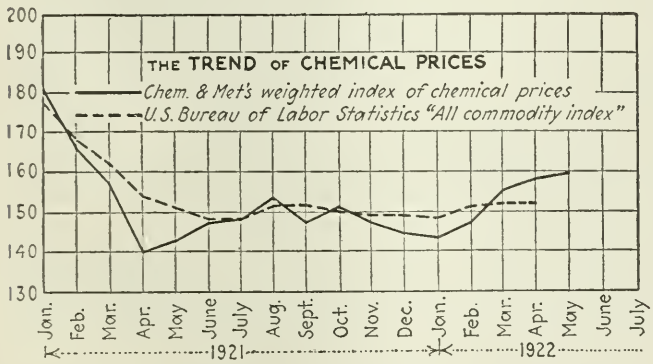
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Better Business Conditions in the Chemical and Allied Industries

Marked improvement in the fundamental business situation is evident in practically every branch of industry. Striking progress was made during the past month, not only in production but also along distributive and consuming lines. Basic industries, such as those producing chemical and metallurgical products, have been especially affected by the business revival, since for the most part the fabricating industries are dependent upon them for the crude raw materials of commerce.

The phenomenal building boom which is spreading over the entire country is of broad industrial significance, for it means less unemployment and, therefore, increased purchasing power. The construction industry, according to the *Commerce Monthly*, is second only to agriculture when measured in the terms of the number of persons employed. It is natural, then, that much of the improvement in the so-called process industries is directly attributable to new



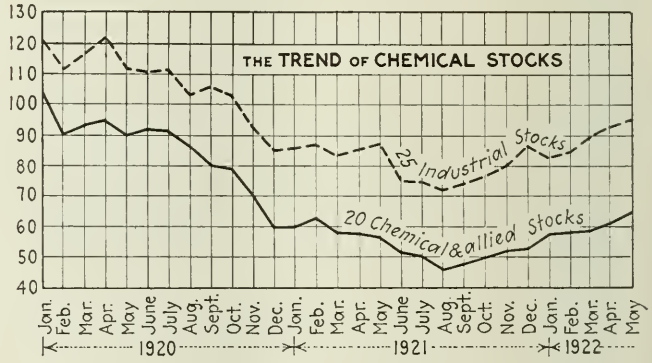
building. The F. W. Dodge Co. reported that the value of new construction in April, 1922, in twenty-seven northeastern states amounted to $353,161,900, which is far in excess of any month ever reported. The previous record month was July, 1919, with $317,698,000.

This activity has contributed greatly to the demand for metals. The iron and steel industry in April was operating at 75.2 per cent of its capacity. Steel ingot production of 2,896,966 tons was the largest output in any month since November, 1920, and was more than three times that of July, 1921. The output of pig iron in April, 2,072,114 tons, was the largest since January, 1921, and was over two and a half times that of last July. The orders for fabricated structural steel were almost equal to the capacity of fabricating firms, according to the Department of Commerce. Sales reported during April amounted to 115,247 tons by seventy-five firms having a capacity of 116,918 tons, or at the rate of 99 per cent of capacity.

Progress in the Process Industries

Other process industries prospering on account of the building boom include the production of glass, enameled ware and paint and varnish. One of the world's largest paint-manufacturing firms recently reported to the Philadelphia Reserve Bank that its gallonage production of house paint has increased 35 per cent over 1920 and over 30 per cent above 1921. The latter year, it will be recalled, was unusually good for the paint industry notwithstanding the general industrial depression.

The rubber industry, favored by low prices for its raw materials and a record demand from the automobile manufacturers, is working with feverish activity. The Philadelphia Bank sponsors the statement that tire production at Akron is at the rate of 85,000 tires a day. Even in the peak



of 1920 the daily output was but 110,000. This fact carries most significance when it is considered that before the depression it took 72,000 men to produce these tires, while today 77 per cent of the former record production is being accomplished with 27,000 men. Automobile production increased 30 per cent, from 152,647 passenger cars in March to 196,512 in April. This is the largest production since August, 1921, and compares favorably with the record of 220,000 in March, 1920.

The non-ferrous metal industries, emerging from their long period of stagnation, appear to be making a remarkable recovery. The prices for most of these products have finally reached the turning point. Copper has been one of the last of the basic commodities to respond to the tendency toward higher prices. The *Engineering and Mining Journal-Press* average for May was one-half cent above the March and April averages and since the first of April copper has shown a decidedly advancing tendency. The May average for lead of 5.4c. compares with 4.7c. in March and 5.1c. in April. The advance in zinc has been regular and long continued, the upward trend dating from February. Tin has not fluctuated widely, but has been successively stronger during the last 2 months. Quicksilver, antimony and tungsten are also advancing.

In certain of the process industries, however, improvement is inclined to be "spotty." The individual industries are often affected differently by the various economic factors. Thus the coal strike is beginning to be felt in some quarters and it is contended that if the dye industry were not so seriously curtailed because of the inactivity in the textile mills, there might be occasion for some concern re-

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	158.12
Last week	157.72
June, 1917	222
June, 1918	272
June, 1919	229
June, 1920	274
June, 1921	147
April 1918 (high)	286
April, 1921 (low)	140

This index number is based on the wholesale prices in the New York market for acetic acid, citric acid, hydrochloric acid, nitric acid, sulphuric acid, ethyl alcohol, methanol, anhydrous ammonia, ammonium sulphate, barium chloride, bleaching powder, borax, caustic potash, caustic soda, copper sulphate, formaldehyde, glycerine, potassium carbonate, saltcake, soda ash, crude sulphur, benzene, aniline oil, cottonseed oil and linseed oil.

garding supplies of the basic coal-tar products. Production in the petroleum industry has been proceeding considerably in excess of domestic consumption and exports. Stocks are piling up and temporarily the industry appears in a weaker statistical position. On the other hand the 10 per cent reduction in freight rates recently authorized by the Interstate Commerce Commission may be looked upon as a strengthening factor in the heavy chemical, fertilizer and other industries which in the past have suffered from excessive transportation charges.

The Financial Situation

Financially the month of May has been much the same as March and April. The lower money rates and the strengthening economic and industrial situation have added impetus to the unusual activity in the stock market. The advance during May was less spectacular than in the preceding month, but the underlying situation continued strong and practically all of the earlier gains were maintained. The *Wall Street Journal's* average of twenty industrial stocks opened the month at 92.74 and after suffering a very slight reaction during the middle of the month advanced to 96.63 on May 31. CHEM. & MET.'s average of the stock quotations for twenty representative chemical and allied industrials was 63.8 on May 1 and by the end of the month it had shown a gain of 4.4 points.

The effect of easier money rates has already been commented on in these columns. It is of interest to note, however, that on May 19, time money—i.e., fixed date loans—was quoted in New York at the lowest level since August, 1917. Thirty-day loans were negotiated at 3¾ per cent. Call money at that time was available at 3 per cent. The foreign exchange market during May was well sustained, and about the only outstanding feature was the new high levels reached by the pound sterling. On May 1 it was quoted at $4.42¾, on May 5 it had touched $4.44⅞ and on May 18 reached $4.44 15/16. By the end of May it had reached $4.48—the highest point since July 14, 1919.

Wholesale Prices

Commodity prices during May for the most part maintained their earlier gains and showed increased stability. The general index number of the Federal Reserve Board advanced 2 points as compared with the preceding month. The all commodity figure of the Bureau of Labor Statistics remained stationary at 152, but indexes for both chemical and metallurgical products advanced during April. CHEMICAL & METALLURGICAL ENGINEERING'S weighted index of chemical prices averaged 159.32 for the month of May, as compared with 158.04 during April. On May 24 this index had reached 160.49, but later receded somewhat on account of slightly lower prices for such basic chemicals as ammonium sulphate, caustic soda and cottonseed and linseed oils.

The Outlook

The review of the business situation would not be complete without some discussion of the outlook, particularly in the chemical and related industries. In general it may be safely contended that activity in these industries will continue without major reversals. As the summer season approaches there may be some slackening in the extreme pace set during recent months, but there can be little doubt that genuine improvement in chemical and related industries is scheduled for next fall and winter.

The Beet Sugar Situation

"As a result of the war, the world's beet sugar production, due entirely to shrinkage in Europe, decreased from nearly 9,000,000 long tons in 1912-1913 to 3,500,000 long tons in 1919-1920. This production is again on the up grade, reaching nearly 5,000,000 long tons in 1921-1922. Cane-producing countries, endeavoring to overcome this great falling off, increased their production from 9,250,000 long tons in 1912-1913 to 12,500,000 long tons in 1917-1918, and to 11,500,000 long tons in 1921-1922; this development being largely in Cuba, where the production was increased from 2,500,000 long tons in 1913-1914 to an average of nearly 3,900,000 long tons in the past 3 years.

"Out of the past season's domestic beet sugar production of 20,200,000 bags (900,000 long tons), there remained unsold 5,700,000 bags (250,000 long tons), on March 31, 1922, compared with over 10,000,000 bags (450,000 long tons) a year ago."

The foregoing paragraphs are extracted from the letter by H. Reiman Duval, president of the American Beet Sugar Co., which accompanied the report of that company's operations for the year ended March 31, 1922. The financial statement showed a net loss of $3,134,046, after allowing for taxes, charges and inventory adjustments. Preferred dividends and minor adjustments increased the deficit to $3,455,455. In 1921 the American Beet Sugar Co. reported a net income of $133,509, equal to $2.67 a share on outstanding preferred stock.

President Duval reported that the past year was but a continuation of the "unbroken movement toward normal conditions—a period of falling prices, large losses, liquidations and readjustments." That the future is more promising is shown by the fact that stocks are at a lower level than at any time in recent years and that better financial conditions and increased buying power appear likely to continue throughout the year.

Census of Chemical and Fertilizer Plants

In a special compilation made for the Finance Committee of the Senate, the Bureau of the Census shows that there are 598 establishments in the United States engaged in the manufacture of chemicals. The capital employed is given as $484,488,412. Salary and wage payments total $97,188,958. These establishments pay $28,338,749 in federal taxes and $3,592,640 in state taxes. The value of the products of these factories in 1919 was $438,658,869. The average number of wage earners employed during that year was 55,586. The aggregate horsepower of the plants was 376,940.

There were 600 establishments engaged in the manufacture of fertilizer. Their combined capital was $311,633,259. The total of salary and wage payments was $36,934,732. The value of products in 1919 was $281,143,587. The average number of wage earners was 26,296. The primary power used amounted to 125,939 hp.

The New York Market

NEW YORK, June 5, 1922.

The effects of the holiday interruption and the approaching season of slackened production were somewhat evident in the chemical market during the past week although conditions on the whole were regarded as satisfactory. Apparently the hand-to-mouth buying policies pursued by the consumers and their disinclination to lay in heavy stocks of chemical products indicate that trading this year will be less affected than usual by the summer lull. A surprising number of chemicals formerly regarded as staple commodities and practically always sold on contract between producer and consumer are now figuring actively in the resale and speculative markets.

It is apparent, too, that a number of important price revisions are imminent. Thus in the coal-tar group higher prices are daily expected for benzene, toluene and perhaps other crudes and intermediates. The reason for this is that the coal strike is beginning to pinch in some quarters and is already seriously curtailing byproduct operations. Oxalic acid, notwithstanding its recent upward revision, continues to grow firmer and higher prices are generally demanded. On the other hand, the new prices for ammonium sulphate and nitrate of soda are expected to be considerably lower than the present schedules and the buyers of these commodities naturally prefer to await the official announcement of the producers.

General and Special Chemicals

Acetic Acid—The market for the various strengths of acetic acid was considerably easier during the week. Glacial could generally be bought at 8½@9c. in carlots, but it was evident that in some large sales the former figure was

shaded to 8c. or even less. The 28 per cent strength was available at $2.25 per 100 lb.—a reduction of 10c. from last week's quotations.

Ammonium Sulphate—New prices for this article have not yet been announced, but it is rumored that sales are being made at $3 or less per 100 lb. The open price for f.a.s. material at New York is $3.25.

Barium Chloride—Barium chloride for immediate delivery is quite generally quoted around $100. Imported material to arrive in June and July has been sold at or below $90. Domestic producers report an active demand for their June output at $100.

Caustic Soda—The alkali market continues to maintain its previous strength and the large producers are reporting excellent business. Standard brands of solid caustic are being offered for export at $3.85@$3.90 per 100 lb. f.a.s. New York. Domestic shipments from New York are at $3.75. Contract prices for solid are said to be at 2½c. per lb., basis 60 per cent, works.

Copper Sulphate—This product is extremely scarce and prices are nominally quoted at 6c. per lb. An unprecedented demand from agricultural consumers and the higher prices for the metal are said to be the explanation.

Glycerine—The outstanding incident in this market last week was the announcement that the Japanese Government had placed an order in Great Britain for 250 tons of dynamite glycerine at a figure approximating 14 cents. The domestic market for chemically pure remains unchanged—refiners quoting 14¾@15c. in bulk.

Nitrate of Soda—Slightly lower prices prevail for spot material, with goods for future delivery offered at $2.25@$2.60. Large shipments have recently been received and the market is apparently well supplied. The price agreement between producers is soon to expire and lower prices are expected.

Oxalic Acid—A further advance in this acid brings the price up to 14@14¾c. for carlots at works. A noticeable scarcity of spot material has resulted in 15c. being demanded by first hands.

Prussiate of Soda—With the exception of a 10-ton lot on Saturday, but very small quantities of this material have reached the New York market and prices have varied over a wide range. Some sales early in the week were reported as low as 21c., but in general 23@25c. was asked for spot goods. Shipment material was quoted at 20½c.

Sal Ammoniac—The gray, granular material was obtainable from the domestic producers at slightly lower figures. Their price for carlots was 7⅞@8c. The imported sal ammoniac was selling at 7@7¾c.

Sodium Acetate—One large manufacturer was asking 5½@6½c. for carlots, but in other quarters this commodity was still available at its former price, 5@5¼c.

Coal-Tar Products

Aniline Oil — Some sales are reported at less than the manufacturers' quotation of 15@16c.

Benzene—An upward revision of benzene prices is considered likely, due pricipally to the curtailed production caused by the coal strike.

Beta-Naphthol—The market for this commodity has been unsteady and generally weaker. A number of producers quote 23c., where 25c. was the predominating figure a week ago.

Naphthalene—Considering the season, business in naphthalene may be regarded as fair. Some lower prices were obtainable, though generally from dealers rather than manufacturers.

Phenol—The scarcity of this product has strengthened its price considerably and the U.S.P. grade is quoted nominally at 14@15c., with the latter figure the more prevalent.

Linseed Oil and Naval Stores

Linseed Oil—Coincident with the lower flaxseed prices this oil has suffered another decline and it is generally reported that 82@83c. per gal. for carlots is the prevailing price. The immediate future is not certain, but many are inclined to think that a return to prices of a few months ago is easily possible. On the other hand, an early enactment of the new tariff will tend to sustain present high prices. Imported oil is offered at 77@78c., duty paid, for June arrival.

Turpentine—Market somewhat easier and prices are declining slightly.

Rosin—The advances predicted in these columns last week have resulted in the following prices per barrel of 280 lb., ex-yard: B, $5.45; D, $5.70; E, $5.90; F, $6.10; G, $6.15; H, $6.20; I, $6.20; K, $6.40; M, $6.70; N, $6.90, W.G., $7.75 and W.W., $8.25.

The Chicago Market

Chicago, Ill., June 1, 1922.

The general tone of the industrial chemical market in this section is firmer. Imported chemicals in particular are very firm and price advances are numerous. It was generally reported that while stocks were sufficient for present needs any unusual demand would cause a shortage. Consumers are beginning to show more confidence in the market and in some quarters business could almost be called brisk.

Industrial Chemicals

Spot stocks of the alkalis are reported to be only moderate and the tone of the market is slightly firmer. Small or moderate lots of *caustic soda* are available at $3.85@$3.95 per 100 lb. for the solid and $4.35@$4.50 for the ground. *Caustic potash*, while unchanged as to price, is exceptionally firm, and imported 88-92 per cent material cannot be located under 6¾c. *Soda ash* is reported to be moving well at $2.20@$2.30 per 100 lb. for 58 per cent material in cooperage.

Alums are moving only in a routine way and are unchanged as to price. *Potash alum* is available at 4½c. per lb. for the lumps and 5½c. for the powdered. *Barium chloride* is exceedingly scarce and only a few scattered lots are available at $120@$130 per ton. Owing to the strength of the metal, *copper sulphate* has been advanced to 6c. per lb. by the leading factors. A good movement is reported at this new figure. *Sal ammoniac* is in fair request and the white granular is offered at 7¾@7⅞c. per lb., the higher figure representing the prevailing price for domestic goods. A slightly better demand is to be noted for *carbon tetrachloride* and resale material in large drums is quoted at 10@10½c. per lb. No change is announced in the price of *furfural*, which is available at 50c. per lb. *Formaldehyde* continues dull and easy at 10c. per lb. for single barrels. This price can easily be shaded with a firm order. *White arsenic* is firm at 8@8½c. per lb. for small or medium quantities. *Glycerine* is exceptionally dull and supplies of the c.p. material can be bought at 14c. per lb., bulk basis.

Bichromates are in an easy position but are unchanged as to price. *Potassium bichromate* is offered at 11¾c. per lb. in single cask lots and the soda in similar quantities at 9@9½c. *Potassium permanganate* is dull and easy, with holders of spot goods asking 16c. for the U.S.P. crystals. Cabled quotations from abroad are slightly lower, which had a disturbing effect on the market. The prussiates are probably the firmest items on the list, the firmness no doubt due to the increasing scarcity of supplies both here and abroad. Practically nothing can be had from abroad for immediate delivery and only small quantities are available for the future. *Red prussiate of potash* is still off of the market and the yellow is very scarce at 34@36c. per lb. *Hyposulphite of soda* continues to move in a routine way at $3.85 per 100 lb. for pea crystals in barrels.

Linseed Oil and Naval Stores

Lower prices on *linseed oil* are predicted by a leading factor; however, the movement to the consuming trade continues very good. Boiled oil today is quoted in 5-bbl. lots at 93c. per gal, with the usual 2c. reduction on the raw.

Turpentine is scarce and the movement very good. The tendency of this material is toward higher prices, which is no doubt stimulating sales to a certain extent. Today's price on 5-bbl. lots is $1.05 per gal. *Rosins* are reported to be getting firmer every day, with a good movement. The WG grade is quoted today in less than carlots at $8.75 per 280 lb.

The Iron and Steel Market

PITTSBURGH, June 2, 1922.

The steel market has become quieter still. There is a fair volume of activity in the aggregate, but the turnover is much lighter than in February, March and April. Buying of steel at present is chiefly against newly developed requirements, the regular buyers, jobbers and manufacturing consumers being on the whole well covered for some time to come. Freight-car buying has perhaps been at a slightly lower rate in the past week or two. The automobile trade does not appear to be buying much steel at the moment, although the production of cars is substantially at record rate. Lettings of fabricated steel contracts represented 77 per cent of the shop capacity in March and 99 per cent in April, the high month since July, 1918, but May lettings are now estimated at only about 66 per cent. In fact, there is no important line of steel consumption outside of the automobile trade that presents the appearance today of using as much steel as it did in 1912 and 1913, yet the production of steel is at a rate 25 per cent greater than in those years.

The change in the market situation in the past fortnight, whereby there is less search by buyers for early delivery material, is probably attributable not to decreases in buyers' actual requirements but to a change in buyers' appraisals of the prospects of steel production, there being less fear that the steel mills will be unable, on account of the coal strike, to maintain their operations. Certainly the record of the first two months of the coal strike is impressive, for the mills have increased their production in this time. Last December steel ingots were produced at an annual rate slightly under 20,000,000 tons. By April 1 the rate had risen to about 35,000,000 tons. The rate today is about 38,000,000 tons, and the average rate since April 1 has probably been all of 37,000,000 tons. This means production of finished rolled steel at the rate of 2,600,000 net tons a month in the past two months. Besides this amount of steel, the tonnage assigned to any one line of consumption seems small, hence most experienced observers have doubts whether all the steel shipped is actually passing into ultimate consumption.

STEEL PRICES

Steel prices are firm all along the line, as follows: Bars, shapes and plates, 1.60c.; blue annealed sheets, 3.40c.; black sheets, 3.15c.; galvanized sheets, 4.15c.; hoops, bands and hot rolled strips; 2.25c.; standard steel pipe, 71 per cent basing discount; plain wire, 2.25c.; tin plate, $4.75. Nails are held at $2.40 by the leading interest and at $2.50 by the independents. The fact that the leading interest has failed to make an advance in nails, in the circumstances, may be regarded as significant of Steel Corporation's general policy. In most of the lines named some independent producers are quoting higher prices, and are probably securing them on small tonnages for early deliveries, but on the whole the volume of such business is hardly sufficient to suggest that the market is likely to reach higher levels.

A decision as to freight rates on iron ore from Lake Superior mines to lake is momentarily expected, the prospect being that there will be a reduction of 25 cents, making the rate from the Mesabi range 75 cents. Season prices for Lake Superior ore will then be developed, and will likely represent a reduction of at least 50 cents from the 1921 schedule, when Mesabi non-bessemer was $5.55 f.o.b. Lake Erie dock. A 50-cent reduction would include the 25 cents mentioned, a 10-cent reduction in the vessel rate, and a 15-cent concession by the ore producers themselves. The general rate reduction ordered last week by the Interstate Commerce Commission will apply to iron ore from Lake Erie docks to furnaces, and to coal, coke, limestone, pig iron, scrap and other rates generally, averaging a 10 per cent reduction. With the prospective reduction in Lake Superior iron ore the average cost of making pig iron at Northern furnaces will decline, say, $1.25 or $1.50 per ton, and the reduction in the cost of making steel will be about the same amount. As pig iron and steel prices are subject to so many influences, a decrease of this amount in cost would hardly be identified in market prices. The part of blast-furnace cost attributable to ore is largely theoretical, as the furnaces still have large piles of ore.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride	lb.	-	$0 38 - $0 40
Acetone	lb.	$0 08 - $0 09	09½ - 10
Acid, acetic, 28 per cent	100 lbs.	2 25 - 2 50	2 55 - 3 00
Acetic, 56 per cent	100 lbs.	5 00 - 5 25	5 30 - 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	8 50 - 9 00	9 50 - 9 75
Boric, crystals	lb.	11 - 11½	11½ - .12
Boric, powder	lb.	11 - 11½	11½ - 12½
Citric	lb.	-	45 - 46
Hydrochloric	100 lb.	1 10 - 1 20	1 25 - 1 70
Hydrofluoric, 52 per cent	lb.	11 - 11½	11 - 12
Lactic, 44 per cent tech	lb.	09½ - 10	10 - 12
Lactic, 22 per cent tech	lb.	04 - 04½	04½ - 05
Molybdic, c.p.	lb.	3 00 - 3 25	3 30 - 3 75
Muriatic, 20 deg. (see hydrochloric)		-	
Nitric, 40 deg.	lb.	06 - 06½	06½ - 07
Nitric, 42 deg.	lb.	06½ - 06¾	07 - 07½
Oxalic, crystals	lb.	14 - 14½	14 - 15
Phosphoric, 50 per cent solution	lb.	08 - 08½	08½ - 09½
Picric	lb.	22 - 24	24 - 30
Pyrogallic, resublimed	lb.	-	1 65 - 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 - 11 00	-
Sulphuric, 60 deg., drums	ton	12 00 - 14 00	-
Sulphuric, 66 deg., tank cars	ton	15 00 - 16 00	-
Sulphuric, 66 deg., drums	ton	19 00 - 20 00	20 50 - 21 00
Sulphuric, 66 deg., carboys	ton	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 - 20.00	-
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 - 22 50	23 00 - 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 - 32 00	33 00 - 34 00
Taanic, U. S. P.	lb.	-	60 - 75
Tannic (tech.)	lb.	.40 - 45	.46 - .50
Tartaric, imported crystals	lb.	-	.28 - 29
Tartaric acid, imported, powdered	lb.	-	.28½ - .30
Tartaric acid, domestic	lb.	-	- .30
Tungstic, per lb. of WO	lb.	-	1 00 - 1 10
Alcohol, ethyl (Cologne spirit)	gal.	-	4 75 - 4 95
Alcohol, methyl (see methanol)		-	-
Alcohol, denatured, 188 proof No. 1	gal.	-	.30 - .32
Alcohol, denatured, 188 proof No. 5	gal.	-	.30 - 32
Alum, ammonia, lump	lb.	03½ - .03¾	.04 - 04½
Alum, potash, lump	lb.	03½ - .04	04½ - 05
Alum, chrome lump	lb.	07½ - 08	08½ - 08¾
Aluminum sulphate, commercial	100 lb.	1 50 - 1 65	1 70 - 2 25
Aluminum sulphate, iron free	lb.	02½ - .02¾	.03 - 03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ - .07¾	.08 - 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 - .30½	.30½ - .31
Ammonium carbonate, powder	lb.	07 - .07½	.07½ - .08
Ammonium nitrate	lb.	.06 - .06½	.06½ - .07½
Amylacetate tech.	gal.	-	2.00 - 2 25
Arsenic, white, powdered	lb.	07½ - 07½	.07½ - .08
Arsenic, red, powdered	lb.	12 - 12½	12½ - 13
Barium chloride	ton	100.00 - 105 00	107.00 - 110 00
Barium dioxide (peroxide)	lb.	.20 - .21	.21½ - 22
Barium nitrate	lb.	.06½ - .07	.07½ - 08
Barium sulphate (precip.) (blanc fixe)	lb.	.03¾ - .0	.04½ - .04½
Blanc fixe, dry	lb.	.04 - 04½	-
Blanc fixe, pulp	ton	45.00 - 55.00	-
Bleaching powder	100 lb.	1 60 - 1 75	1 80 - 2 75
Blue vitriol (see copper sulphate)		-	-
Borax	lb.	.05½ - .05¾	.06 - .06¾
Brimstone (see sulphur, roll)		-	-
Bromine	lb.	.27 - .28	.28½ - 35
Calcium acetate	100 lbs.	1 75 - 2 00	-
Calcium carbide	lb.	04½ - 04¾	.05 - 05½
Calcium chloride, fused, lump	ton	24.00 - 24 50	24 75 - 27 00
Calcium chloride, granulated	lb.	01½ - 01¾	.02 - 02¼
Calcium peroxide	lb.	-	1 40 - 1 50
Calcium phosphate, tribasic	lb.	-	15 - 16
Camphor	lb.	-	.79 - 83
Carbon bisulphide	lb.	.06½ - .06¾	.07 - 07½
Carbon tetrachloride, drums	lb.	.09½ - .10	.10½ - .12
Carbonyl chloride, (phosgene)	lb.	-	.60 - .75
Caustic potash (see potassium hydroxide)		-	-
Caustic soda (see sodium hydroxide)		-	-
Chalk, precip.—domestic, light	lb.	.04¾ - .04½	-
Chalk, precip.—domestic, heavy	lb.	03½ - .03¾	-
Chalk, precip.—imported, light	lb.	04½ - .05	-
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	05 - 05½	.05¼ - .06
Chloroform	lb.	-	.30 - .32
Cobalt oxide	lb.	-	2 00 - 2 10
Copperas	ton	20 00 - 22 00	23.00 - 30 00
Copper carbonate, green precipitate	lb.	19 - 20	20½ - .21
Copper cyanide	lb.	-	.58 - .60
Copper sulphate, crystals	100 lb.	6.00 - 6 15	6 25 - 6 50
Cream of tartar	lb.	-	.25 - .26
Epsom salt (see magnesium sulphate)		-	-
Ethyl acetate com. 85%	gal.	-	.60 - .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	-	.90 - .95
Formaldehyde, 40 per cent	lb.	08½ - .08¾	.09 - .09¼
Fullers earth, f.o.b. mines	net ton	16 00 - 17 00	-
Fullers earth—imported powdered—net	ton	30 00 - 32 00	-
Fusel oil, ref.	gal.	-	2 15 - 2 50
Fusel oil, crude	gal.	-	1 30 - 1 50
Glauber's salt (see sodium sulphate)		-	-
Glycerine, c. p. drums extra	lb.	-	.15 - 15½
Iodine, resublimed	lb.	-	4 20 - 4 25
Iron oxide, red	lb.	-	.12 - .18
Lead acetate	lb.	-	.09¾ - .12
Lead arsenate, powd.	lb.	.14 - .14½	.14½ - .15½
Lead nitrate	lb.	-	.15 - .20
Litharge	lb.	07½ - .08	.08½ - .09
Magnesium carbonate, technical	lb.	08½ - .08¾	.09 - .09½
Magnesium sulphate, U. S. P.	100 lb.	2 50 - 2.60	2 65 - 2 85
Magnesium sulphate, technical	100 lb.	-	1 00 - 1 80
Methanol, 95%	gal.	-	.57 - .58
Methanol, 97%	gal.	-	.59 - .60
Nickel salt, double	lb.	-	.11 - .11½
Nickel salt, single	lb.	-	.11 - .11½
Phogene (see carbol chloride)		-	-
Phosphorus, red	lb.	.45 - .46	.47 - .50
Phosphorus, yellow	lb.	-	.30 - .35

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Potassium bichromate	lb.	09¼ – .10	.10⅛ – .10
Potassium bromide, granular	lb.	..... –	.17 – .20½
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.05 – .05¾	.06 – .06½
Potassium chlorate, powdered and crystals	lb.	.06¾ – .07	.07¼ – .08
Potassium cyanide	lb.	..... –	.45 – .50
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6.25 – 6.75
Potassium iodide	lb.	..... –	3.30 – 3.40
Potassium nitrate	lb.	.07½ – .07½	.08 – .09
Potassium permanganate	lb.	.14 – .14½	.14½ – .20
Potassium prussiate, red	lb.	nominal	nominal
Potassium prussiate, yellow	lb.	32 – .32½	.32½ – .33
Rochelle salts (see sodium potas tartrate)	....	..... –	..... – ....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07¼ – .07⅝	.07⅝ – .08⅜
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	20.00 –25.00	..... – ....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.90 – 2.00	2.10 – 2.50
Soda ash, dense	100 lb.	1.95 – 2.05	2.10 – 2.60
Sodium acetate	lb.	.05 – .05¼	.05½ – .06
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07¼ – .07½	.07½ – .08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06 – .06½	.06¼ – .07
Sodium chloride	long ton	12 00 –13 00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09 – .09½	.09¾ – .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.85 – 3.90	3.95 – 4.25
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03¼	.03½ – .04
Sodium nitrite	lb.	.08¾ – .09	.09¼ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.25 – .25½	.25½ – .25¾
Sodium silicate, solution (40 deg.)	100 lb.	.85 – 1.00	1.05 – 1.25
Sodium silicate, solution (60 deg.)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.05	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.03¾ – .04½	.04½ – .05
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04½
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18 00 –25 00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09¾ – .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran	lb.	.06 – .06½	.06¾ – .08
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.15 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzene, pure, water-white, in drums (100 gal.)	gal.	.29 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.27 — .32
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.50 — .55
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.23 — .26
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — 25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — 1.00
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
Ortho-amidophenol	lb.	.40 — 2.50
Ortho-dichlor-benzene	lb.	2.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75
Ortho-nitro-toluene	lb.	$0.10 — $0 13
Ortho-toluidine	lb.	.14 — .18
Para-amidophenol, base	lb.	1.25 — 1.30
Para-amidophenol, HCl	lb.	1.30 — 1.35
Para-dichlorbenzene	lb.	.13 — 16
Paranitroaniline	lb.	.75 — .77
Para-nitrotoluene	lb.	.55 — .65
Para-phenylenediamine	lb.	1.55 — 1 60
Para-toluidine	lb.	.90 — 1.00
Phthalic anhydride	lb.	.35 — .38
Phenol, U. S. P., drums	lb.	.14 — 15
Pyridine	gal.	1 75 — 2 75
Resorcinol, technical	lb.	1.30 — 1 35
Resorcinol, pure	lb.	1.75 — 1.80
Salicylic acid, tech., in bbls.	lb.	.25 — .25½
Salicylic acid, U. S. P.	lb.	.26 — .26½
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.10 — .12
Sulphanilic acid, crude	lb.	.24 — .26
Tolidine	lb.	1.20 — 1.30
Toluidine, mixed	lb.	.30 — .35
Toluene, in tank cars	gal.	.25 — 28
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax	lb.	$0.20 — $0.21
Beeswax, refined, dark	lb.	.26 — .28
Beeswax, refined, light	lb.	.30 — .32
Beeswax, white pure	lb.	.35 — .40
Candellila, wax	lb.	.35 — .36
Carnauba, No. 1	lb.	.45 — .46
Carnauba No. 2, North Country	lb.	.25 — .25½
Carnauba, No. 3, North Country	lb.	.16 — .16½
Japan	lb.	.16½ — .17
Montan, crude	lb.	.04 — .04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — ....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ — ....
Paraffine waxes, refined, 118-120 m.p.	lb.	.02½ — .03
Paraffine waxes, refined, 125 m.p.	lb.	.03 – .03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 — .04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 — .05¼
Stearic acid, single pressed	lb.	.09 — .09¼
Stearic acid, double pressed	lb.	.09½ — .09¾
Stearic acid, triple pressed	lb.	.10½ — .10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50 gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.45	— $5.70
Rosin E-I	280 lb.	5.90	— 6.10
Rosin K-N	280 lb.	6.40	— 6.90
Rosin W. G.-W. W	280 lb.	7.75	— 8.25
Wood rosin, bbl	280 lb.	6.25	— ....
Spirits of turpentine	gal.	.96	— 96½
Wood turpentine, steam dist	gal.	.85	— ....
Wood turpentine, dest. dist.	gal.	.70	— .70
Pine tar pitch, bbl	200 lb.	.....	— 6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	.....	— 9.50
Retort tar, bbl	500 lb.		— 9.00
Rosin oil, first run	gal.	.36	— ....
Rosin oil, second run	gal.	.38	— ....
Rosin oil, third run	gal.	.46	— ....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.10
Pine oil, pure, dest. dist.	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref.	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.25	— 3.40
Blood, dried, f.o.b., N. Y.	unit	3.55	— 3.65
Bone, 3 and 50, ground, raw	ton	27.00	— 28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10	— 3.20
Nitrate of soda	100 lb.	2.65	— 2.80
Tankage, high grade, f.o.b. Chicago	unit	3.00	— 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50	— 3 75
Tennessee, 78-80%	ton	7.00	— 7 50
Potassium muriate, 80%	ton	33.50	— 35.00
Potassium sulphate	unit	1.00	— ....

Crude Rubber

Para—Upriver fine	lb.	$0 18 —	.19¼
Upriver coarse	lb.	.13 —	
Upriver caucho ball	lb.	.13 —	.13½
Plantation—First latex crepe	lb.	.17½ —	.1 ½
Ribbed smoked sheets	lb.	.15½ —	.1 ¼
Brown crepe, thin, clean	lb.	.14 —	.
Amber crepe No. 1	lb.	.14½ —	..

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.11	— $0 11½
Castor oil, AA, in bbls	lb.	.12	— .12¼
China wood oil, in bbls	lb.	.13½	— 1¼
Coconut oil, Ceylon grade, in bbls	lb.	.08⅜	— .09
Coconut oil, Cochin grade, in bbls	lb.	.09¼	— .09½
Corn oil, crude, in bbls	lb.	.11½	— .11¼

Cottonseed oil, crude (f. o. b. mill)	lb.	$0.10 —	$0.10½
Cottonseed oil, summer yellow	lb.	.12 —	.12½
Cottonseed oil, winter yellow	lb.	.13 —	.13½
Linseed oil, raw, car lots (domestic)	gal.	.85 —	.86
Linseed oil, raw, tank cars (domestic)	gal.	.82 —	.83
Linseed oil, in 5-bbl lots (domestic)	gal.	.89 —	.90
Olive oil, denatured	gal.	1.15 —	1.17½
Palm, Lagos	lb.	.07½ —	.07½
Palm, Niger	lb.	.06½ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.85 —	.86
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	....

FISH

Light pressed menhaden	gal.	$0.54 —	. ..
Yellow bleached menhaden	gal.	.57 —	....
White bleached menhaden	gal.	.56 —	....
Blown menhaden	gal.	.61 —	....

Miscellaneous Materials

All f.o.b. New York, Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$900 00	$1200.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	90 00	—125 00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	22.00	— 28 00
Barytes, ground, white, f.o.b. mills	net ton	17.00	— 23 00
Barytes, ground, off color f.o.b. mills	net ton	13.00	— 21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	— 24 00
Barytes, crude f.o.b. mines	net ton	8.00	— 9.00
Casein	lb.	.14	— .15
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	— 8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	— 9 00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	— 20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00	— 20.00
China clay (kaolin), imported, lump	net ton	14.00	— 20.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, No. 1 pottery grade	long ton	6.40	— 6.75
Feldspar, No. 2 pottery grade	long ton	5.75	— 5.90
Feldspar, No. 1 soap grade	long ton	7.00	— 7.50
Feldspar, No. 1 Canadian, for mill	long ton	21.00	— 22.00
Graphite, Ceylon lump, first quality	lb.	.06	— .07
Graphite, Ceylon chip	lb.	.04½	— .05½
Graphite, high grade amorphous crude	ton	15.00	— 30.00
Kieselguhr, f.o.b. mines, Cal	per ton	40.00	—
Kieselguhr, f.o.b. N. Y	per ton	55.00	— 60.00
Magnesite, calcined (crude)	per ton	8.00	— 12.00
Pumice stone, imported	lb.	.03	— .05
Pumice stone, domestic, lump	lb.	.05	— .05½
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	81	— .82
Shellac, orange superfine	lb.	.84	—
Shellac, A. C. garnet	lb.	.62	— .63
Shellac, T. N.	lb.	.80	—
Silica, glass sand, f.o.b. Indiana	per ton	1.25	— 2.25
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	— 4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16 00	— 16.00
Silica, building sand, f.o b. Pa	per ton	2 00	— 2 75
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	— 12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	— 20.00

Refractories

Bauxite brick, 56% Al_2O_3, f.o.b. Pittsburgh	per 1,000	$130.00
Chrome brick, f.o.b. Eastern shipping points	net ton	40–42
Chrome cement, 40-50% Cr_2O_3	net ton	23.00
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	23.00
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	28–35
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	26–28
Magnesite brick, 9-in. straight (f.o b. works)	net ton	53
Magnesite brick, 9-in. arches, wedges and keys	net ton	70
Magnesite brick, soaps and splits	net ton	90
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	30–32
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	33–35
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	27–30
Silicon carbide refractory brick, 9-in	1,000	1100.00

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 78-82% Mn, domestic	gross ton	67.00 —	69.00
Spiegeleisen, 19-21% Mn	gross ton	36 00 —	..
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2 25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	56 00 —	58.00
Ferrosilicon. 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6 00 —	.....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.00 —	3.50

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried	net ton	$6 00 —	$12.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	19 00 —	20 00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	19 00 —	20 00
Coke, foundry, f.o.b. ovens	net ton	6 75 —	7 00
Coke, furnace, f.o.b. ovens	net ton	6 25 —	6 50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	17 50 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20 00 —	22 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.26½ —	.27
Manganese ore, chemical (MnO_2)	net ton	60.00 —	65 00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.50 —	...
Monazite, per unit of ThO_2, c.i f., Atlantic seaport	unit	27 00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	10½ —	.11
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.12 —	13½
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	Nominal	
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2 50 —	2 75
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	2 75 —	3.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1 25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2 25 —	2 50
Vanadium pentoxide, 99%	lb.	12.00 —	14 00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic	13.625
Aluminum, 98 to 99 per cent	19.00–20.00
Antimony, wholesale lots, Chinese and Japanese	5.40–5 50
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	29.00–32.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.75
Lead, New York, spot	5.65–5 75
Lead, E. St. Louis, spot	5.50
Zinc, spot, New York	5.75
Zinc, spot, E. St. Louis	5.25–5.30

OTHER METALS

Silver (commercial)	oz.	$0.72½	
Cadmium	lb.	1.15–1.20	
Bismuth (500 lb. lots)	lb.	2.00@2.10	
Cobalt	lb.	3.00@3.25	
Magnesium, ingots, 99 per cent	lb.	1.10	
Platinum	oz.	85.00@87.50	
Iridium	oz.	150.00@175.00	
Palladium	oz.	55.00	
Mercury	75 lb.	55.00	

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20. 25
Copper bottoms	27.75
Copper rods	19.25
High brass wire	16.75
High brass rods	14 25
Low brass wire	18 25
Low brass rods	18 75
Brazed brass tubing	23 00
Brazed bronze tubing	28 00
Seamless copper tubing	20 75
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible	10 25@10.50
Copper, heavy and wire	10 00@10.25
Copper, light and bottoms	7 75@ 8 25
Lead, heavy	3 90@ 4 15
Lead, tea	2½–2
Brass, heavy	4 50@ 4 75
Brass, light	4 00@ 4 25
No. 1 yellow brass turnings	4 00@ 4 25
Zinc	2.00@ 2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$2 48	$2 48
Soft steel bars	2 38	2 38
Soft steel bar shapes	2 38	2 38
Soft steel bands	2 98	2.98
Plates, ¼ to 1 in. thick	2 48	2.48

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

TEXARKANA—The plant of the Liberty Cotton Oil Co., Rose Hill, has been acquired by new interests, headed by N. P. Sanderson. A company is being organized to operate the property, and preliminary plans are being considered for extensions and improvements. Work will be commenced at an early date.

California

RICHMOND—The Pacific Sanitary Mfg. Co., recently organized with a capital of $2,000,000, will take over and operate three existing plants in this vicinity, heretofore controlled by officials of the new organization. These plants comprise an enameled-iron works at North Richmond, and two potteries on Barrett Ave., San Pablo. Plans are under way for extensive additions and improvements in all three plants, to increase the capacity approximately 100 per cent. N. W. Stern is president, and M. E. and E. S. Wangenheim, first and second vice-presidents, respectively.

OXNARD—The Associated Oil Co. has plans under way for additions and improvements in its local distributing plant to cost about $50,000.

COALINGA—The Continental Petroleum Refining Co. is planning for the construction of a series of new distributing plants in the San Joaquin Valley section. Property has been acquired at Hanford and Tulare, and the first plants will be located here. Other sites will be purchased at an early date.

Georgia

DUBLIN—The Southern Mfg. Co. will soon commence the construction of a new local plant for the manufacture of paints, varnishes, etc. A list of equipment is being arranged for installation, to include grinders, chasers, etc. L. H. Harville is general manager.

Illinois

MATTESON—The K. I. Herman Chemical Corp., 332 South Michigan Ave., Chicago, has commenced the construction of its proposed local plant, 3-story and basement, 60x140 ft., estimated to cost approximately $300,000. The general contract has been awarded to the Chicago Heights Construction Co., Chicago Heights. Harvey C. Miller, 112 West Adams St., Chicago, is architect. K. I. Herman is head.

CHICAGO—The Western Foundry Co., 3634 South Kedzie Ave., manufacturer of small gray iron and other metal castings, has filed plans for the construction of a 1-story plant addition, 76x138 ft., to cost about $15,000, exclusive of equipment. Frank D. Chase, Inc., 645 North Michigan Ave., is architect.

Louisiana

MONROE—The Atlas Oil Co. will commence the immediate construction of a new carbon mill and gasoline extraction plant in the Ouachita Parish district. The initial works, with equipment, will cost in excess of $200,000.

HOMER—The Atlantic Oil & Refining Co., Shreveport, has acquired the local property of the Gilliland Co., as well as holdings and plant of the same company at Haynesville, from P. J Hurley and George O. Baird, receivers. A consideration said to be $3,300,000, was given for the property, and the new owner has tentative plans under way for a number of additions and improvements.

Maryland

BALTIMORE—The Pyrocolor Corp., 503 East 88th St., New York, N. Y., manufacturer of special composition indestructible signs and kindred specialties, has tentative plans under consideration for the construction of a new local plant, and is in negotiation for the purchase of a suitable site. The Industrial Bureau of the Merchants' and Manufacturers' Association, Baltimore, is interested. Lawrence L. Stevens is engineer in charge.

Massachusetts

CHELSEA—The United Indigo & Chemical Co., Ltd., 176 Federal St., Boston, has work under way on an addition to its plant at 960 Broadway, to be 40x60 ft.

Michigan

IONIA—The Michigan Porcelain Tile Co. has awarded a contract to Glenn Pierce, Ionia, for the erection of a new 1-story and basement plant, 120x160 ft., to cost about $40,000, for the manufacture of tile and other burned clay products. Harry E. Kidder is general manager.

Missouri

ANNAPOLIS—The Annapolis Lead Co., 1217 International Life Bldg., St. Louis, has awarded a general contract to Stupp Bros., St. Louis, for the erection of its proposed new local plant, consisting of a crusher and concentrating building, power house and other structures. The plant will have an initial capacity of about 1,000 tons, and will cost approximately $400,000, including machinery. M. C. Rhodes is president.

KANSAS CITY—The Rubber Mfg. Co. is planning for enlargements in its plant, comprising the former works of the Rubber Products Co., recently acquired. It is purposed to increase the capacity to 1,000 tires and tubes per day.

New Jersey

NUTLEY—George LaMonte & Son, Kingsland Rd., manufacturer of paper products, have awarded a contract to Henry Doremus, 36 Orange St., Newark, for the construction of a 1-story plant addition, 60x80 ft. Fletcher-Thompson, Inc., Fairfield Ave., Bridgeport, Conn., is engineer.

YARDVILLE—A new company is being organized under the direction of Edward D. Newman, 29 Broadway, New York, N. Y., to operate the plant of the Zee Zee Rubber Co., recently acquired from the receiver, Henry Klag, Jr., for a consideration of $58,000. The works will be used for the manufacture of automobile tires and tubes, and a number of improvements will be made. The plant comprises two main 1-story buildings, 50x90 ft. and 40x90 ft., respectively, on a 3½-acre site.

NEWARK—The Federal Button Co., New Jersey Railroad Ave. and Market St., manufacturer of composition products, has plans under way for the construction of a 4-story addition to its plant at Wright and Emmett Sts., comprising the former works of the Klaxon Co., and recently acquired. Present buildings will also be remodeled and improved. The work, including machinery installation, is estimated to cost close to $300,000. S. Mendel is president; and Edward J. Duggan, secretary and treasurer.

DELAIR—The Kieckhefer Paper Co., Camden, manufacturer of paper products, has let a contract to Erwin & Leighton, 126 North 12th St., Philadelphia, Pa., for the construction of a new plant on the river front at Delair, N. J. The company is a subsidiary of the Kieckhefer Box Co., Milwaukee, Wis. J. W. Kieckhefer is president.

New York

ONEIDA—The Mohawk Asbestos Slate Co., Madison Ave., has tentative plans under way for the construction of an addition to its plant.

NORTH TONAWANDA—The Frontier Mfg. Co., Erie Ave., is considering plans for the rebuilding of the portion of its oil-manufacturing plant, destroyed by fire, May 23, with loss reported at about $22,000.

BROOKLYN—The Hugo Brand Leather Co., 178 William St., New York, has acquired the 2- and 3-story buildings, on site 71x100 ft., on 13th St. near 3rd Ave., South Brooklyn, for a new plant. The property heretofore has been held by the Charles A. Schieren Co., manufacturer of similar leather products.

BUFFALO—The Department of Public Works will take bids until July 11 for the construction of its proposed new filtration plant at the city water works, estimated to cost in excess of $3,500,000, including equipment. George G. Andrews, City Hall, is water commissioner. Plans will be available about June 11.

Oklahoma

WAYNOKA—The Santa Fe Salt Co. has plans under way for the construction of a new plant with initial output of about 200 tons of salt per day. The company has extensive salt deposits in Woods County, where the plant will be located. P. L. Clifton, Pomeroy, O., is president and manager; C. T. Cavan, Waynoka, is consulting engineer.

ALLEN—The Pacific Petroleum Co., Tulsa, has leased the local oil refinery of the Crystal White Refining Co., and in the future will operate the plant. It is proposed to develop at once a capacity for handling about 1,000 bbl. of crude oil a day. R. A. Irwin is general manager.

Pennsylvania

PHILADELPHIA—The Gill Glass Co., Inc., Amber and Venango Sts., will break ground at once for the construction of a 2-story addition, 85x120 ft., estimated to cost about $42,000. The general building contract has been let to William R. Dougherty, 1608 Sansom St. Francis D. Gill is president.

LIMERICK—The Vulcweld Rubber Co., Pottstown, has preliminary plans under way for the construction of a new local plant on property recently acquired, about 300x400 ft., to be equipped for the manufacture of automobile tires and other rubber products.

PHILADELPHIA—The Griburn Co. has leased a portion of the building at 721-23 Cherry St., for a new plant for the manufacture of lubricating oil products.

Texas

MINERAL WELLS—The Great Texas Oil & Refining Co., Fort Worth, has preliminary plans under way for the erection of a new local refinery with initial output of about 1,000 bbl. a day. The company is now operating plants at Breckenridge and De Leon, and is capitalized at $2,000,000. F. O. Stevenson is consulting engineer.

BRECKENRIDGE—The Hurley Gas Co. will soon commence the construction of a new gasoline extraction plant, on site about 2 miles from the city. It will be equipped for a capacity of about 6,000 gal. per day, with facilities for handling approximately 15,000,000 cu.ft. of gas daily. W. P. Dykemann and H. P. Lyons are in charge.

WICHITA FALLS—The City Council is planning for the immediate installation of a new filtration plant at the municipal waterworks. It is estimated to cost close to $25,000.

Virginia

GOSHEN—The N. Q. Speer Co. has plans under way for the installation of a new local plant for the production of glass sand, with estimated cost reported at about $30,000.

GLOUCESTER—The Roaring Springs Marl Lime Co. is planning for the immediate development of a tract of lime property, totaling about 10 acres, and will install machinery for an output of about 50 tons a day. A complete lime producing plant is contemplated. R. M. Janney heads the company.

NORFOLK—The City Gas Co. will make extensions and improvements in its artificial gas plant to cost about $175,000. Plans have been completed. T. Norman Jones is general manager.

West Virginia

NITRO—The Charleston Paper Mfg. Co., Charleston, W. Va., has acquired local property consisting of a number of buildings, on a tract of about 10 acres of land, for the establishment of a new plant. The structures will be remodeled and machinery installed at an early date, with cost estimated at approximately $350,000. Charles G. Hartje, Steubenville, O., is president of the company.

WARWOOD—The Wheeling Oxygen Co., Wheeling, has preliminary plans under consideration for the erection of a new local plant for the manufacture of commercial oxygen products.

MORGANTOWN—The University of West Virginia, Lee Coulter, dean, is completing plans and will soon take bids for the erection of a new 2-story chemical laboratory, estimated to cost close to $400,000, including equipment. Paul A. Davis, 3d, 1713 Sansom St., Philadelphia, Pa., is architect.

PADEN CITY—The Paden City Glass Mfg. Co. will soon break ground for the erection of a new plant addition, 80x140 ft. Bids for equipment will be called during June. The company has recently increased its capital to $150,000 for expansion. David Fisher is president.

Canada

HAMILTON, ONT.—The Firestone Tire & Rubber Co., Akron, O., will soon commence the construction of a new local plant, to be equipped for an initial capacity of 3,500 tires a day. It is proposed to have the factory ready for operation late in the fall.

Industrial Developments

RUBBER—The Armorcord Rubber Co., Morgantown, W. Va., has resumed operations at its local plant following a shutdown for a number of months.

The B. F. Goodrich Co., Akron, O., is arranging for an immediate increase in working schedule from 5 to 5½ days, with 8-hour working day as a minimum in all parts of the mills, and an overtime schedule operative in a number of departments. Production is now on a basis of approximately 18,000 tires a day.

The Hood Rubber Co., Watertown, Mass., has adopted a capacity schedule of production in all departments at its plant with the exception of the rubber footwear branch, which is now running at about 70 per cent of normal.

The Seiberling Rubber Co. is operating on a basis of 2,500 tires per day at its Barberton, O., and New Castle, Pa., plants, the former averaging 1,400 daily of the aggregate, and the latter 1,100 tires.

The Essex Rubber Co., Trenton, N. J., has adopted a double-shift basis of operation in a number of departments at its plant, giving employment to approximately 400 persons. The shock absorber department is running under exceptionally heavy production.

Tire plants at Akron, O., are now running at close to 90,000 tires a day, collectively, or about 90 per cent of maximum production. There is a shortage of skilled labor in the local industry, and a number of plants are advertising for help.

CEMENT—All cement mills in the Birmingham, Ala., district are operating on full time, with regular working force. The plants at Ragland, Leeds and Demopolis are increasing production to maximum and taking on additional employees.

Cement mills in the Lehigh Valley section of Pennsylvania are developing full production, including the Atlas Portland Cement Co., Lehigh Portland Cement Co., Alpha Portland Cement Co. and Coplay Cement Co.

IRON AND STEEL—The La Belle Iron Works has advanced operations to close to 85 per cent of normal at its Wheeling, W. Va., works. The company has inaugurated an improvement program at its Steubenville, O., plant, including blooming mill and open-hearth departments, and will add about 250 additional men to the working force as soon as completed.

The Replogle Steel Co. has blown in its furnaces at Wharton, N. J., following a shutdown for a number of months. During this period the furnaces have been rebuilt and a number of other plant improvements made. A good working quota is being employed and will be increased at an early date.

The Carnegie Steel Co. is now operating at its Homestead, Pa., works on a full 100 per cent basis in all departments. The plant at Duquesne, Pa., is also being brought up to this working basis, and will soon give employment to additional operatives.

A number of plants in the Shenango Valley section of Pennsylvania, vicinity of Sharon, are making ready for considerable increase in outputs. The Sharpsville Furnace Co. is rebuilding its stack and expects to have the unit ready for service at an early date. The Clair Furnace Co. is making improvements in its furnace stoves. The Shenango Furnace Co. is increasing the capacity of one of its stacks to 500 tons of pig iron a day. The expansion and improvement program at the different mills is estimated to cost close to $400,000.

The Wheeling Steel & Iron Co., Wheeling, W. Va., has brought its Top Mill blast furnaces up to 100 per cent capacity, following a curtailment of many months. The Yorkville plant of the company is running on a basis of close to 70 per cent of normal; the Belmont mill is operating at about 65 per cent of regular output; the Benwood plant at slightly better than 40 per cent, while the Martin's Ferry, O., mills are still on the inactive list.

The Gulf States Steel Co., Gadsden, Ala., is increasing production at its local plant; a night force is being assembled for the bar mill, and will be placed in service at an early date, making a double shift for this division of the works.

The American Sheet & Tin Plate Co., Sharon, Pa., has resumed operations at the last of its hot mills at the Sharon, Pa., plant, and is now running full. The company has also placed two more hot mills in service at its New Castle, Pa., works, bringing production up to 100 per cent with complete battery of twenty mills.

MISCELLANEOUS—The Hillside Mines Co. has started operations at its new fluorspar mill near Rosiclare, Ill., and will develop capacity production. The plant has been in course of construction for some time past and has a rated output of 25 tons of crude ore per hour, under single shift. It is electrically operated in all departments, and is one of the largest plants of its kind ever built. G. H. Jones, formerly vice-president of the Inland Steel Co., is head of the company.

The Holly Sugar Co. is planning for the early resumption of operations at its mill at Delta, Col. The plant was closed throughout 1921.

The Hercules Powder Co., Kenvil, N. J., is increasing production at its local plant and adding to the working force. The mill has been running under low production for a number of months past.

The American Smelting & Refining Co., Raritan Copper Co., Barber Asphalt Paving Co. and the Henry Maurer Co., manufacturers of firebrick, etc., all with plants at Perth Amboy, N. J., have resumed operations following a curtailment due to a strike of employees. Approximately 2,500 men have been out with a demand for increased wages. A settlement has been effected on a basis of 5 cents an hour advance in wage scale.

The Ralph Gypsum Co., Le Roy, N. Y., is arranging for immediate operations at its properties in the northwestern section of the city.

The United States Industrial Alcohol Co. is running at full at its plant at Curtis Bay, Baltimore, Md., and plans to double the present output during the coming months, following the completion of extensions and installation of new machinery, now under way. The company has reopened its different branch plants, including the works at New Orleans, La., closed during the early months of the year.

Capital Increases, etc.

THE GRAND RAPIDS PLASTER CO., Grand Rapids, Mich., has filed notice of increase in capital from $250,000 to $400,000.

THE HORWEEN LEATHER CO., 2015 Elston St., Chicago, Ill., has filed notice of decrease in capital from $1,200,000 to $500,000.

E. I. DU PONT DE NEMOURS & CO., Wilmington, Del., has disposed of a common stock issue of $2,000,000, the proceeds to be used for general operations.

THE DETROIT VARNISH CO., 1960 East Milwaukee St., Detroit, Mich., has filed notice of dissolution under state laws.

THE BURNSIDE TISSUE MILLS, INC., East Hartford, Conn., has filed notice of increase in capital from $150,000 to $400,000, for general expansion in paper plants.

THE FORMICA INSULATION CO., Cincinnati, O., has filed notice of increase in capital from $100,000 to $150,000.

THE AMERICAN RADIUM CO., 7 East 42nd St., New York, N. Y., has filed notice of increase in capital from $100,000 to $200,000.

THE ILLINOIS RUBBER CO., Chicago, Ill., a Delaware corporation, has filed notice of change of name to the Nuelle Rubber Co.

THE BOHEMIAN GLASS CO., INC., 17 West 42nd St., New York, N. Y., has filed notice of increase in capital from $25,000 to $250,000.

THE PHILLIPS PETROLEUM CO., 115 Broadway, New York, N. Y., is disposing of a bond issue of $600,000, the proceeds to be used for expansion, general operations, etc.

Property of the VALLEY FORGE MAGNESIA CO., Port Kennedy, Pa., will be sold by the receivers, George Flint and Wilfred S. Griffiths, including land, buildings and equipment.

THE SHELL-UNION OIL CORP., San Francisco, Cal., has arranged for a new preferred stock issue of $20,000,000, the proceeds to be used for general operations, expansion, etc.

New Companies

THE PAPER & PULP PRODUCTS CO., New Haven, Conn., has been incorporated with a capital of $100,000, to manufacture pulp and paper products, and chemicals for treatment of same. The incorporators are Grant Hammond, E. M. Sime and A. W. Chambers, 315 Exchange Bldg., New Haven.

HENRY SUNDHEIMER, INC., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The incorporators are Henry Sundheimer, N. H. Maas and I. Skutch. The company is represented by Feiner & Maass, 66 Pine St., New York.

THE PACIFIC AMMONIA CHEMICAL CO., Seattle, Wash., has been incorporated with a capital of $300,000, to manufacture chemicals and chemical byproducts. Robert W. Greer is the principal incorporator. The company is represented by Raymond G. Wright, Leary Bldg., Seattle.

THE INDUSTRIAL CHEMICAL PRODUCTS CO., 31 East Woodbridge St., Detroit, Mich., has been incorporated under state laws to manufacture chemicals and chemical byproducts. The incorporators are Wilbert Kromis, Ray J. Smith and Clete Boyle, 1298 Beniteau Ave., Detroit.

THE EUGENE ARNSTEIN PAINT CO., 253 North Western Ave., Chicago, Ill., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture paints, oils, varnishes, etc. The incorporators are Richard Alheim, Carl R. Hines and Alfred J. Parker.

THE RADIUM SULPHATE MFG. CO., Wilmington, Del., has been incorporated with a capital of $100,000 under state laws, to manufacture chemical and affiliated products. The company is represented by Horace G. Eastburn, Ford Bldg., Wilmington.

THE ART BRONZE & IRON WORKS, INC., Danville, Pa., has been incorporated with a capital of $50,000, to manufacture brass, bronze, iron and other metal products. D. J. Reese, Danville, is treasurer.

THE AMERICAN NATIONAL PETROLEUM CO., Paintsville, Ky., has been incorporated with a capital of $60,000, to manufacture petroleum products. The incorporators are M. F. Patrick, Hervie Stambaugh and D. G. Sublte, all of Paintsvilles.

THE INSULATALL PRODUCTS CORP., Buffalo, N. Y., has been incorporated with a capital of $100,000, to manufacture brick, tile and kindred products. A. C. Smith, 2342 Fillmore Ave., Buffalo, is the principal incorporator.

THE SILICON PRODUCTS CORP., Wilmington, Del., has been incorporated under state laws with a capital of $1,250,000, to manufacture commercial silicon and kindred specialties. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington.

THE RITZ CHEMICAL CO., 25 Division Place, Newark, N. J., has filed notice of organization to manufacture and deal in chemicals and chemical byproducts. Walter L. Swartz heads the company.

THE VI-CAR OIL & REFINING CO., Franklin, Ky., has been incorporated with a capital of $100,000, to manufacture refined petroleum products. The incorporators are D. T. Blakey and John S. Milllken, both of Franklin.

THE DALLES FOUNDRY CO., The Dalles, Ore., has been incorporated with a nominal capital of $8,000, to manufacture iron, steel and other metal castings. The incorporators are Carl and C. O. Mattes, and H. U. Martin, all of The Dalles.

THE ELLWOOD CHEMICAL CO., New York, N. Y., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are F. Michelson, G. F. Borowski and C. E. Smith. The company is represented by Walter & Woolf, 120 Broadway, New York.

THE GULF TURPENTINE & ROSIN CO., Wilmington, Del., has been incorporated under state laws with capital of $600,000, to manufacture turpentine, rosin and affiliated products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE VENTURA-COLORADO OIL CO., Portland, Me., has been incorporated under state laws with capital of $300,000, to manufacture petroleum products. P. E. Coyle is president, and A. B. Ewing, treasurer, both of Portland. H. P. Sweetser, Portland, represents the company.

THE TRIANGLE SWEEPING COMPOUND CO., 1105 Garfield Ave., Chicago, Ill., has been chartered under state laws to manufacture chemicals, sweeping compounds, etc. The incorporators are Edwin W. Piper, Armin M. Freitagg and Edgar J. Scott.

THE LUNAPOL POLISH CO., INC., 363 Cal-

vert Bldg., Baltimore, Md., has been incorporated with a capital of $20,000, to manufacture chemicals, chemical compounds, polishes, etc. The incorporators are W. Arthur Darby, F. Stanley Porter and Theodore C. Waters.

THE HOUSTON CLAY PRODUCTS Co., Houston, Tex., has been incorporated with a capital of $10,000, to manufacture brick, tile and other burned clay products. The incorporators are W. M. Merritt, C. L. Hunter and George Kruger, all of Houston.

THE JAMES T. BLUE CHEMICAL Co., Washington, D. C., has been incorporated under Delaware laws with a capital of $25,000, to manufacture chemicals and chemical by-products. The incorporators are James T. Blue, Emery W. Williams and Joseph N. Gownder, all of Washington. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington.

Industrial Notes

THE DODGE SALES & ENGINEERING Co., Mishawaka, Ind., announces the removal of its New York City branch from 21 Murray St. to the new Dodge Bldg., located at the corner of Park Place, West Broadway and Murray St., and known as 53 Park Place.

THE AMERICAN INDUSTRIAL ENGINEERING Co., Chicago, has recently taken an order from the Tennessee Coal, Iron & R.R. Co. for the installation of complete low-pressure pulverized coal-burning plant for utilizing pulverized coal as fuel under one of the boilers in that company's new power plant at Ensley, Ala. The boiler under which this installation is to be placed is a Sterling 834 hp. designed to operate at 200 per cent of rating. A particularly interesting feature of this installation is in the system of control whereby the operation with this fuel will be practically automatic. The pulverized coal-burning equipment is designed with sufficient capacity to run the boiler on this fuel alone, but it will be operated in conjunction with blast-furnace gas, so that the two fuels can be used independently.

THE NITRO PRODUCTS CORP. and the SEYDEL MANUFACTURING Co. announce the merger of their interests and their future operation under the name of the Seydel Chemical Co., with manufacturing facilities in Nitro, W. Va., and Jersey City, N. J.

THE CELITE PRODUCTS Co., Chicago, Ill., announces that the first large freighter to be loaded entirely with Celite products recently left Port San Luis, Cal., bound for Atlantic ports by way of the Panama Canal. A second freighter is now receiving its cargo, and this will be followed by still another boat also devoted exclusively to their materials. Although the Celite Products Co. has made water shipments quite frequently in the past to the Atlantic coast, this is the first time that three entire vessels have been used to the exclusion of other cargoes. Loaded to capacity, these ships mark a departure from their established transportation method which will undoubtedly be repeated at frequent intervals.

THE METAL & THERMIT CORP., New York, announces the removal of its Pittsburgh branch office from 1427 Western Ave. to 801-807 Hillsboro St.

THE NATIONAL ANILINE & CHEMICAL Co. has moved its executive office to 40 Rector St., New York.

G. M. SHERMAN, formerly representing the Quigley Furnace Specialties Co., has connected with the Keystone Refractories Co. of New York and has been made New England sales manager, with offices at 818 Hospital Trust Bldg., Providence, R. I.

THE AMERICAN-LA FRANCE FIRE ENGINE Co., INC., and S. F. Hayward & Co., their subsidiary, have moved their New York offices to the Fisk Bldg., 57th St., between Broadway and Seventh Ave.

THE HILLSIDE FLUORSPAR MINES announce the completion of a new mine, comprising a shaft three-level development with the lowest level at 350 ft. The plant is electrically equipped throughout, including a mill concentrating building for separation of fluorspar from the impurities in the material as mined. The spar is stored in concrete bins drained and covered to insure dryness and thence loaded direct into railroad cars by belt conveyors. The mine on the original Rosiclare (Illinois) vein is now producing gravel and lump fluorspar.

THE RAYMOND BROS. IMPACT PULVERIZER Co., Chicago, Ill., has established a permanent Western office at 1002 Washington Bldg., Los Angeles, Cal. The office will be in charge of W. B. Senseman.

THE OLIVER CHEMICAL Co. has purchased a site at Penticton, B. C., and will commence at once to erect a factory for the manufacture of spraying compounds. The company, which really consists of John Oliver, Premier of British Columbia, and his two sons, has been operating an experimental plant at Vernon, B. C., for some time, and the company's sprays have met with so much favor in the Okanagan Valley, which is the principal fruit district in the province, that the larger venture has been decided upon.

THE QUIGLEY FURNACE SPECIALTIES Co., New York, announces that the American Supply Co., 135 Washington St., Providence, R. I., has been appointed agent for the Providence district to represent the Quigley company. The Quigley products are warehoused in Providence for quick delivery to local points.

THE RAYMOND BROTHERS ENGINEERING Co., Chicago, has recently been incorporated for the manufacture of equipment for "Rayco" pulverized coal systems for the utilization of pulverized coal as fuel in metallurgical operations, cement plants, and under boilers in power plants, and for the designing and installation of such systems. The new company takes over the business of the American Industrial Engineering Co. of Chicago, which has made a number of such installations, and L. H. Bergman, who has been secretary and chief engineer of the American Industrial Engineering Co., will remain as general manager of the new company. Mr. Bergman has been specializing for a number of years in the design, installation and operation of pulverized coal systems and is widely recognized as an authority on the subject, particularly in connection with the relation of furnace design to the most efficient use of this form of fuel. The Raymond Brothers Engineering Co. is a subsidiary corporation of the Raymond Brothers Impact Pulverizer Co., Chicago. The general offices of the Raymond Brothers Engineering Co. will be at 1315 North Branch St., Chicago.

THE COMBUSTION Co., 4256 North Western Ave., Chicago, Ill., has purchased from the receiver for the General Combustion Co., Chicago, the name, patent rights, drawings, patterns, trade marks and good will, including all contract records.

THE BRISTOL Co., Waterbury, Conn., on May 1 opened a new branch office at Philadelphia, Room 1311, Widener Bldg. C. C. Eagle, Jr., salesman and service engineer, is in charge.

THE ROTHACKER FILM MFG. Co., 1339 Diversey Parkway, Chicago, Ill., has made an eight-reel educational film for the Carborundum Co. entitled "The Jewels of Industry."

Two Italian chemists who have become acquainted to some extent with American methods and American materials through their war experience indicate their desire to make arrangements for representation of American firms in Italy. These men are interested in import of chemicals, chemical apparatus and related supplies. Those who desire to develop Italian markets may care to communicate with Anthony Costa, via le Observanza 22, Bologna, Italy, and Antonio Redaelli, via Lozzaro Palazzi 21, Milan, Italy.

H. H. Buckman and G. A. Pritchard of New York and Mineral City, Fla., announce that they have sold their interest in and severed their connection with BUCKMAN & PRITCHARD, INC., to the Titanium Pigment Co., Niagara Falls, N. Y., which will continue the business in the production of zirconium silicate and other specialties for enameling and affiliated service.

The pulverized fuel department of the Quigley Furnace Specialties Co. has lately been operated as the Quigley fuel systems department of the Hardinge Co., Inc. This pulverized fuel business has now been incorporated as the QUIGLEY FUEL SYSTEMS, INC., with general offices at 26 Cortlandt St., New York City. William H. Baker is president, W. O. Renkin managing engineer and L. W. Marso represents the company in the Pittsburgh district. The new company is entirely independent of the Hardinge Co., although Mr. Baker continues as vice-president and consulting engineer for the Hardinge Co. The company is just completing the largest installation of powdered coal in the world at the steel works of the Societe Anonyme Ougree-Marihaye at Liége, Belgium.

THE CENTRAL STEEL Co., Massillon, O., has appointed Frank Gibbons district sales manager of the Cleveland district, with headquarters at 904 Swetland Bldg.

THE GENERAL ELECTRIC Co. announces that following a meeting of the board of directors, held in New York May 16, C. A. Coffin retired as chairman and was succeeded by Owen D. Young, long associated with the company as vice-president. The position of president was filled by the election of Gerard Swope, president of the International General Electric Co., succeeding E. W. Rice, Jr., who requested to be permitted to devote his entire energies to the further upbuilding of the scientific, engineering and technical phases of the company's work in the broadest sense and who will become honorary chairman of the board of directors. Anson W. Burchard, for many years identified with the company as vice-president, with particular reference to public utilities and foreign investment, was elected vice-chairman of the board. J. R. Lovejoy, vice-president in charge of sales, was elected a director, as was also G. F. Morrison, vice-president.

Manufacturers' Catalogs

HENRY VOGT MACHINE Co., Louisville, Ky., is distributing, upon request, copies of its new bulletin on its new water-tube boiler, which is illustrated and described. The purpose of the bulletin is to outline the factors that should be given consideration when purchasing water tube boilers and to explain briefly the principles of design, the details of construction, and other features of the boiler.

THE CONNERSVILLE BLOWER Co., Connersville, Ind., has issued an attractive catalog, No. 20, on Connersville Cycloidal Pumps. This catalog is limited to illustrations and descriptions of cycloidal rotary pumps, which the company builds in a number of styles for a great variety of applications and in many sizes with displacements as small as 1/20 gal. per revolution and as large as 1,200 gal. per revolution. The construction of the pumps is given and also their advantages.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN FOUNDRYMEN'S ASSOCIATION is holding a convention and exhibit at Rochester, N. Y., this week. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet- at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 12.

NATIONAL LIME ASSOCIATION will hold its annual convention June 14-16 at the Hotel Statler, Cleveland, O.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

The following meeting is scheduled to be held in Rumford Hall, the Chemists' Club, New York: June 9—American Chemical Society, regular meeting.

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Consulting Editor
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Managing Editor

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
H. C. PARMELEE, Editor

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Volume 26 — New York, June 14, 1922 — Number 24

Less Politics And a Better Tariff

WHILE Republicans and Democrats alike were inclined at first to be hostile to the Senate Finance Committee's proposal to introduce an element of flexibility in the tariff, there is an increasing recognition of the meritorious features of such a provision. Sentiment in that direction is being encouraged each day as the debate drags along in the discussion of details with which Senators can have only limited knowledge. It is becoming more apparent that machinery must be set up to give an opportunity for all concerned to be heard and to make possible the adjustments that economic changes require.

Those who oppose giving the President power to alter rates see in it not only the surrender of valuable prerogatives but fear that the President will be influenced to grant favors to special interests. As is well known, the plan for a flexible tariff contemplates a study of each case by the United States Tariff Commission. The President would act only on its recommendation after the particular case had been carefully studied by that body.

The idea is to handle tariff matters in much the same way that the Interstate Commerce Commission adjusts freight rates. If Congress were to attempt to pass upon the reasonableness of railroad rates, it is very apparent that intelligent action could not be had. With the increasing intricacy of the interchange of goods between countries, the tariff is entirely comparable, in diversity, with railroad rates.

If the flexible provisions are written into the law—and it is believed on Capitol Hill that this will happen—complaints probably will be filed with the Tariff Commission just as rate cases are now initiated with the I. C. C. With machinery much like that being operated by the Interstate Commerce Commission, careful consideration can be given to all phases of the particular duty involved and ample time provided for all concerned to be heard. This usually is not the case with Congressional committees. Notwithstanding the fact that the Senate Finance Committee was unprecedentedly liberal in the time it accorded witnesses, there were many instances where millions of dollars were involved and yet only two hours could be given to the entire discussion. When it is considered that Senators have manifold duties, there is little possibility of their being able to familiarize themselves with the economic situation surrounding the thousands of articles affected by a tariff bill. Furthermore if railroad rates could be adjusted only once in four years, great inequities would be occasioned. Just such inequities are being worked by the existing tariff policy, although these will not become fully apparent until the elastic system has been put into operation. A sudden change in industrial methods abroad frequently has resulted in very serious injury to an American industry. An example is had in the Canadian process for making acetic acid synthetically from acetylene. In other cases, actual practice frequently demonstrates that a rate is too high or too low. If the lesson of experience could be applied immediately, great losses and unnecessary burdens could be avoided.

The Need of Another Hearing on Chemical Warfare

DR. JOHN BASSETT MOORE, former Counselor of the Department of State and now a member of the lately created International Court of Justice, has been appointed to represent the United States on the Rules of Warfare Commission authorized by the recent Disarmament Conference. This High Commission is to consist of not more than two representatives each for the United States, Great Britain, France, Italy and Japan. The time and place of meeting are still to be determined. The names of the other members of the commission have not yet been made public.

We have been in communication with Dr. MOORE, with a view to providing a way for the presentation of a memorial in relation to chemical warfare. He reminds us that "the commission shall be at liberty to request assistance and advice from experts in international law, and in land, naval and aërial warfare," and points out that the question of assistance and advice from experts is one which the commission as a whole rather than any single member of it is to regulate. He very naturally desires to avoid saying anything just now which might place him in an attitude of speaking for the commission in advance of its constitution and organization.

We sympathize with him in his attitude. But that does not relieve us of our obligations. The learned International Disarmament Conference at Washington concluded that there is to be no more chemical warfare. There were two opinions presented on the subject: One, that it is wise to declare that there is and shall be no such thing, and the other, recognizing its existence, to establish measures of control. The conflicting opinions were presented respectively by

1. Statesmen and lawyers who are unfamiliar with chemical and physical processes, and representatives of the military service that do not know how to use chemical warfare for offense or to meet it in defense.

2. Chemists and physicists who recognize the constant possibility of the use of these munitions and that in a conflict at arms the force that uses chemical warfare against an unprepared army is almost certain to win. Supporting these was the smaller section of the military service that is familiar with chemical warfare

in offense and defense, and that realizes its effectiveness.

The members of the conference were themselves statesmen and lawyers, also unfamiliar with the processes and principles of science, and they listened with greater favor to the talk of the uninformed than to the advice of the informed. It was the old situation with which we are familiar in industry: When science gets a hearing the listeners either will not or cannot understand.

Here is a weapon of offense that doubles the potency of munitions, that can put regiment after regiment of enemy troops *hors de combat* at once, make them prisoners of war, and yet avoid a single fatal casualty. And it can also deal death at wholesale. The wrath of man is one of the devastating forces of nature, and when it bursts out into war it is, like fire and flood, a monster of destruction. Anger is madness, and we cannot reason with madness. Now chemical warfare is a weapon already developed and at hand. At any time in future wars chemical munitions will be available, like a loaded pistol, quickly made ready for use—and we are sure to discover that to forbid their use will not prevent it.

War is different from peace. There is not even a *code duello* among nations. Consider, for instance, the many phases of "military strategy" and how criminal and dishonorable the very substance of it is in times of peace! We repeat that in time of war we are dealing with madmen. Soldiers won't fight until their wrath is aroused. And the great conference in Washington agreed that in the event of such madness no signatory power was to misbehave in the matter of chemical warfare.

What will a signatory power do if it finds itself engaged with an enemy that uses so-called chemical munitions? How binding will that agreement be when such an enemy begins to conquer?

The High Commission that is about to assemble will consist of statesmen and lawyers. It is doubtful if a single man of ripe scholarship in physical science will sit in conclave. They will be men of great legal learning and of splendid type, judged by the American representative already named. What they will need to know is the ease and secrecy with which so-called chemical munitions may be launched when the fortunes of war turn against an army in battle. They will be eminent humanists who are familiar with the workings of the human mind in peace and in war. With the facts properly presented it is to be hoped that they will not, as did the Washington Conference, close their own minds to the unfamiliar language of science.

The subject is of supreme importance because civilization as we understand it is at stake. The weapon is always at hand, and it is sure to be used. To forbid it and let it go at that is like cautioning a Sicilian, engaged in a struggle to the death with his mortal enemy in a dark alley, not to draw his stiletto, or to request a negro to keep his razor in his boot during a fight.

It is the duty of the chemists of the United States and England, France, Italy and Belgium to explain the nature and operation of chemical warfare to the High Commission so that its members can really understand. It is difficult to explain, and the situation is difficult to meet, but that does not exonerate us from our duty in trying to make matters clear. Now is the time for our chemical societies to appoint committees to get the memorials ready to present.

Labor Unions Are Suable

ON THE simple and reasonable basis that it is utterly impossible to do justice otherwise, the United States Supreme Court held on June 5, in the case between the Coronado Coal Company and the United Mine Workers, that strike funds are assessable for damages and that a labor union is suable despite the fact that it is not incorporated.

The decision is of the greatest importance, for there has been agitation for 15 years or more in favor of legislation requiring the incorporation of labor unions. The argument was that the unions were evading responsibility for their acts and escaping the penalties of the law by not incorporating. The Supreme Court now settles this matter. The evasion of failing to incorporate cannot be employed. This seems elementary. It was possible to sue before there were corporations.

The law does seem to be growing more human as we build up interpretations of it. There is the Sherman law of July 2, 1890. For several years it was thought to be so drastic as to be unenforceable, and was considered a dead letter. There was agitation for amending it by writing in the word "reasonable," which would be rather unreasonable, for a "reasonable restraint of trade" would be contrary to the general spirit of law, which requires in most cases that a motive—or reason—be shown. Some years ago the Supreme Court settled the matter by asserting that the Sherman law must be interpreted "in the light of reason," which is really a totally different thing. That is, one cannot be convicted under the law on a mere technicality. Now the Supreme Court holds that a labor union cannot escape by a mere technicality.

On various occasions Congress in making appropriations for government expenditures has provided that no part of the funds should be used for the prosecution of labor unions. The limitation was tantamount to an admission that under the law labor unions are subject to prosecution, and Congress simply degraded itself. It did not enact legislation by imposing such limitations on the expenditure of funds appropriated. The limitations were obtained simply by the activity of the labor union lobby. The issue was not raised in such a manner that the general public would take a deep interest, particularly so since an appropriation is an annual affair, while legislation is permanent unless repealed. Should the labor unions now attempt to have Congress modify the law under which the recent Supreme Court decision was rendered, the whole thing would be brought out into the open and Congress would quickly have forced upon it knowledge that the public will not tolerate legislation to exempt labor unions from the operation of the laws of the land.

Repeatedly during the past few years distinguished leaders of thought in industrial relations have urged that laws in restraint of trade be applied to capital and labor alike. The incorporation of labor unions was advocated at President WILSON'S first Industrial Conference and stanchly opposed by Mr. GOMPERS, who proudly declared that it is impossible to incorporate human souls. This was a fine gesture, but it made no impression as a sound argument. Apparently the Supreme Court has visualized the whole situation very clearly and we may reasonably hope that henceforth labor unions will act and speak with due regard to their responsibility as organized bodies of men.

Byproduct Coking Continues to Gain

DESPITE the interruption of coal supply by the strike the output of byproduct coke has continued to increase since the first of the year until in April 2,227,000 tons was made. This represents about 90 per cent of the rate of production in 1920, when the average output was the maximum ever attained in the history of this industry—namely, 2,565,000 tons per month.

Not only is there this evidence that the byproduct industry is progressing steadily toward high-capacity operation, but also it has recently been announced that a tremendous extension will be made of the coke plants of the Eastern division of the U. S. Steel Corporation. It is stated that another plant even larger than the present Clariton plant will be erected in the near future in order to insure that the metallurgical coke supply of the East will be maintained without dependence upon the beehive branch of the industry.

Long ago the ultimate doom of the beehive oven was foreseen. But the war period and industrial conditions since the war show that even the more optimistic prophets were not unduly sanguine. Already much over half the coke supply comes from byproduct ovens. Soon it will be three-quarters of the total, and one might even dare to forecast that within a decade the beehive branch of the coke industry will be an altogether negligible part of the total when figuring the industry on a national basis. Locally it will, of course, remain in many districts an important or even dominating factor. But as a whole the more efficient system, the one which conserves the more valuable portions of coal will prevail.

Setting a Bad Example

ANNOUNCEMENT has been made by the American Petroleum Institute that hereafter the hydrometer scale with the modulus of 141.5 will be known as the "A.P.I. scale" (American Petroleum Institute scale). Thus at last the petroleum industry recognizes that hydrometers made according to this standard cannot properly be called "Baumé." Also this terminates the long-standing controversy between the Bureau of Standards and the petroleum industry regarding testing and use of this type of instrument.

It is most unfortunate that commercial considerations prevent the petroleum industry from abandoning altogether this hydrometer standard. It has no real excuse for existence on the score of science or technology. It originated from erroneous manufacturing practice and the fact that it has been permitted to take root and grow up within this industry is certainly not to the credit of petroleum technologists. It is commendable, however, that the scale is now recognized by a distinctive name and that the industry no longer attempts to use the A.P.I. standard under the name Baumé, as has often been the former practice.

There is really a question in our own minds as to whether the reasoning which led to the perpetuation of this standard is sound. The industry feels that a change in hydrometer standard would mean a change in specifications that would be unacceptable to the customers or else the loss of the certain fraction of a degree just at the limiting point of gravity specifications. This small change in the limit of gravity would be particularly important on such products as gasoline and would have real dollars-and-cents significance. Nevertheless it does seem unfortunate, to say the least, that the actual gravity of petroleum products cannot be recognized by hydrometer specifications which are acceptable in other industries and which could for all but this one commercial reason quite readily be used in petroleum marketing. It is certainly to be hoped that other industries will not emulate this example of special standards, for we already have far too many methods of expressing specific gravity.

Old Man, Go Back to School

OVER fifty years ago HORACE GREELEY created a magnificent slogan. When he said: "Go west, young man," he stimulated the imagination of the youth of his day and many followed his advice. We have no such slogan, but we have a message, "Go back to school, old man!" Study some more. Round out your development. Enlarge your point of view. There's an answer to "Why?" and "How?"

It is true that there are fewer chemists unemployed now than there were in August, so our friends in the employment bureau of the Chemists' Club tell us. Nor will there be great difficulty in placing this year's crop of graduates. It is also true that some firms are waiting till this year's graduates are ready before filling in their organizations because they are looking for cheap men. But what will be the fate of these graduates in industry? Their position almost without exception will be routine. Advancement will usually be very slow and a dead wall will be encountered over which there is no jumping in that company. Another company will treat them little better. Gradually from the control laboratory they will drift into the plant. Their progress will always be slow because they have not the technical equipment for pulling themselves above the average. This has been the experience of the vast majority of chemists and chemical engineers in the past. Their salaries remain low and their work stays routine.

As distinguished from the average is the group of chemists and chemical engineers who have taken this additional training. In general their progress through the research and operating departments is more rapid. They hold the desirable positions both from the standpoint of compensation and of interest. They had completed a college course before they entered professional training and then they had returned for graduate work and training in research. In short, their more mature mentality was stimulated by their study.

These two classes are not completely differentiated. They overlap. Men without additional training dominate. Men with it are submerged in routine. But the distinction is there. There is no escaping the essential fact. Success is in proportion to background, education and training.

And this year with the average weekly wage probably less than $25 and with the general history of the profession as it is, "Go back to school, old man." With two or three years of research behind you and with the true significance of Ph.D. after your name your services are much more easily marketable. With a year or two of research you will be able to lift yourself out of the technical routine. With a year or more of engineering studies or advanced courses you will be out of the routine class. Beg, borrow or—no, don't steal, but work for your expenses. It can be done. And the return on the investment is several hundred per cent.

Readers' Views and Comments

Atmospheric Pollution From Sulphuric Acid Plant Fumes

To the Editor of Chemical & Metallurgical Engineering

SIR:—I desire to call attention to two omissions in the article on "Atmospheric Pollution From Sulphuric Acid Plant Fumes," which you published under my name in your issue of May 24, 1922. Your readers may recall that the writer, in summing up the work of the committee of the American Institute of Chemical Engineers, stated that "the report of the committee places squarely upon the shoulders of the Manufacturing Chemists' Association the responsibility for further advances and action in this matter. Unfortunately in your abbreviation of the manuscript, however, you omitted the particular paragraph in the official report of the Institute's committee on which my statement had been based. That paragraph reads:

> The committee believes legislation and regulation concerning atmospheric pollution are more properly the subject for action by the chemical manufacturing associations, but that the Institute should hold itself ready to co-operate with such associations when called upon.

Of somewhat less importance but nevertheless of current interest in connection with the paper Dr. O'Gara is to present before the Institute's meeting at Niagara Falls on June 19 is the second omission:

> Your committee has especially requested Dr. P. J. O'Gara, head of the department of agriculture and semelter byproducts investigations of the American Smelting & Refining Co., Salt Lake City, Utah, to publish at the earliest possible date the conclusions of his notable work on atmospheric pollution.

I am grateful to you for the opportunity of bringing these matters to the attention of those of your readers who are interested in the important subject of atmospheric pollution.

JAMES R. WITHROW.

Columbus, Ohio.

Electric Steel in California

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the May 3 issue of CHEMICAL & METALLURGICAL ENGINEERING the author of the article on the Electric Steel Plant at the Southern Pacific Shops made certain statements upon which I desire to comment.

Under the subject of "Cost," in the second column, the statement is made that the electric furnace was selected for this plant on account of a smaller production cost, when compared to other forms of melting equipment. In referring to open-hearth operations the author then continues: "Inability to obtain 'hot metal' for the open-hearth furnace militated against this process." I do not see why any plant in California should exclude the open-hearth furnace from an installation on this account. California already has open-hearth furnaces in operation producing over 30,000 tons of steel a month, using scrap only, scrap and ore, or cold pig scrap and ore. These furnaces are producing ingot steel at less cost than can a Heroult furnace of the capacity described, comparing steel of the same grade and analysis. The inability to obtain hot metal is no well-founded reason for eliminating the open-hearth furnace, with the conditions for steel manufacture and supplies of raw melting stock existing on the Pacific Coast. The engineers who decided the choice of furnace for this plant may have desired to use the hot metal pigging process, but this is no interference unless an iron blast furnace were operating with a hot metal surplus from its casting requirements.

The author states also, "Furthermore, on account of the refractory nature of California iron ores, the erection of a blast furnace in this region is a very distant possibility." There are no refractory iron ores in California, considered as commercial ores of iron. The *nature* of the iron ores from a metallurgical or chemical standpoint has not contributed to the delay in establishing blast furnaces and reduction plants. In Placer County a plant operated in 1881 and produced over 5,000 tons of merchantable iron. The fact that California magnetites and hematites are suitable for pig-iron production has been demonstrated and proved since 1881, and in recent metallurgical history they have been proved suitable for electric reduction also. There seems to be current rumor in certain uninformed and misinformed circles on the Western Coast that the iron ores are not suitable for iron production. Until I read this article I never heard of a California iron ore as exhibiting any "refractory nature," and I have been working on the Pacific Coast with such ores since 1909.

R. C. GOSROW,

Chicago, Ill. Metallurgical Engineer.

Ido, the New Universal Language

To the Editor of Chemical & Metallurgical Engineering

SIR:—I note with interest the letter on "Ido, the New Universal Language," by Earl Walter Sutton, and I believe it will help the cause of introducing the international language. He said at the end, in regard to Europe: "I am informed that Esperanto is there meeting with the fate of Volapuk—obscurity." I believe he is wrong in this, as I follow the Esperanto movement quite closely and only wish it were spreading with the same rapidity in America as in Europe.

The difficulty that we international language people are chiefly confronted with, it seems to me, is prejudice against any artificial language. It would, therefore, be a good thing if all of us international language people could get together and agree not to throw one another down, or claim special perfection as against the others, but try to overcome the inherent prejudice of humanity.

In an article recently published in the new International Year Book, 1921 (Dodd, Mead & Co.), the writer of international languages seems to think that Esperantida (the latest) is going to win out.

I wish Mr. Sutton would put these three languages in parallel columns and let us know without prejudice what he thinks of their respective merits. I believe he would find that there is not 5 per cent difference in their virtues; hence the more reason for getting together and letting the truth hit where it will.

G. W. LEE,

Librarian, Stone & Webster, Inc.
Secretary, Esperanto Association of North America.

Boston, Mass.

Meeting of American Foundrymen and Institute of Metals

Rochester Entertains Foundry Trades—Prominent Metallurgists From Europe and Canada Guests of the Association—Ten Technical Sessions on Various Phases of Iron, Steel and Non-Ferrous Foundry Technique—Attention Also Paid to Industrial Relations

AFTER an interval of 18 months, spanning the business depression, the American Foundrymen and the Institute of Metals held a very successful joint meeting at Rochester, N. Y., June 5 to 9. According to custom, an extensive collection of modern foundry and shop equipment and supplies was on exhibition by over a hundred manufacturers and firms, and was visited by large numbers.

The selection of meeting and exhibition places was much happier than the last. Rochester possesses far more hotel accommodations than Columbus—an important detail bearing upon the enjoyment of any gathering—and the local committee having this matter in charge was very efficient. Technical sessions and the exhibits were held in Exposition Park, where a number of substantial buildings are set amid charming lawns, trees and flowers. Indeed, out of doors provided active competition with the business of the day.

As usual, many entertainments and plant visitations were provided. Governor Allen of Kansas was the principal speaker at the annual banquet, which, as is usual nowadays, was converted into bedlam by a company of "musicians" whose principal claim to fame is the possession of tremendous lungs and amazing endurance. Not the least of the feature events was a boat ride on Lake Ontario, where, in the apt language of the official announcement, "Lunch and supper will be served and refreshments will be provided continuously."

European Exchange Papers

Shortly after the Columbus convention the A.F.A. completed arrangements with the Institution of British Foundrymen for each association to have prepared annual exchange papers. Since that time the Association Technique de Fonderie de France and the Association Technique de Fonderie de Liége, the foundry associations of France and Belgium respectively, have consented to join in this arrangement, to promote greater friendship and respect of the foundrymen of these countries for each other.

F. J. Cook, of Rudge-Littley, Ltd., West Bromwich, Birmingham, England, presented the first exchange paper of the Institution of British Foundrymen, entitled "American vs. British Gray Cast Iron." Experience with poor quality of cast iron contained in many imported American machine tools, and reports appearing in American papers of failures of flywheels or of parts passing superheated steam have given the English foundrymen the impression that their gray cast iron is distinctly superior. While the methods of casting and breaking test-bars vary considerably in the two countries, it is possible to allow for these factors in making comparisons, and the author's works never produces metal testing as low as the electric furnace American iron described by George K. Elliott having similar silicon content but much lower sulphur and prosphorus.

Englishmen give especial attention to the relative amounts of combined carbon and graphite carbon, seeking a microstructure which contains (under 1,000 magnifications) fairly large areas of well-defined, laminated pearlite partly inclosed by thick sheaths of cementite, and relatively small thin graphite flakes. Silicon, sulphur and phosphorus are not so closely considered in England; in Mr. Cook's opinion, the distribution of phosphorus is of far more moment than its amount. If, after deep etching with 20 per cent HNO_3, bright, well-defined veins appear in a dark background (under 30 magnifications), the metal may be confidently expected to be far superior, even double in tensile strength, to an iron of the same chemical composition which appears with mottled, poor contrast after the same treatment. The author also expressed the opinion that this characteristic clear definition of phosphide existed in the pig by virtue of manufacture in slow-running furnaces with blast not over 900 deg. F., and persisted throughout subsequent melting.

New French Electric Furnace

R. Sylvany, of the Association Technique de Fonderie de France, described an electric furnace employed at Jarville during the war for the deoxidation of converter metal. Using 1,000 kg. per heat, with 3,000 amp. direct current at 80 volts, 8 tons of metal was handled per 24 hours, or one heat in 3 hours. The furnace is a closed crucible, set in a tilting device. It is charged and poured through the top, normally closed by a tight fitting cover. Through this cover passes a sheathed carbon electrode, of cross-section about half that of the crucible. Direct current is used; this electrode is positive and becomes hollowed out into an efficient heat reflector. Refining appears to be quicker with direct current, possibly because free oxygen is immediately attracted to the carbon electrode and consumed.

A strong magnesia bottom is shaped into a trough, to contain the first molten metal which forms electrical contact with a bundle of pure iron wires at either side, imbedded in a mixture of magnesia and tar, and united at the ends to give good contact. These electrodes operate during the melting or preheating period. For refining, current is drawn from the bath near its surface by an upper row of electrodes consisting of a great number of 10-mm. wires set into the side lining. Use of many small metal conductors gives uniform distribution of the current to all parts of the slag layer, and it is rapidly heated to attain correct fluidity and intense chemical action.

European Malleable Iron

Recognizing the evident superiority of American malleable iron, and its ability to compete with steel

castings, T. Levoz, of Auxonne, France, described efforts which the Europeans were making to improve their product. He ascribed the failures due to scoured molds to oxidized metal rather than superheated metal. Therefore it is essential that malleable shall be melted in furnaces capable of producing hot metal without forming ferrous oxide. Few European foundries have an output which warrants a reverberatory furnace; a cupola puts far too much oxygen into the metal; the crucible requires fine raw materials or excessively high temperatures. Germans have solved the problem by melting in the cupola and then blowing out the silicon in a side-blown converter. If a bottom-blown converter is used, ferrous oxides remain after the silicon has gone, and are reduced by carbon more or less promptly with the absorption of heat. Consequently the metal is chilled, it boils, traps slag, and liberates graphitic carbon at the moment of solidification even if it has been superheated sufficiently to pour a good casting. Using a side-blown converter and deoxidizing with aluminum, good results were obtained in France during the war.

Subsequently an electric furnace was added, making a triplex process. It is recommended that the cupola be provided with double row of tuyeres, thus separating the combustion zone from the fusion zone. A side-blown converter must be used, which ejects the slag as fast as it is formed and produces ferric oxide at the surface of the bath. An electric furnace then holds the metal for the necessary refining operations. Such hot, clean metal pours into castings of superior surface condition and even of very thin section, and can remain in the sand until quite cold. After annealing the physical properties approach those of cast steel.

One great advantage of the combination of equipment described is that the foundry possessing it can produce at will any kind of iron or steel casting.

Steel Castings

"Analysis Control in Acid Electric Steel Practice" was discussed by A. C. Jones, of the Electric Steel Co. of Chicago, who stated that off-analysis heats are often far more costly than imagined. A prolific cause of off-heats is frequent and unnecessary changes in furnace practice, trying to correct some fault which is not due to the quality of the metal. Continuous production of standard analysis by a carefully devised routine in a tight furnace will of course give the least trouble. Bridging over unavoidable delays is often done by charging heavy scrap into the hot empty furnace; this charge will lose more Si, Mn and C because it will be excessively oxidized during the wait. Especially avoid current interruptions during the melting-down period.

Low silicons are usually due to excessive oxide in rusty scrap or slow melting. The slag resulting is thin and watery, holding less than 30 per cent SiO_2. It should be partly removed, some silica sand scattered over the bath, bringing the refining slag to 50 to 60 per cent SiO_2, and the melt then thoroughly stirred. Finally add enough high-silicon pig to bring to analysis.

High silicon in just melted metal is recognized by very quiet metal when making a temperature test. It is often caused by reduction by carbon, if the melt contains more than 0.25 and is very hot. Excess silicon is best reduced by stirring in sufficient ore.

Carbon is seldom too high, unless there is electrode trouble. It can be lowered somewhat by an excessively siliceous slag, but the reaction adds silicon to the metal. Oreing down may be resorted to, but at greater time, expense and wear on furnace. Carbon can easily be brought up by pigging at the end of the heat; or in case all other elements are high, by dipping the electrodes into the metal.

Open-Hearth Design

Willis McKee, of Cleveland, Ohio, described recent advances in open-hearth design, particularly in reference to the use of water-cooled equipment about the ports, which enables a "blow-torch" flame to be maintained consistently. He further recommends eliminating gas-regenerating chambers, locating the producers close to the furnace and introducing the gas into the air uptakes directly. Using the blow-torch principle, the air and gas thoroughly mix before issuing into the furnace. The combination is at a good temperature, because the air has a higher temperature than usual, since its checkerwork is heated by the entire waste gases from the furnace. Furthermore, the scheme saves a checkerworkful of gas at each reversal, and enables many economies to be effected in the construction of the furnace.

Non-Ferrous Sessions

Physical Properties of Cartridge Brass

C. Upthegrove and W. G. Harbert, of the University of Michigan, presented a brief paper of the above title giving data to show that the differences in temper in brass persisted after cold-working. For instance, a coarse-grained brass resulting from a high anneal was softer than a fine-grained, low-anneal brass, and remained softer after equal amounts of work had been done upon them. (Heavier reductions naturally increase the hardness, but did not change the relationship.) These hardnesses persist and even increase slightly upon annealing at 200 deg. C., whereupon recrystallization sets in, progressing most rapidly for those having heavy cold-work, and all differences in hardness disappear after annealing to 550 deg. C., when a hardness of 60 Brinell (500 kg.) appears for this analysis—68.5 Cu, 31.5 Zn. Higher anneals cause this figure to fall slightly. (Brinell 43 at 750 deg. C.)

Electrical Properties of Nickel and Monel Wires

Supplementing data published in Bureau of Standards Circular 100, Messrs. Hunter, Sebast and Jones, of Rensselaer Polytechnic Institute, showed that nickel wires of lowest resistance (specific resistance 7.55 to 7.60 microhms per cm. and temperature coefficient of 0.0056 ohm per degree C. per ohm at 20 deg. C.). may be made in limited amounts by slitting a sound cathode sheet and rolling it into a wire.

If any quantity of such material is desired, the purest metal must be melted by having a hot vacuum furnace so designed to receive a charge of, say, 5 lb., and melt it very quickly so as to pour within a very few minutes. Even then about 0.75 per cent of manganese must be used to make a sound casting. Under such circumstances the specific resistance of 9.12 with temperature coefficient of 0.0049 may be had. The authors also publish curves comparing the relative resistance of electrolytic nickel, grade A, C and D, and Monel metal at temperatures varying from 20 to 1,000 deg. C. As would be expected, the specific resistance rises and the temperature coefficient falls with growing impurity. Furthermore, the curves show definitely the reversible

magnetic transformation at about 360 deg. C. to be lowered progressively with increasing impurities, arriving at 93 deg. C. for Monel. Magnetic releases operating at any temperature between those limits could apparently be constructed of nickel alloys of varying purity.

Embrittlement of Copper Wire on Annealing

Another evidence of the extreme sensitivity of high-grade metal to foreign substances was cited by T. S. Fuller, of the General Electric Co. He found that if high-conductivity copper wire was packed in sea sand in a closed iron pipe and annealed 1 hour at 800 deg. C. in an electrically heated furnace, it was rendered so brittle it would break on a right-angle bend. The trouble was thought to be due to reduction of CuO by hydrogen or carbonaceous gas derived from the steel or organic matter in the sand, whereupon some resulting gases of slow diffusibility accumulate in sufficient volume to wedge the grains apart—at least at the surface, the most dangerous region. Oxygen-free copper was not made brittle. Neither was commercial tough pitch wire, annealed in Al_2O_3 in a porcelain tube, or annealed in calcined sand in an electrolytic iron tube.

N. B. Pilling, of the Westinghouse Co., pointed out that copper may be deoxidized in molten c.p. salt, by H_2 derived from the dissociation of traces of water of crystallization. In fact it is at times extremely difficult to maintain non-reducing atmospheres. At other times copper does not seem to be so sensitive to its surroundings, as witness the everyday performance of brazing operations.

Technical Control in the Foundry

E. H. Dix, Jr., described the foundry at McCook Field, Dayton, Ohio, where all the castings for experimental aircraft parts are made and where the design and alloys are perfected before contracts are let for larger quantities. Their furnace equipment consists of stationary and tilting crucible furnaces, and a high-frequency induction furnace for melting refractory alloys or hardeners. Temperatures during melting and pouring are controlled carefully—base metal thermocouples protected by iron tubes are used in aluminum alloys. For quick readings iron-constantan "pyods" are useful. Bare No. 6 gage chrome-alumel wires spread wide apart may also be used—they waste away slowly, but are easily re-welded, and the metal lost does not harm the alloy. In brass or bronze a chromon tip protecting tube has been very satisfactory. Following is a table of temperatures used for the small castings used in aircraft:

Alloy	Melting Point Liquidus, Deg. F.	Maximum Furnace Temp., Deg. F.	Pouring Temp., Deg. F.
Cu 8, Al 92	1,148	1,400	1,200 1,300
Cu 10, Al 90	1,130	1,400	1,200 1,300
Cu 85, Sn 5, Zn 5, P 5	1,780	2,000	1,950
Cu 88, Sn 10, Zn 2	1,825	2,200	2,050
Cu 80, Sn 10, Pb 10	1,735	1,950	1,900
Cu 60, Zn 37+3 Hardener	1,600	1,800	1,700 1,750

An extended study has been made in order to locate the correct way to place a test coupon or to cast a test-bar so that it will really represent the condition of the finished casting. Separately cast test-bars have been decided upon; thereby all disputes as to methods of gating may be avoided. In correlating the properties given by such standardized test-bars to those of important castings it is the practice to pour several full-sized castings from the same heat, and those castings are tested as nearly as possible under the same stresses as they will receive in service. Many different heats are cast, varying the pouring conditions and the disposition of gates.

Microscopic examination of all heats is made. All the data—pouring conditions, physical tests, chemical analysis and metallography—are then collected on one card and filed. With a sufficient accumulation of such data, it is thought that in time very definite and valuable indications may be derived from the microscopic examination.

Metallic Oxidation at High Temperatures

One of the most important papers of the meeting was presented by N. B. Pilling and R. E. Bedworth, of the Westinghouse Co., in that it gave a new and stimulating idea on the subject of corrosion. The authors confine their attention to oxidation by atmospheric gases at high temperatures—i.e., temperatures where the solid phases participating in the reaction diffuse with high speed, and this diffusion has become the dominant force.

In the first place, noble metals are separated from base metals by the fact that the dissociation pressure of the oxides of the noble metals are equal to or above atmospheric pressure at temperatures below the melting point, whereas the corresponding values for the base metals are extremely minute. But the character of the first-formed oxide furnishes a further classification of base metals: If the layer of oxide formed takes up more space than the volume of metal which was oxidized to produce it, the oxide layer forms a tight fitting, solid sheet, thus impeding further oxidation. Computations made on this basis for twenty-three metals separate those which oxidize readily from those which do not. Some of the former—having a porous or cellular oxide structure—have been shown to oxidize at a uniform rate until all the metal has vanished. Compact oxide coatings, however, have been shown to grow at a rate which varies inversely as the thickness—i.e., "the speed of the reaction is not determined by any property of the metal at all, but by some combination of physical properties of the oxide." These properties of the oxide coatings are discussed, and an equation derived between the rate of oxidation and the temperature which closely agrees with experimental values.

Leady Bronze, So-Called "Engine Brass"

R. E. Lee and F. B. Trace, of Allegheny College, told in an interesting manner of an investigation undertaken to determine proper foundry practice to produce Cu: Sn: Pb alloys containing up to 30 per cent Pb without "segregation"—i.e., with a structure simulating that of a eutectic—despite the fact that the system is not truly eutectiferous and that 15 per cent is sometimes spoken of as the limit for lead in such alloys. Sometimes high lead is handled by addition of nickel or other "carrier."

It was found, however, that if the melt was superheated to 2,000 deg. F. (or 200 deg. higher if all virgin metal was used), deoxidized by phosphor copper and skimmed, the metal, which formerly tended to separate into two immiscible layers, becomes capable of more intimate mixing or even is mutually soluble. The charge is quickly dumped into an oversize pot, which gives the necessary stirring, and also chills it to 1,800 deg. F., whereupon it is poured into firmly rammed sand molds, and cooled in the mold. When a 5x10½-in.

bearing is made in this way it possesses high strength, and a fracture shows a uniform light color, free from dark "segregated" spots, even though it contains no nickel. Well-selected scrap may form all the charge except necessary additions to bring to analysis.

Melting Furnaces for Brass and Aluminum Alloys

A posthumous paper by T. H. A. Eastick emphasizes the fact that no "best" furnace or fuel existed for copper alloys. N. K. B. Patch, of the Lumen Bearing Co., agreed emphatically, saying that successful melting is a combination of fuel, furnace and brains, and if sufficient brains are available, almost any furnace will do. Therefore the character of the available help is as important as the first cost of a furnace or the fuel cost. The electric furnace is of considerable advantage in holding down melting losses in certain alloys which must be poured very hot, but often the open flame furnace will do just as well if the atmosphere is properly maintained. Jesse E. Jones, of the Westinghouse Co., recommended that large foundries diversify their equipment and thus be ready for any emergency, citing an incident where Mr. Marconi provided three independent sources of current to make sure that certain demonstrations would not fail for lack of power. Two sources did fail, but the third worked!

Aluminum foundrymen were unanimous in saying that a satisfactory furnace of large capacity was yet to be designed. When this arrived it would probably be an electric furnace, because the atmosphere is most easily controlled, although present designs left something to be desired. Robert J. Anderson, of the Bureau of Mines, in presenting his paper entitled "Aluminum and Aluminum-Alloy Melting Furnaces," recommended for sizable foundries an open flame furnace, barrel shaped, about 12 ft. long by 6 ft. in diameter. This should be operated with close temperature and atmospheric control, and additions of pig made periodically to match pourings, so as to maintain a molten bath at all times.

Apparently the iron pot holding 400 lb. of Al is widely used, even by large foundries, and many members spoke of methods whereby the life and performance could be bettered. Mr. Anderson said that forty-seven heats per pot was the average of many reports in his hands, and that the chemical composition of the iron did not seem to have much influence. A sound gray iron, preferably low in carbon, silicon and phosphorus, was as good as or even better than more expensive high-silicon irons. Many pots would fail in a very few heats, but that was ordinarily due to defective molding practice. W. M. Weil, of the National Smelting Co., said it was perfectly possible to get 300 heats from an iron pot if properly cared for. In the first place, the furnace setting should be deep, with at least 1 ft. for a combustion chamber below the pot. The burner is placed tangentially at the very bottom, so that the swirling flame envelops the pot without striking it. Furthermore the burner should be operated with a very slight deficiency in oxygen, so that scaling would not waste the pot and obstruct the heat flow. The inside of the pot is sand-blasted during the night and painted with lime and silicate of soda. It was further recommended that the pot be made somewhat deeper than the diameter, to reduce the surface of the bath.

John A. Lange, in a paper, "Melting Aluminum for Rolling Into Sheet," described the development of a quick melting furnace which on long campaigns has given the following performance:

	Charge		
	Virgin Metal	Clean Mill Scrap	Oily Stamping Scrap
Melting loss	9%	16%	31%
600 b.t.u. gas per 1,000 lb. Al	2,500 cu.ft.	2,800 cu.ft.	2,900 cu.ft.
Wt. of charge	1,100 lb.	850 lb.	850 lb.
Time to melt	23 min.	23 min.	23 min.

This furnace is also shaped like a drum, the chamber being 33 in. in diameter and 96 in. long, and tilts when pouring. One end has a 9-in. pouring opening, while the opposite has an 18-in. charging and skimming opening, closed by a swinging door, reducing the opening to 9 in. for the burner. Automatic air-gas mixing valves were installed. The drum makes a complete revolution in 4½ minutes, a feature which promotes uniform and rapid melting. The lining is of special 5½-in. low-silica firebrick, which withstands 10,000 heats.

About 1 lb. of cryolite is charged with the cold charge, and when melted about 4 oz. of $ZnCl_2$ scattered over the bath and the dross immediately skimmed. Temperatures of the furnace atmosphere should not exceed 1,800 deg. F. Metal is poured at 1,250 deg. F. into cast-iron ladles containing ½ teaspoonful of $ZnCl_2$, skimmed and poured into open-top slab molds about 12 x 18 x 1¾ in.

Natural-Gas Gasoline in 1921

The output of natural-gas gasoline in 1921 increased 23 per cent over that in 1920, but the market for natural-gas gasoline was rather unstable because of the depression in the petroleum industry, according to a preliminary statement of the United States Geological Survey. The statement is based on incomplete returns from the producers and is subject to revision. Seventy-five per cent of the output was recovered at compression plants and the remainder at absorption plants. The average daily production was 1,297,000 gal., as compared with 1,054,093 gal. in 1920. The average production per plant in 1921 was 408 gal., compared with 333,400 gal. in 1920.

A decrease in the value of natural-gas gasoline was naturally produced by the breaking of the market due to the depression in the petroleum industry. The total value in 1921 was about $6,000,000 less than in 1920. The prices received by the producers declined to 8 cents a gallon, and the average price as computed from the total output in 1921 was 5 cents less than in 1920. Although the output was greater, 5 per cent less gas was treated, so that the plants showed increased efficiency in 1921. The average yield of gasoline per thousand cubic feet of gas was 0.2 gal. greater in 1921.

Texas has become an active field for the natural-gas gasoline industry, with an output in 1921 that was 172 per cent greater than in 1920 and occupied second place in the list of producing states. California also increased its production, but West Virginia, which was second in rank, showed a decrease and occupied fourth place.

The following figures are for unblended natural-gas gasoline. It is understood that blending with higher grade gasoline is essential before the product can be used for motor fuel.

	Compression and Vacuum Process		Absorption Process	
	1920	1921	1920	1921
Number of plants	967	957	187	204
Gasoline produced, gal.	281,131,973	355,346,900	103,611,949	118,311,600
Average price per gal., cents	17.9	13	20.8	17
Estimated volume gas used, 1,000 cu.ft.	112,887,802	134,817,400	383,543,150	344,609,200
Average yield of gasoline per 1,000 cu.ft., gal.	2.49	2.6	0.27	0.4

Hydrogen Peroxide—A Novel Process for Its Manufacture

By H. A. Doerner

THE following experiments were carried out at the plant of the Chemical Products Co. in the year 1916 and the results of the work are embodied in a patent owned by that company. At that time the company was manufacturing hydrogen peroxide, using the usual phosphoric acid method, and was having difficulty in obtaining a supply of phosphoric acid of satisfactory quality. There were impurities in most of the acid then obtainable, which resulted in an inferior product. The expense of purifying the acid would have been serious and the plant was not equipped to do it. This situation led to an attempt to find some substitute for the phosphoric acid.

Since the barium salt formed by the action of the acid on barium peroxide must be separated from the hydrogen peroxide solution produced, it is evident that an acid which gives an insoluble barium salt must be used unless distillation is employed. Sulphuric acid cannot be used except in conjunction with phosphoric, because free sulphuric acid causes decomposition of the hydrogen peroxide. Carbonic acid is the only other cheap acid which forms an insoluble barium salt. Textbooks on chemistry state that hydrogen peroxide may be prepared by slowly adding barium peroxide to a carbonic acid solution according to the equation

$$BaO_2 + H_2O + CO_2 = BaCO_3 + H_2O_2$$

The use of carbon dioxide would effect three important advantages:

1. No impurities would be introduced by the acid.
2. The byproduct, barium carbonate, is more valuable than the barium sulphate produced by the usual method.
3. Carbon dioxide is cheaper than the phosphoric and sulphuric acids required by the usual method. Since the cost of liquid carbon dioxide as placed on the market is largely due to the expense of liquefying and to the overhead on costly containers, this economy can be greatly increased by operating the process near to a source of carbon dioxide, and using the gas at comparatively low pressure.

Experimental Tests Encouraging

Preliminary experiments in the use of carbon dioxide were not encouraging. The gas was bubbled through an emulsion of barium peroxide in ice water. The hydrogen peroxide decomposed nearly as fast as it was formed. Slowly adding the barium dioxide to ice water through which the carbon dioxide was bubbling gave only slightly better results. Nothing approaching commercial requirements in recoveries or strength of product could be obtained by the method as described in textbooks.

In comparing these experiments with the commercial method it seemed probable that the failure of the former was largely due to the fact that an excess of carbon dioxide could not be maintained because of its slight solubility and slow absorption in water. An excess of barium peroxide, even if local, will cause decomposition and loss of hydrogen peroxide as shown by the reaction

$$H_2O_2 + BaO_2 = Ba(OH)_2 + O_2$$

It seemed reasonable to expect that if barium peroxide were slowly added to a solution of carbon dioxide which was maintained at a relatively high concentration by means of an atmosphere of carbon dioxide under high pressure, a condition analogous to that in the usual method would then exist and good results be obtained.

We were unable to devise an experimental apparatus which would accomplish the above-mentioned conditions without involving a greater expense than would be permitted. The difficulty lay in the problem of slowly feeding the barium dioxide into a chamber having a high internal gas pressure. So we decided to see what results could be obtained by treating an emulsion of BaO_2 (barium peroxide) and water to a high pressure of carbon dioxide gas. To this end we made a reaction chamber of pipe fittings consisting of a 2-in. sleeve closed at one end by a cap and connected at the other end by means of a bushing and a ¼-in. pipe to a cylinder of carbon dioxide. The chamber was charged with an emulsion of barium dioxide and water, tightly closed, cooled to 4 deg. C. by an ice pack, connected to the cylinder of carbon dioxide and the pressure turned on to 80 lb. pressure for 20 minutes, during which time the reaction chamber was kept agitated in order to facilitate the rapid absorption of carbon dioxide.

The completion of the reaction can be judged by the fact that during the reaction carbon dioxide must be continuously supplied in order to maintain the pressure, but when the reaction is completed the pressure will remain constant without such addition. The pressure was then released, the reaction chamber opened, the charge quickly filtered and tested to determine the percentage of hydrogen peroxide recovered. This was calculated as follows:

A weighed portion of barium peroxide in a measured quantity of water will give a hydrogen peroxide solution of definite strength if perfectly converted. The ratio of the actual strength (as determined by titration with permanganate) to the theoretical strength gives the percentage recovery. A large number of such tests were made with various conditions of time, pressure, amount of charge, etc. The results ranged from 50 to 80 per cent recovery. They indicated that the carbon dioxide was absorbed as rapidly as the barium peroxide could dissolve, thus maintaining an acid condition even in the presence of an excess of barium peroxide.

The Commercial Unit

These results were so encouraging that it was decided to proceed at once to an apparatus of commercial size, as the problem of feeding the barium peroxide into the reaction chamber could be worked out more easily than in a smaller device. A 6 x 6-ft. vertical cylindrical iron tank was provided with a mechanical stirrer, a false bottom of canvas filter cloth supported by a wooden frame, and an outlet pipe with valve under the false bottom. Access to the interior was obtained by a manhole having a tightly fitting cover. Valve-controlled inlets for compressed air, carbon dioxide and barium peroxide emulsion were provided, also pressure gage, small outlet cock for taking samples and a thermometer well.

Our most difficult problem was to introduce the barium peroxide into the pressure tank, and we tried a number of different pumps without success. We also tried to feed the barium peroxide as a dry powder through a cock in which a rotating plug provided with a small depression or pocket was substituted for the ordinary plug having an opening clear through it. It was hoped that as the plug rotated the barium peroxide

would fall from the hopper above into the depression in the plug and be carried around and dropped into the reaction chamber. The device failed because it was impossible to prevent excessive leakage of gas and also because the barium peroxide powder refused to drop consistently into and out of the pocket of the rotating plug, due to its cohesive nature.

We also made an emulsion of barium peroxide with water and tried to pump it into the reaction chamber with several different types of pumps. None of these pumps could be kept in operation for any length of time due to the tendency of the barium peroxide to settle out in the valves and thus prevent them from operating. These deposits would set into a hard cement, and this tendency was increased by any carbon dioxide which might force its way back into the pump system.

Solution of Feeding Problem

This difficulty was never completely overcome, but we finally devised a simple single-stroke plunger pump using ordinary brass check valves, which operated fairly well and could be cleaned easily and quickly when necessary. I believe that a more satisfactory method would be to emulsify the barium peroxide in a small auxiliary pressure tank and permit it to run by gravity into the reaction chamber after equalizing the pressure in the two. It would be necessary to use some other means than a direct application of the carbon dioxide atmosphere for equalizing the pressure, because reaction would then take place in the emulsion chamber and the hydrogen peroxide formed would be destroyed by the excess of barium peroxide.

Our procedure was as follows: A mixture of about equal weights of ice and water was put into the reaction vessel, all openings closed, the agitator put in operation and carbon dioxide admitted to about 60 lb. pressure.

A 100-lb. batch of barium peroxide emulsified in 200-lb. ice water was prepared in a small mixing tank and pumped into the reaction tank at a rate which required from 2 to 3 hours to handle four batches, a complete run. From time to time samples were withdrawn and tested for percentage of acidity, and the pump speed and carbon dioxide pressure were regulated accordingly. We found that the best results were obtained at about 0.2 normal acidity, alkalinity and high acidity both causing decomposition and loss of hydrogen peroxide.

Irregular action and sometimes complete failure of the pump caused by barium peroxide settling in the valves and pipes frequently caused the acidity to fluctuate to a dangerous degree. Decomposition would then commence and the additional heat thereby generated would consume the ice. This condition would be indicated by a rise in temperature, and it was then necessary to filter the charge as quickly as possible in order to prevent a total loss.

The decomposition of H_2O_2 in alkaline solution could be accounted for as explained above, but we were doubtful concerning the reason for the harmful effect of high acidity. One theory advanced was that iron from the apparatus was brought into solution, causing catalytic decomposition. An interesting fact is that the barium carbonate precipitate was granular when formed at the proper acidity, but flocculent when either high acidity or alkalinity existed.

Yields Obtained on Large Unit

Our average recoveries were low, 80 to 85 per cent, which was due mostly to faulty mechanical and thermal control. On several runs we obtained recoveries as high as 95 per cent, which compares favorably with those obtained by the usual method on the same grade of barium dioxide. We were treating the lower grade of our barium peroxide production and we later heard that the Eastern manufacturers who purchased the bulk of our supply obtained very poor extractions on certain lots. Slow filtration also accounts for considerable of our losses in many instances.

After filtering the charge, the barium carbonate was washed several times with water and the washings were used as an initial solution for the next run. The main filtrate still contained some barium in solution as bicarbonate, most of which was precipitated with sulphuric acid. The final trace of barium was precipitated with phosphoric acid, a slight excess being used. After again filtering, the hydrogen peroxide solution was run to storage tanks and air bubbled through it to remove carbon dioxide.

Baffling Instability: "The Home Brew Problem."

The hydrogen peroxide so produced conformed to all the tests required by the trade, both as to purity and stability. Some impurities commonly introduced by the mineral acids were completely absent, and we found no other brand which excelled in purity. For several months it was put on the market with complete confidence in the belief that it was of superior quality. Then reports of disaster began to arrive. I use the word report advisedly, because a considerable portion of our product decomposed and the pressure of the liberated oxygen blew the corks out of the bottles.

It was a very baffling situation. Our chemical tests revealed no impurities which could cause the trouble, and most baffling of all was the fact that samples which gave a satisfactory stability test were not stable. The stability test consists in heating a flask of hydrogen peroxide on a water bath and measuring the rate of decomposition at definite temperatures. The presence of percarbonic acid, which would be destroyed during the first stage of the stability test, might account for the facts. Another theory is that minute traces of metal from the apparatus were held in solution, but the cause has never been definitely proved. We kept samples of each run and many of the samples showed no appreciable loss after many months, so we concluded that the cause of instability could not be an inherent factor of the method.

Market conditions caused us to discontinue the manufacture of hydrogen peroxide before the question of stability was solved. It is the writer's opinion that enameled ware equipment designed to give good mechanical and thermal control would solve the problem of stability both during and after manufacture, and that the process is superior to present methods.

Texas Leads in Oil Refining

The extent of the growth of the refining end of the petroleum industry in Texas is shown by the fact that there are now 109 oil refineries in the state, 63 of which are on the active producing list at the present time, with aggregate production of 345,150 bbl. per day. In addition, there are 9 refineries in course of construction. Texas now stands as the leading state of the Union in this branch of the industry, and is third in point of production of crude petroleum, with a record of 105,209,500 bbl. in 1921.

Some Causes of Rejections in Boiler Tubes

By H. G. Carter

IN THE manufacture of boiler tubes very low-carbon solid round billets are charged into a furnace and heated to a good forging temperature, which is in the vicinity of 2,100 deg. F. Upon being brought to the proper heat the billets are put into a piercing machine, where the center is punched out, the solid billets being thus converted into rough seamless tubes. These tubes are permitted to cool (usually by permitting them to roll into a tank of water) and sent to a pickling room, where the scale is removed, after which they are taken to a draw-bench and the ends tapered for a "tong hold." They are then drawn through a die and over a mandrel or plug. This process is repeated until the desired outside diameter and wall thickness is obtained, the tubes being given several process annealings and picklings during the drawing operations. When the desired size has been reached, the tubes are given a final annealing, straightened, cut to length and presented for inspection and testing.

Tubes are rejected chiefly on account of the following defects: crookedness, non-uniformity of wall thickness, seams, tears, excessive scale and brittleness as shown by expanding, flattening or hydraulic pressure tests.

FIGS. 1 TO 4—STRUCTURE OF DEFECTIVE BOILER TUBE

Fig. 1—Coarse grain. Etched with HNO_3. × 60

Fig. 2—Burned steel. Unetched. × 30

Fig. 3—Lap seam. Etched with HNO_3. × 60

Fig. 4—Crack following dirt string. Unetched. × 60

Rejections due to crookedness and brittleness are usually temporary, because crooked tubes are put through a straightening machine and the brittle ones reannealed and both returned for inspection.

Tubes that are rejected because of non-uniformity of wall thickness are redrawn to make tubes of a smaller size and after annealing and straightening are submitted for inspection.

Tubes with seams and tears are absolutely rejected and are either scrapped or sold for low-grade tubing for uses such as electrical conduits.

Let us look into the cause of some of these rejections.

Brittleness is usually the result of large grains caused by overheating during the annealing, which is the result of carelessness on the part of the furnace man or is caused by poor furnaces of improper design or by faulty pyrometers. Fig. 1 shows a structure which failed the expanding and flattening tests due to excessive grain size, but was salvaged by reannealing, which produced a much finer structure.

Another cause of brittleness not usually discovered in the inspection department is due to burnt steel, a defect which generally appears in the piercing machine or at the draw-bench. Burning can usually be traced to the heating for piercing. Fig. 2 shows an extreme example of burnt steel; here the grain boundaries have opened and are lined with iron oxide. Other examples of burnt steel have been observed, not sufficient to oxidize the grain boundaries to a visible extent, but the billet was nevertheless so brittle that drawing was impossible. Of course burning may take place in the steel mill, but this does not usually happen.

Lap seams are the usual type found in seamless tubes and are caused by folding excess metal over upon itself during the first pass in the drawing process, which is subsequently drawn down to a thin fold but not united to the metal beneath it. Fig. 3 shows such a seam.

Tears occurring during the drawing process and cracks resulting from hydraulic tests are usually traceable to dirt chains and ghost streaks. Fig. 4 shows a crack from a fracture following a dirt chain. Cracks often follow a ghost streak (band of metal which remains bright after etching with Stead's reagent). Excessive dirt in steel is usually found to be located within these ghost streaks.

Rejections due to crookedness, non-uniformity of wall thickness, excessive scaling, brittleness caused by overheating in annealing and burnt steel (excepting steel burnt at the steel mill) are preventable, unnecessary and constitute a very large part of the total rejections. They are the result of carelessness, incompetency or the lack of intelligent supervision of those in charge of the departments in which they originate.

Rejections caused by dirt, gas holes, ghosts, segregations and burning at the mill may be classified as unavoidable rejections, except that they can be greatly reduced by purchasing a good grade of steel and by making a complete trial run of a few bars before starting the entire shipment through the mill.

Waverly, Mass.

The Katathermometer

The katathermometer is an instrument contrived by Dr. Leonard Hill, an eminent English physiologist. Dr. Hill, after exhaustive experiments, concluded that the rate of cooling of the human body was the controlling factor in determining comfort or discomfort. The katathermometer measures the rate of cooling of the body. A preliminary study by the Bureau of Mines indicates that the instrument will be useful for making determinations of comfort conditions in coal and metal mines.

Handling the Finished Products of Industry—III

General Consideration of Soap Manufacture—Why It Is Profitable to Use Mechanical Methods in Handling Finished Soap—Two Examples From Existing Soap Factories, Showing Amount of Non-Productive Labor Eliminated in Each Case*

By GRAHAM L. MONTGOMERY

HANDLING the finished product—from the time the last true manufacturing process is completed until the article passes out of the ownership of the maker—often costs more than all the other charges which the work must bear, as pointed out in the first article of this series. This is particularly true in an industry where the process of manufacture is one entailing but little labor, an industry essentially adapted to production in bulk. In such an industry the operations necessary to prepare the finished product for the market are the operations entailing most of the non-productive labor and are responsible for most of the labor cost which enters into the sale price. The reduction of the cost of this non-productive labor therefore presents the possibility of increase in profits or reduced selling price. As an illustration of such an industry and an example of the steps which can be taken toward cutting down the non-productive labor, let us consider the manufacture of soap and its preparation for the market.

Soap Manufacture

Soap making is an ancient art. During the many centuries of the development of this art a routine of manufacture has been established which eliminates all unnecessary labor during the process. Whatever the type of soap manufactured, be it soft or hard soap—cold or hot process—the material flows from step to step by gravity or pump. The function of labor has been reduced to the control of the process and there is little possibility that much more reduction in labor can be brought about.

In handling the raw material, the field for economies is again small. Today this raw material is largely liquid and its handling is extremely simple and inexpensive. In case a hard fat forms the basis of manufacture, it is first melted and can then be handled as an oil would be. The savings possible in this part of the work are at best slight, so slight that their study promises little immediate reward.

The last operation in the manufacture of the soap leaves it in the large block in which it has set in the frame. A number of these blocks are shown in the accompanying illustration. As these blocks stand, they are finished soap and no further changes need be made in their constitution. But they are not in marketable form. They must be made into cakes of a size suitable to the uses and the buying habits of the consumers who will ultimately purchase them. Other operations that must be gone through—depending on the quality and use of the soap—are: marking with suitable name or trade mark, wrapping and packing in boxes, cartons, or cases.

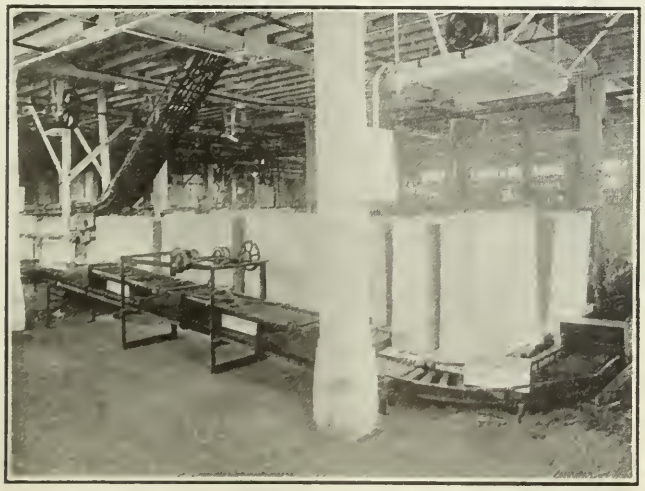
Preparing Soap for the Market

The first operation performed in preparing soap for the market is to cut the blocks mentioned above into slabs. This is done by forcing the block through a frame in which are a number of vertically strung wires. The spaces between these wires determine the thickness of the slabs. After the slabs are formed they are put through the cutting machine. Sometimes this machine only cuts the slabs into strips and then these strips have to be put through another cutting machine which cuts them into bricks of soap of a proper size to form the desired cake. Usually these two cutting operations are done on one machine, the slab being forced through the strip-cutting wires and then all the strips together being moved at right angles through the brick-cutting wires.

The bricks of soap resulting from the last operation are placed next in the press. This takes each brick separately and presses it into the desired cake-form. At the same time the names, trade marks, ornamental designs or other devices are imprinted on its surfaces. Some grades of soap contain too much moisture when in the brick form and it is necessary to dry or cure them before they reach the press. If space is available and cheap, this can well be done by the atmosphere in any well-ventilated and dry room. It is, however, more usual to place the soap bricks in drying rooms, where the drying is expedited and kept under control through the use of artificial heat.

After the cakes leave the press, the next operation generally consists of placing the wrapper on them. This is now usually done in automatic machines, although in some cases where the cake is of a fancy shape it is still customary to do the wrapping by hand. From the

*Article I of this series appeared in Chem. & Met. Eng., vol. 26, No. 18, p. 823, May 3, 1922. Article II appeared in vol. 26, No. 19, p. 885, May 10, 1922.



BLOCKS OF SOAP FROM FRAMES WAITING TO GO THROUGH SLABBER

wrapping department, the soap passes to the packing tables. Here it is packed in some sort of container, depending on the quality of the soap and how it is marketed.

Labor Used in Preparing Soap for Marketing

The routine of preparation described above is not the only one used and various manufacturers follow different methods, according to the kind of soap they make and the requirements of their market. It is, however, general enough to serve as a pattern, any variations which occur being easily interpreted in the above terms.

The labor used in these operations consists of that needed to perform the actual cutting, pressing, wrapping and packing; and that used in moving the soap from operation to operation. Of the former, it is safe to consider the cutting and pressing as productive, since these two processes actually enhance the market value of the soap. The wrapping and packing, together with all the handling, are non-productive.

As stated above, there is little opportunity to cut down the productive labor in soap making. The use of automatic machinery for cutting and pressing is quite general. In the exceptional cases where machines are not employed for this work, it is possible to effect a considerable labor saving by adopting these machines. And in almost all cases where drying rooms are employed between these two operations there is handling in connection with these rooms which could easily be eliminated. That, however, actually comes under the non-productive classification.

The non-productive labor in soap making is, as we have seen, almost entirely confined to that expended in handling the finished soap. Of late years there has been a creditable introduction of automatic wrapping machinery and some plants have also installed more or less complete mechanical handling equipment from the presses onward to the packing tables. The following two examples from actual working installations will serve to show what has been accomplished to date and perhaps point the way to a more complete realization of the savings to be obtained from such improvements.

Before passing to these examples it is well to point out that no attempt is here made to criticise the manufacturing methods in vogue throughout the soap industry. It is no doubt possible that improvements which will lessen the cost of this manufacture can and will be effected as time goes on. But while the present processes and methods hold their favored place with manufacturers, and assuming no immediate, decided drop in cost of raw materials or fixed charges, it is to the reduction of the non-productive labor cost to which we must look for lowered production costs and increased efficiency.

A Plant for Making Cheap Soap in Large Amounts

Let us take for consideration first a plant where the total bulk of product is large—where the product, while divided into two or three grades, is really all about the same, and where the selling price must, in accordance with the nature of the product, be low. In the first place, in making soaps of these grades, the methods employed by all manufacturers in the actual manufacture are essentially the same. The raw materials will in most cases be obtained by all the competitors at about the same price. The amount of labor is about the same for any of these plants, diminishing proportionately per ton output as this output increases. This fact makes it desirable for every manufacturer to increase the bulk of his sales and hence the relative output per unit of productive labor cost in order to compete with others in the field. However, most of the producers have sufficient bulk of product to meet this condition successfully and if they desire to reduce their total production costs so that they may increase their profits or lower their prices they must look to some other means. A number of plants of this type have found the solution in the almost complete adoption of mechanical equipment for the handling and forming of the soap between the point where the frame is stripped and that where the soap is loaded out of the plant.

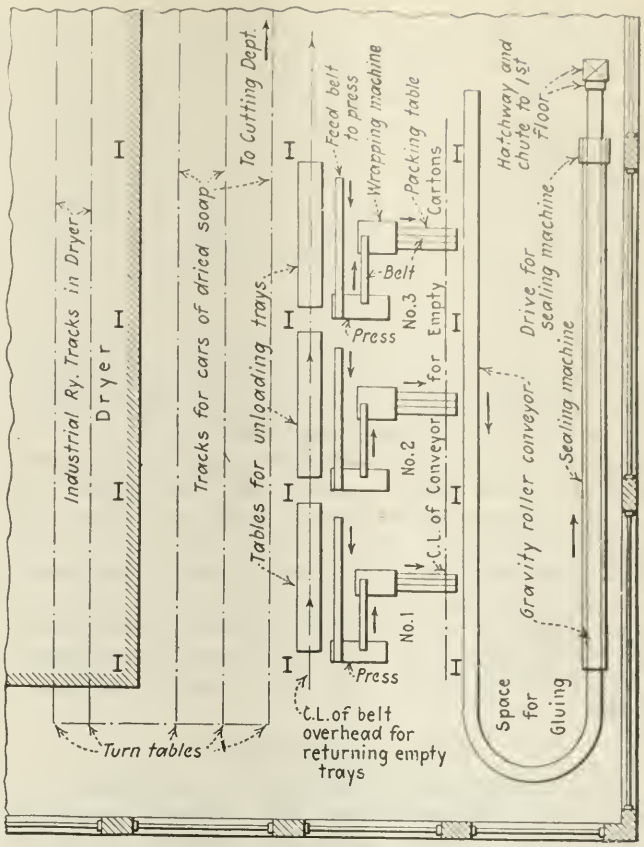


FIG. 1—PLAN OF HANDLING IN PRESSING, WRAPPING AND PACKING DEPARTMENTS

The sketch marked Fig. 1 shows a part of one of the most complete installations of this type of equipment so far put in. Here the blocks of soap from the frames, shown in one of the accompanying illustrations as standing on the wheeled bottom of the frame after the frame-sides have been removed, are put through a slabbing machine. This cuts the blocks into slabs having the cross-sectional dimensions of the original block for length and breadth and thickness enough to meet the requirements of the finished cake. The slabs are then put through the cutting machine, which, automatically in two cuts, produces bricks of soap of the proper size to be pressed into the finished cakes.

These bricks are placed by hand on slatted wooden trays as they come out of the cutter, about 100 bricks to the tray. The filled trays are stacked ten high on wooden platform industrial railway cars, making 1,000 cakes per car. After a car receives its full load of trays, it is pushed down the track and into the drier. Here the soap is dried sufficiently so that it is stiff enough for pressure into the desired cakes.

On leaving the drier, the carful of trays of soap bricks is taken by means of the turntables in the industrial railway to one of the tracks marked for this purpose on Fig. 1. The trays are removed and piled upon the adjacent tables. Between each of these tables and the belts marked "Feed Belt to Press" stands a worker whose function it is to remove the cakes from the trays and place them one at a time on the press feed belt. When a tray is emptied, it is placed on the overhead belt conveyor and returned to the cutting machines to be refilled.

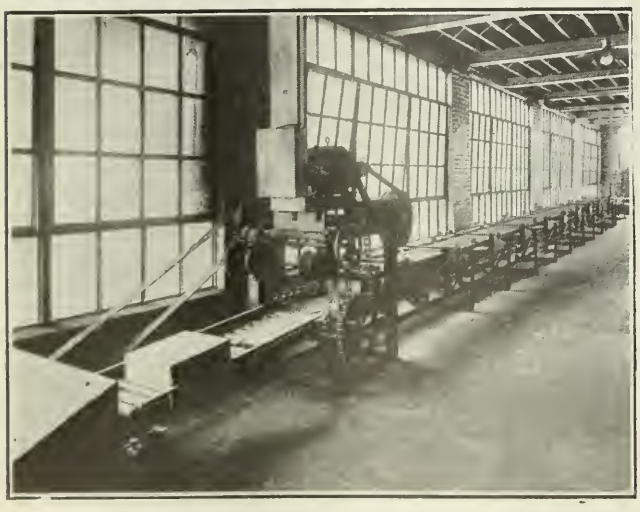
The soap bricks on the press feed belt are automatically fed one by one into the press. This press takes each cake and presses it into the shape desired for the finished cake, at the same time imprinting on the sides of the cake the desired name, trade mark, etc. After this pressing is completed, the cake is automatically discharged to a second belt. This second belt conveys the cake to the wrapping machine. Here the cake is wrapped and passes onto a third belt, which runs down the center of the packing table. On either side of these tables the packers stand and place the cakes of soap in paper cartons as they take them off the belt. The empty cartons are fed in on a gravity roller conveyor which passes over these packing tables, as shown on Fig. 1.

Sealing the Cartons

After the cartons are filled they are placed, open side up, on the U-shaped gravity roller conveyor shown in Fig. 1. This conveyor takes the cartons to the point marked "Space for Gluing." Here the flaps of the carton are glued down and the carton is turned over, so that its own weight, pressing it down against the conveyor, tends to seal it. In this way it enters the sealing machine, shown in the accompanying illustration. This machine forces the carton to pass between upper and lower sets of rollers, which exert sufficient pressure to seal it effectually. After passing out of this machine the carton is delivered by gravity conveyor to an inclined conveyor of the push-bar type, which delivers the cartons to the car-loading and storage system of gravity conveyors on the floor below.

Loading by Conveyors

This system of gravity conveyors, shown on Fig. 2, is so arranged that three cars may be loaded at the same time, the cartons coming either direct from the packing department above or from any one of the storage spaces shown on the figure. This is accomplished by means of an ingenious arrangement of switches. The end sections, which extend into the cars when they are being loaded, can be raised out of the way when not in use so that the track is free for movement of cars. The loading platform, with three cars in position for loading, is shown in the accompanying illustration.



SEALING MACHINE AND CONVEYOR TO FIRST FLOOR

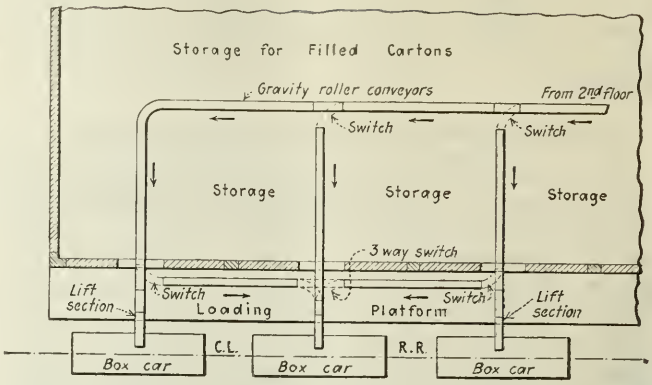


FIG. 2—LOADING CONVEYOR SYSTEM

A Plant for Making Expensive Soaps in Large Variety

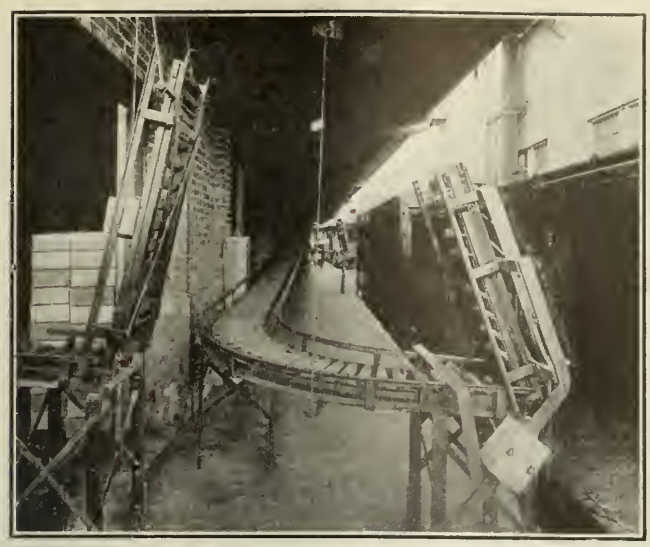
The second example is a plant for the manufacture of toilet and other similar grades of soap. In the particular plant in question the soap is packed in two ways. That for the general market is pressed into oval cakes bearing the trade name on one side and the manufacturer's name on the other. Each of these cakes is then wrapped in a fancy wrapper. After wrapping, three cakes are placed in a fancy pasteboard box and these boxes are in turn placed in paper cartons or wooden boxes for shipment.

Soaps to be shipped from this plant to South America are cut into bars only. The name and trade mark are pressed into these bars, which are then packed in paper-lined wooden cases of heavy construction, holding 100 bars each. The difference in packing methods is due to the fact that South American shipments undergo particularly rough treatment and precautions must be taken to prevent damage to the soap.

It will be noticed that the soap made in this plant is not put through a drying room between the cutting and pressing. This is because of the manufacturing methods used by the plant, the moisture content of the soap from the frames being right without further drying.

How the Soap Is Handled

Fig. 3 shows the layout of the departments where the finished soap is handled in this plant. The soap which is shipped abroad in the heavy cases is adapted to an extremely simple handling routine. The slabs are brought from the fourth floor to the fifth floor in the elevator shown on Fig. 3 on hand trucks and transferred by hand from these to the cutting machines. The packers stand at the discharge of the cutting machines and as the bars come from the machines, place them in cases which are standing on one of the roller conveyors adjacent. When a case is filled, it is shoved to the end of the conveyor and at this point the cover is fastened on. As fast as the last operation is finished, the boxes are transferred to the gravity conveyor which runs at right angles to those mentioned above. This last conveyor takes the case to the large spiral chute



LOADING PLATFORM AND CONVEYOR

shown on the outside of the building. The cases go down this chute directly into the shipping department.

Handling Fancy Toilet Soaps

The toilet soaps are delivered to the fifth floor in slabs as described above and are transferred from the elevator to the department where they are cut—shown in Fig. 3—on hand trucks. After being cut and pressed into the desired cake form, the cakes are loaded into wheeled transfer boxes and pushed over to the row of twelve packing tables shown.

These soaps are packed, three or more per box, in fancy paper boxes. When the boxes are filled and closed, the packers place them one by one on the gravity conveyors which run between the ends of the packing table and the wall toward the small spiral chute leading to the third floor. These boxes run by gravity down the conveyor to this chute and down the chute to the table marked "Receiving Table" on the third floor.

At this receiving table, the small boxes are placed either in paper cartons or wooden cases depending on where and how they are to be shipped. These cartons and boxes when filled weigh about 200 lb. each. When they are filled and sealed or covered, they run down a gravity roller conveyor which leads from the receiving table to the large outside spiral chute. Then they run down this chute to the shipping department.

The Shipping Department

The foot of the large spiral chute is situated in a one-story building which serves for a shipping department. The outlet of the chute discharges onto a roller conveyor of slight inclination, which serves for distributing the cases and cartons to storage areas or for delivering them to truck or freight car as desired. Due to the slight inclination of this conveyor, the packages move only when slightly pushed. This serves to keep them at rest while they are marked or labeled.

Labor Saved in First Plant Cited

In the first example given the labor employed from the point where the soap is in the frame up to the point where it is unloaded from the tray to the press is the same as if there were no labor-saving devices employed in the plant. Beyond this point the labor used is as follows: One worker to remove soap bricks from trays and place them on press feed belts, making three in all. Two workers at each packing table, making six in all. One worker for gluing cartons. Three men on loading platform. Total workers now employed for work in question is thirteen.

Before the labor-saving machinery was installed the labor required was as follows: One worker unloading trays at each press, making three in all. One worker feeding each press, making three in all. One worker feeding each wrapping machine from discharge of press, making three in all. Two workers packing at discharge of each wrapping machine, making six in all. One worker gluing cartons. Six workers trucking sealed cartons from second floor to storage and shipping on first floor. Six workers on first floor loading cars. Total workers formerly employed, twenty-eight.

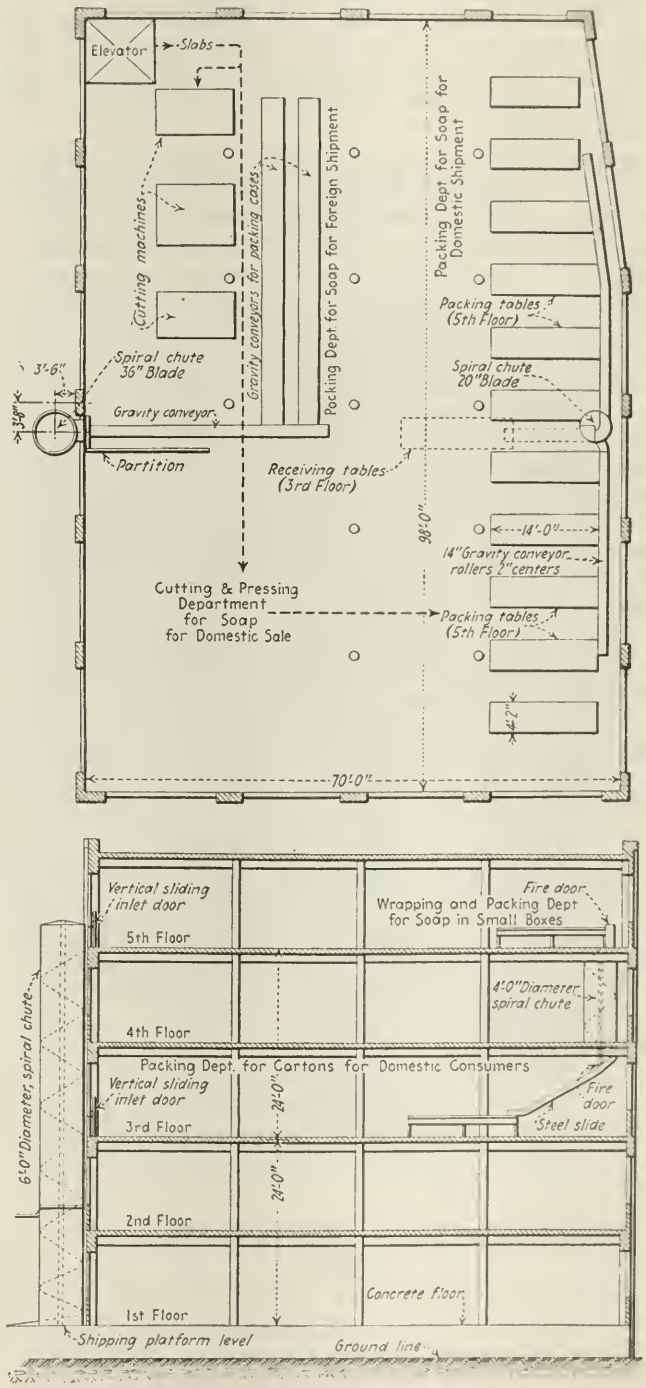


FIG. 3—PACKING DEPARTMENT AND CONVEYORS FOR FINE SOAP FACTORY

The saving, then, in labor due to the installation of labor-saving machinery in this plant was fifteen men, or 54 per cent. Since this type of work requires workers of the same pay-rate throughout, we can safely say that a saving of 54 per cent of this labor cost was effected. As the workers on the press and wrapping machines and at the packing tables were enabled to turn out a larger product than formerly, the actual returns of the new equipment were even greater than this 54 per cent.

Labor Saved in Second Plant Cited

In the second example given the labor must be analyzed in three parts: First, that where the soap is packed for shipment to South America. Second, that where the soap is packed for ordinary shipment. Third, the labor saved in the shipping department.

In the first division of this work the same number of men is used for packing and closing the cases as formerly, this number being five. The men used to truck the cases to the elevator, two in number, are no longer employed.

In the second division the workers employed at the cutting, pressing and packing work and for handling the soap between these processes remains as before, the number being twenty-two. From the packing department to the shipping room there are no workers used, where formerly six were employed.

In the third division, the shipping department, two men are now employed, one to place boxes on the conveyor, the other meanwhile unloading them in truck or car; or one to label and tag, while the other removes boxes from the conveyor. Formerly, for unloading from the elevator with hand trucks and wheeling the boxes to the various required points, six men were needed to handle the same volume of product in the same time. This gives us a saving of four workers in this division of the work.

To recapitulate, the plant now employs twenty-nine workers on this labor where it formerly employed forty-one, so that the saving amounts to 29 per cent. As in the first plant, more volume of product can now be turned out in the same time, so that this 29 per cent does not represent all the advantage made possible through the material handling equipment that was installed.

Conclusions

From the examples which have been cited above, it is evident that the more complete the handling system used the larger is the percentage of the non-productive labor that can be eliminated, provided all other influencing conditions remain the same.

It is also evident that, taking no account of increased production through elimination of confusion and through speeding up of work, savings made through a lowered labor turnover, and the decrease in the management burden, material handling equipment in many cases pays well by the non-productive labor it eliminates alone.

The writer desires to express his appreciation of the kindnesses extended to him by The Dow Co., of Louisville, Ky., the manufacturer of the conveying equipment described in this article. The data which form the basis of this discussion and the photographs and drawings used for illustrating were made available by The Dow Co., and The Dunning & Lueckel Engineering Co., of New York City.

Commercial Production of Mucic Acid

Mucic acid [$(OH)_4C_4H_4(CO_2H)_2$] is one of the most recent of the rare organic chemicals to become available on a large commercial scale. It is being produced at Eureka, Mont., by a process patented by Professor Acree of Harvard University and worked out on a plant scale by the International Chemical Products Co., of Baltimore, Md. The process consists in the hydrolysis and oxidation of mixtures of glucose and galactose obtained from the species *Larix occidentalis*, which is commonly known as Western larch. Oxalic and other organic acids are obtained as byproducts.

Some idea of the extent of operations can be obtained from the statement that the Montana plant covers 20 acres and has an annual output of approximately 600 tons of mucic acid. The production has been almost entirely sold to the manufacturers of self-rising flour. The cost of the product is said to be considerably less than that of citric acid or cream of tartar and when its higher neutralizing strength is considered, it is entirely comparable with the cost of high-grade phosphates.

Mucic acid is a white crystalline or powdered material, without water or crystallization. It is readily assimulated in the metabolism of the human body,[1] probably due to the fact that it is a partly oxidized carbohydrate. Most of this company's output is of the chemically pure grade, but a small amount of the technical product has been sold for use in the dyeing of textiles, where it acts as a mordant and fixing agent in the place of cream of tartar. Mucic acid is marketed under the trade name "Cream of Milk Sugar."

The principal use of mucic acid at present is as a baking acid in the self-rising flour industry. It is claimed that its insolubility in the cold enables it to be kept in a baking mixture almost indefinitely without releasing leavening gas. This property is also of value in connection with its use in baking powders. Samples of baking powders containing mucic acid have been kept in incubators saturated with water vapor and at the end of a test of 14 months showed losses of less than 2 to 3 per cent of available carbon dioxide. Theoretically, pure mucic acid will neutralize 80 parts of pure sodium bicarbonate as against 75 parts and 45.6 parts in the case of monocalcium phosphate and cream of tartar respectively. The use as a mordant and chrome assistant in the dyeing of textiles has already been mentioned. It is also believed that the pure acid will be comparative with citric acid in the preparation of effervescent salts, soft drinks, ice cream and other food products.

New Alcohol Mixture for Motor Fuel

Tests recently completed by the Sociedad Nacional de Agricultura of Rio de Janeiro, Brazil, indicate that a satisfactory fuel can be produced at a cost which compares favorably with gasoline. The selling price of alcohol at the Campos sugar mills in Brazil is about 27 cents per gal., while the price of gasoline in Rio de Janeiro is about 75 cents per gal. The alcohol is made from sugar cane residue, at present thrown away because of lack of transportation facilities.

The best results were obtained from a mixture composed of 65 parts alcohol, 25 parts ether, 9.5 parts kerosene and 0.5 part pyridine. The consumption of a heavy Benz car during the test was 98.5 c.c. per kilometric ton of weight, while the consumption of a light 1American car was 126 c.c. of gasoline per kilometric ton.

[1]Biochemisches Handlexikon, vol. 2, 1911.

Corrosion of Petroleum Refining Equipment*

By R. R. Matthews and P. A. Crosby

In earlier papers which have been published in this magazine[1] we have shown that in refining mid-continent petroleum in a so-called pipe still hydrochloric acid is formed as result of the hydrolysis of the magnesium chloride in the brine associated with the petroleum. This caused rapid corrosion wherever the acid vapors condensed, and in consequence increased costs of maintenance. As a preventive measure ammonia was introduced into the vapor system; first the anhydrous was used and later aqua ammonia. This reduced the corrosion and lengthened the life of the apparatus—especially of the condensers. It is true that corrosion may also be caused by dissolved gases, such as hydrogen sulphide, oxygen and carbon dioxide, but hydrochloric acid is only the corrosive agent whose cause and effect have been studied here.

In the present paper further evidence is offered of the corrosion caused by hydrochloric acid produced in refining petroleum, and it is shown that this corrosion is not confined to refineries using the pipe still, but is also noted in installations where shell stills are used.

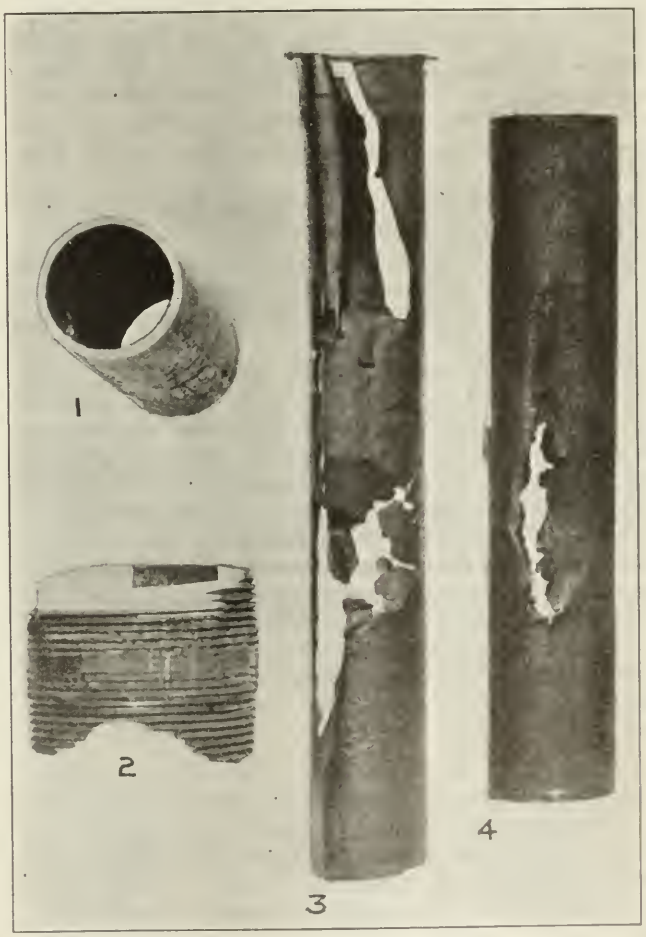
In this particular case eight stills had been set up for continuous operation—that is, the oil flowed from one still to another, each successive still being held at a higher temperature so that by the time the eighth still was reached the finished residual product could be drawn off. Each still was equipped with a dephlegmator and the necessary condensers and coolers, the latter being of the tubular type. The stills were also equipped so steam could be used in the bottoms of them.

This bench of stills has been operated only periodically since completion with, say, a month's operation and then several months' idleness. After about 2½ years it was noted that some of the tubes in the condenser used with No. 4 still were leaking. The next time the bench was not in operation the leaking tubes were replaced. Examination of the tubes removed showed that the top portion, where the vapor entered, had been corroded for about 18 in. on the oil side until the metal was very thin. This was the same sort of hydrochloric acid corrosion which had previously been observed in the pipe stills, although it had been felt that such trouble might be avoided in the shell stills because considerable salt water would settle from the crude oil in the first still and could be drawn off. Furthermore, the remainder of the brine would be dehydrated in the next still and the salts pass with the oil through the other stills, causing no trouble.

In order to investigate this point in the laboratory, crystalline magnesium chloride was added to water-free oil and then heated up slowly in a distillation flask. Hydrochloric acid vapors began to come over shortly after reaching a temperature of 175 deg. C. (347 deg. F.), and considerably more were noted when the temperature was brought up to 200 deg. C. (392 deg. F.). This showed that the water of crystallization in the crystalline magnesium chloride is sufficient for the hydrolysis. Of course, the brine in the oil consists largely of sodium chloride, and, even though concentrated considerably, or reduced to crystalline form in passing through the first stills, there would probably be but little acid liberated at first because of the relatively small proportion of magnesium chloride. As the oil reached the hotter stills, rapid hydrolysis would result. The laboratory results show that when such stills were reached, acid would be produced and carried over with the oil vapors. The result of the latest tests indicates that this hydrolysis takes place most vigorously at temperatures above 150 deg. C. (302 deg. F.); and that sodium and calcium chlorides apparently do not enter into the reaction.

Conditions in No. 4 still were extremely favorable for this hydrolysis of $MgCl_2$. The temperatures of the oil in this still were found to fluctuate between 177 deg. C. (350 deg. F.) to 243 deg. C. (470 deg. F.) during the time the stills had been operated, and this temperature, aided by the fact that superheated steam was being used, undoubtedly resulted in the formation of hydrochloric acid vapors, which were carried over until they struck the cold tubes of the condenser. The condensation there, of course, meant action on the tubes and eventually reduced them to the paper-like thinness which was noted when they were removed.

Later it was also found necessary to change the tubes



FIGS. 1 TO 4—EXAMPLES OF CORRODED PETROLEUM REFINERY EQUIPMENT

Fig. 1—Section of standard No. 13 gage tube used in the tubular condensers and heat exchangers. The piece is set on end so that the thickness of the metal can be noted.

Fig. 2—A short nipple showing how threads on pipes were corroded away.

Fig. 3—A piece of one of the corroded tubes removed from a condenser at the bench of eight stills.

Fig. 4—A portion of the tube taken from the heat exchanger, showing the place where it gave way.

*A paper read before the Petroleum Section of the American Chemical Society at Birmingham, Ala., April 5, 1922.

[1]Chem. & Met. Eng., vol. 22, No. 11, p. 491 (March 17, 1920), and vol. 23, No. 23, p. 1122 (Dec. 8, 1920).

in the condenser on No. 5 still. Temperatures there were found to have ranged from 182 deg. C. (360 deg. F.) to 260 deg. C. (500 deg. F.). The condensers on the four other stills have not yet caused trouble, so it seems likely that the most of the hydrochloric acid is liberated in the temperature range from 175 deg. C. to 250 deg. C. Michael Freund,[2] in experiments with Russian petroleum, also found that these temperatures and conditions were most conducive of this type of corrosion.

Other refiners of our acquaintance have also noted this acid formation, but it appears to cause more serious corrosion where steam is used in the stills. No doubt the steam does assist somewhat in the hydrolysis of the magnesium chloride and also dilutes the acid at the point of condensation. thus spreading it over a large surface of the metal.

Acid Corrosion in Heat Exchanger

Another evidence of acid corrosion was noted when a tube in a tubular heat exchanger, in which the hot residual oil flowed around the tubes and crude oil through them, suddenly started to leak. The heat exchanger was arranged with baffle plates so that the crude oil made four passes through the tubes in going from the bottom to the exit at the top. It was first thought that the tube had given way as a result of the abrasion of the earthy matter which is always carried along with the crude, but when the tube was removed the hole was found to be on the top side. If the abrasive matter had caused the hole, it would probably have been on the bottom, since such matter is heavier than oil, especially when the oil is warm and the viscosity thus decreased.

Careful examination of the removed tube showed the hole had been made from the inside, and the fact that it was on top supported the idea that it was another case of hydrochloric acid corrosion. Comparison with the other examples of this sort of corrosion helped to confirm this conclusion.

It was rather surprising to learn, however, that hydrochloric acid corrosion had taken place to such an extent at that particular point, since the temperature of the crude oil there was seldom above 110 deg. C. (230 deg. F.). Investigation, however, showed it was decidedly feasible, since oil-well casing has been known to be badly corroded by such action and Rogers[3] calls special attention to this point, showing that it is possible for this corrosion to take place at such temperatures. To be sure, the action at that temperature is slight, but is not to be ignored. The heat exchanger referred to had been in service for about 1½ years before the tube gave way, thus furnishing concrete evidence that the action is slow but positive.

Remedial Measures

Experience here has shown that ammonia introduced into the vapor fractionating system of pipe stills is the best combative agent thus far found for reducing the corrosive effect of the hydrochloric acid. In addition it no doubt neutralizes organic acids which might aid in the corrosion. Ammonia will not prevent such effects as noted in the heat exchanger, however, since it is introduced beyond that point in the vapor system. Also the use of ammonia on a bench of stills would be rather difficult, due to the necessity for introduction into the vapor system of each still. Thus, on the whole, the most practical solution would be to remove the salt water from the crude oil as it come from the well, or at least before it is put into the pipe line. Various methods of dehydration of crude oil have been proposed and some are in use, but none has yet removed the brine so thoroughly that this sort of corrosion would be entirely prevented.

The authors desire to acknowledge the assistance of P. E. Foster and R. C. Roberts, who are directly in charge of the stills where these observations have been made.

Roxana Petroleum Corporation,
Wood River, Ill.

[2] *Chem. Zeit.*, vol. 43, No. 149, p. 587.
[3] Professional Paper 117, U. S. Geological Survey, p. 80.

The A.P.I. Scale for Reporting Gravity of Liquid Petroleum Products

In reporting the gravity of liquid petroleum products, the United States Petroleum Association in 1864 adopted a scale, or rather a set of instruments graduated in accordance with a scale, on which the readings were expressed in "degrees Baumé." Since that time this scale has been in general use, without change, throughout the petroleum industry. Later investigation following the adoption of this scale showed it to be represented by the conversion modulus 141.5.

In industries other than the petroleum industry, however, an American standard Baumé scale based on a modulus of 140 has found universal use for reporting the gravity of liquids lighter than water.

The confusion arising from the use of the two scales —namely, 140 and 141.5—the readings on both of which were designated in "degrees Baumé," was brought to the attention of the American Petroleum Institute by representatives of the petroleum industry and, at the same time, the necessity was urged of having one or the other of the two scales formally adopted as a single standard for the industry. The technical advisory committee of the American Petroleum Institute then recommended the adoption of the gravity standard based on the modulus of 141.5, which is most generally in use by the petroleum industry, and on Jan. 23, 1922, the Institute transmitted broadcast to the oil industry a questionnaire which was, in substance, as follows: (1) Do you approve of the modulus 141.5 as applied to the oil industry? (2) Do you approve that the scale be known as the "American Petroleum Institute Scale"? To this inquiry the replies were almost unanimously in the affirmative.

After careful consideration of the question it has now been agreed by the American Petroleum Institute, the Bureau of Mines and the Bureau of Standards that the scale based on the modulus 141.5 be approved and recommended for exclusive use in the petroleum oil industry, and that this scale be designated the "American Petroleum Institute Scale." This action is believed to be in the interest of uniformity of practice within the petroleum industry.

When reporting gravities of liquid petroleum products it is to be understood, therefore, that the hydrometer scale based on modulus 141.5 is standard, and the expression "degrees A.P.I." should be used in order to avoid confusion with the scale based on modulus 140. In reporting the gravity of liquids lighter than water, the United States Bureau of Standards has requested that the expression "degrees Baumé" apply only to the scale based on modulus 140. In cases of doubt or when disputes may arise it is recommended that the gravity reported in "degrees A.P.I." be followed by the statement of the "true specific gravity" in parentheses.

Dip-Brazing With 80:20 Brass and the Heat-Treatment of Brazed Joints

Determination of Satisfactory Methods for Dip-Brazing—Tests on the Strengths of Joints and the Effect of Heat-Treatment—Metallography of Brazed Joints—An Explanation of the Great Strength of the Bond Between Brass and Steel

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BRAZING is by no means a new art, but there are many phases of the subject that have not been covered by the available literature.[1] Especially does this apply to dip-brazing in a high melting point brass and subsequent heat-treatment of the parts. Airplane construction has opened a new field for this art, and in order to use alloy steels at their fullest advantage, heat-treatment of fittings after brazing has become desirable if not necessary.

The experimental work with which this paper is concerned was carried out in the metallurgical laboratory of the Engineering Division of the U. S. Air Service at McCook Field with a view toward establishing a method of satisfactorily dip-brazing and heat-treating alloy steel fittings as well as obtaining data on the strength of brazed joints both in the heat-treated and non-heat-treated conditions.

Brazing Bath

The brazing was done in an ordinary plumbago crucible heated in a melting furnace fired with gas. The brass was made by first melting the copper under a layer of borax or boric acid and finally adding preheated zinc in small pieces. Using a flux over the molten metal held down the zinc loss due to volatilization. The proportion of 80 per cent copper and 20 per cent zinc was used on all the brazed joints reported herein (except a few specimens when a nickel brass was used), varying less than 1 per cent, as shown by chemical analyses made after the brass had been used.

Surface Appearance Caused by Various Fluxes

It was found that a clean specimen could not be obtained by the ordinary method of dipping in brass covered with a layer of borax, due to the rapid volatilization of the zinc and oxidation of both zinc and copper on the surface of the specimen after it was removed. This difficulty is not encountered in brazing with alloys of lower melting point. The high brazing temperature required for 80:20 brass apparently renders the flux very fluid, and permits it to run off the specimen almost the instant it is withdrawn, thus exposing the surface of the hot metal to the atmosphere. In an effort to overcome this difficulty, boric acid and potassium metaborate were both tried as fluxes. A slight improvement was found with potassium metaborate, but it was discovered that a thick layer of boric acid (1 in. or more) nearly obviated the difficulty. However, there were still discolored spots on the specimens.

It was also discovered that if the specimen were immediately transferred into a bath of molten borax or boric acid at about 1,500 deg. F., and held there from 30 seconds to 1 minute, the surface luster was preserved after it had been withdrawn and cooled to room temperature. When a cooling bath of flux is used, its temperature should be 200 to 300 deg. F. below that of the brass. Borax can be kept at a lower temperature, but boric acid becomes too viscous below 1,600 deg. F. and clings in a mass to the specimens when they are withdrawn. Boric acid is otherwise much more desirable, because it can be washed off in hot water, while borax must be cracked off either by quenching, by pounding with a hammer or by a sand blast.

Joints Made by Different Fluxes

As it was desired to determine the flux that would produce the strongest joint with the 80:20 brass, five butt specimens of S.A.E. 1020 steel were brazed with each of the following fluxes: Potassium metaborate, boric acid, borax. Borax was used as a cooling flux.

All the specimens were preheated to a dull red heat before dipping in order to speed up the process and prevent cooling the brass unduly after inserting each specimen. They were allowed to remain in the brass at 1,825 to 1,850 deg. F. for 2 minutes, during which time they were moved up and down. Thereupon the brazed pieces were transferred to a cooling flux of borax at 1,500 to 1,550 deg. F., where they remained 1 minute, then removed and cooled in air. Results are shown in Table I.

TABLE I—DATA ON PRELIMINARY TENSILE TESTS OF BUTT JOINTS TO DETERMINE BEST FLUX

Flux Used	Ult. Str. Lb./Sq.In.	Average	Remarks
Metaborate, $K_2B_2O_4$	28,970	.....	Joint only partly filled
Metaborate, $K_2B_2O_4$	30,800	.....	.....
Metaborate, $K_2B_2O_4$	33,550	.....	.....
Metaborate, $K_2B_2O_4$	.....	.....	Load undetermined
Metaborate, $K_2B_2O_4$	34,350	31,920	.....
Boric acid, H_3BO_3	25,560	.....	Joint $\frac{3}{4}$ filled
Boric acid, H_3BO_3	34,730	.....	Joint $\frac{1}{2}$ filled
Boric acid, H_3BO_3	31,130	.....	Joint $\frac{1}{2}$ filled
Boric acid, H_3BO_3	32,040	.....	Joint $\frac{1}{4}$ filled
Boric acid, H_3BO_3	28,550	30,400	Joint $\frac{1}{4}$ filled
Borax, $Na_2B_2O_7$	34,850	.....	Joint $\frac{1}{4}$ filled
Borax, $Na_2B_2O_7$	36,950	.....	Joint completely filled
Borax, $Na_2B_2O_7$	31,710	.....	Joint $\frac{3}{4}$ filled
Borax, $Na_2B_2O_7$	39,760	.....	Joint $\frac{1}{2}$ filled
Borax, $Na_2B_2O_7$	40,900	36,830	Joint completely filled

Borax appears to be the most desirable flux from the standpoint of the strength of the joint. However, the latter part of the work reported herein was done with a layer of boric acid 1 or 2 in. thick as a flux, and the cooling flux was dispensed with. As noted above, this was done to simplify the process, and it was found that the specimens came out as clean by this method as

[1] "The Metallography and Heat-Treatment of Metals Used in Aëroplane Construction," F. Grotts, CHEM. & MET. ENG., Aug. 1 to Oct. 1, 1918. "Brazing, Welding and Soldering in Aëroplane Construction," Boulton, *Aerial Age*, Oct. 6, 1919. "The Heat-Treating of Brazed Fittings for Aircraft," Archibald Black, *Journal*, S.A.E., March, 1920.

when a cooling flux was used and borax used on the brass. It is believed, however, that borax is more active as a flux than boric acid, and therefore it removes oxide from the joint much quicker, insuring a better joint where there happens to be an excessive amount of scale caused from preheating in an oxidizing atmosphere.

As a means of preventing oxidation of the joints of airplane fittings during preheating, a paste was made by mixing equal parts of borax and boric acid in a little water. The parts to be brazed were dipped into this mixture before heating, and it was found that preheating to a dull red heat produced no scale, as the surfaces and joints were protected by a film of the molten flux. It may be suggested also that the use of a flux while preheating would tend to increase the reliability of the brazing job, since it not only prevents scaling of the joints during preheating but also insures that the joint is well supplied with flux before the brass comes into contact with it.

Preparation of Butt Specimens

Standard tensile test specimens were cut in the middle and the ends faced off square in a lathe. These specimens were left approximately 0.08 in. oversize and no threads were cut on the ends. In order to hold the two parts of each butt specimen in place while brazing, two steel strips, or stays, were welded to opposite sides by means of an acetylene torch, care being taken to align the two parts as nearly as possible. During welding the heat was confined as much as possible to the ends, and there it was very much localized. The middle part, where the braze was to be made, never became hotter than 1,000 or 1,100 deg. F. during the welding of the stays, and excessive oxidation of the surfaces to be brazed was therefore avoided.

Final machining consisted of cutting off the stays, turning the specimen true in a lathe and cutting threads on both ends. This left them clean and true with no brass on them except at the joint.

Strength of Butt Joints

After it was determined to use borax as a flux over the brass, two series of tensile tests on butt joints were made, as shown in Tables II and III. In both cases the brazing temperature was kept within 25 deg. of 1,850 deg. F., the specimens were immersed 2 minutes, then transferred for 1 minute to a borax bath at 1,525 — 25 deg. F. Carbon steel samples were machined and tested, giving an average strength at the joint of 32,680 lb. per sq.in. with three bad samples below this figure. S.A.E. 2335 nickel steel specimens in Table II were quenched in oil from 1,500 deg. F., and drawn at 1,000 deg. F. before testing. Under these circumstances the average strength at the joint was 62,290 lb. per sq.in. and of the steel 149,000 lb. per sq.in. Four samples were so imperfectly joined as to give strengths below this average.

TABLE II—TENSILE TESTS OF CARBON STEEL BUTT JOINTS, NOT HEAT-TREATED

Ult. Str., Lb./Sq.In.	Remarks	Ult. Str., Lb./Sq.In.	Remarks
33,480	Joint ⅛ filled	35,990	Joint 15/16 filled
37,710	Joint ¼ filled	39,300	Joint ⅞ filled
34,180	Joint ¼ filled	28,670	Joint ¼ filled
37,090	Joint ½ filled	37,090	Joint ⅞ filled
14,640	Joint ½ filled	38,790	Joint 15/16 filled
23,910	Joint ½ filled		
		Av. 32,680	

The effect of heat-treatment upon brazed joints is yet uncertain. After obtaining the increased strength from heat-treating nickel steel butt joints as compared with the non-heat-treated carbon steel joints, it was thought that perhaps heat-treatment was a means of increasing the strength of the bond between the two pieces of steel, but later results do not uphold that idea. It is more likely that the brass in tension in the butt joints was supported more by the hard nickel steel than by the soft carbon steel so that the process of necking (which originates in the brass itself) was retarded, causing a higher breaking load. Such a phenomenon as that just described could not take place in a shear test and there was later found no evidence of an increase in shearing strength due to heat-treatment or to the use of nickel steel.

TABLE III—TENSILE TESTS OF NICKEL STEEL BUTT JOINTS QUENCHED IN OIL FROM 1,500 DEG. F. DRAWN IN AIR AT 1,000 DEG. F.

Ult. Str., Lb./Sq.In.	Remarks	Ult. Str., Lb./Sq.In.	Remarks
45,500	Joint ¾ filled	63,970	Joint 15/16 filled
48,460	Joint ¾ filled	72,730	Joint 15/16 filled
71,590	Joint 15/16 filled	67,690	Joint 15/16 filled
69,640	Joint 15/16 filled	35,450	Joint ⅞ filled
86,580	Joint completely filled		
61,270	Joint ⅞ filled	Av. 62,290	

Strength of the Brass

After completing the brazing of the butt joints, three tensile specimens were cast from the brass in sand molds. These specimens were used for tensile tests, shear tests and chemical analysis, and gave extremely consistent results. The castings for the test specimens were poured at the brazing temperature (1,825 to 1,850 deg. F.). Results follow:

Chemical analysis: Cu 79.12, Zn 19.54, Fe 1.34, Sn trace, Pb trace. Ultimate strength in tension, 44,803 lb. per sq.in. Elongation in 2 in., 28.7 per cent. Ultimate strength in shear, 33,530 lb. per sq.in.

Tensile Tests on Lap Joints

A series of carefully made lap joints were tested in tension, but the results were so variable that this method was abandoned as fundamentally incorrect. Therefore a shear specimen was designed and used on all later work on brazing. Butt specimens, while giving fairly uniform results, were extremely difficult to manipulate and expensive and so were discarded in later tests. Shear specimens were made of ¼-in. stock, lapped about ⅝ in. and riveted at each end, making a piece approximately 1½ in. in length with a distance between the rivets slightly exceeding 1 in. One of these specimens is shown in the photograph, Fig. 1, taken after the specimen had been brazed. A hole was drilled in one corner through which a wire could be inserted for dipping. After the brazing had been completed, both ends of the specimen were cut off, thus removing the rivets, and the area of the lap was reduced to exactly ½ sq.in.

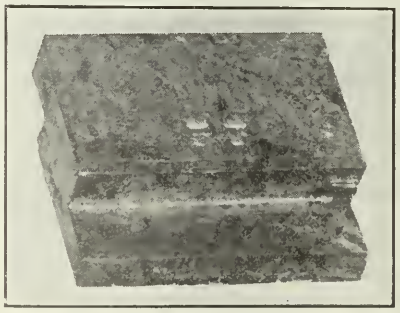


FIG. 1—SHEAR SPECIMEN AFTER BRAZING AND BEFORE MACHINING

Nickel Brass for Brazing

After adopting the shear specimen for brazing tests, the investigation was divided into four steps, as follows:

1. Determination of the merits of a nickel brass.
2. Determination of the proper brazing temperature.
3. Determination of proper clearance between parts.
4. Determination of the effect of heat-treatment.

The first inquiry was conducted by brazing ten specimens of low-carbon steel with 80:20 brass and ten with a nickel brass made with about 6 per cent of nickel substituted for that amount of copper. A clearance of about 0.0025 in. was used on these specimens, a thin copper shim being placed at each end between the two parts just before riveting. A brazing temperature of 1,850 to 1,860 deg. F. was maintained. Borax was used as a flux and boric acid used as a cooling bath. Results follow:

Ultimate strength in shear of the 80:20 brass joints: 36,840, 36,800, 37,680, 34,800, 31,320, 35,840, 36,300. Average: 35,650 lb. per sq.in. Three specimens were not completely brazed over the joint, giving values of 29,890, 25,480 and 28,760. If these are computed with the others, the average strength is lowered to 33,370 lb. per sq.in., approximately the shearing strength of the brass itself.

None of the specimens joined with the nickel brass was completely brazed. Ultimate strength in shear: 25,340, 26,480, 21,540, 25,060, 21,200, 22,060, 24,420, 27,140, 26,860, 24,440. Average: 24,450 lb. per sq.in.

Specimens of the nickel brass were cast and tested with the following results:

Chemical analysis: Cu 73.3, Ni 5.4, Fe 0.85, Zn 20.4. Tensile strength, lb. per sq.in. (average of three ½-in. specimens), 34,666. Elongation in 2 in., per cent, 34. Shear on one ½-in. specimen, lb. per sq.in., 20,450.

Therefore, the use of nickel in the brazing brass with a view toward improving the flowing qualities proved to be useless, as it not only weakened the brass but gave a less uniformly filled joint.

Correct Temperature for Brazing

Before the work was started on the shear specimens, no systematic determination of the proper brazing temperature was made, but the general appearance and behavior of the brass during the brazing of the butt and lap joints had led to the conclusion that 1,850 deg. F. was the proper temperature to use with 80:20 brass. This conclusion was found to be correct after the second series of the shear specimens, shown in Table IV, had been tested.[2] If the imperfect specimens be disregarded, it will be observed that there is a variation of approximately 4,000 lb. per sq.in. in the averages from each group and that the greatest strength is obtained with the lowest brazing temperature. While these results indicate that the low temperature of 1,830 deg. is best, there is danger in maintaining the brass at that temperature, because it is liable to freeze around the specimens when they are inserted. Raising the temperature to 1,850 deg. prevents this danger and does not lower the strength of the joint any appreciable amount. This latter temperature has been used for brazing airplane fittings, and has proved very satisfactory.

TABLE IV—SHEAR TESTS TO DETERMINE EFFECT OF BRAZING TEMPERATURE

Brazing Temp., Deg. F.	Ult. Str., Lb./Sq.In.	Average Ult. Str., Lb./Sq.In.	Brazing Temp., Deg. F.	Ult. Str., Lb./Sq.In.	Average Ult. Str., Lb./Sq.In.
1,830	38,400	.....	1,870	38,000	.....
1,830	39,000	.....	1,870	36,660	.....
1,830	40,200	39,200	1,870	38,520	37,730
1,850	28,880*	.....	1,890	34,800	.....
1,850	36,800	.....	1,890	36,880	.....
1,850	36,960	34,180	1,890	29,600*	33,760

* Flaw in brazing.

[2]All specimens were low-carbon steel, brazed with 80:20 brass under borax, and cooled in boric acid.

Effect of Clearance Between Parts

After the second series was completed the brazing temperature of 1,850 deg. F. was adopted as the proper one and the third group of soft steel specimens was made up, varying the clearance from zero to 0.0075 in. There were twenty specimens in this group with four different clearances. Table V shows the results.

TABLE V—SHEAR TESTS TO DETERMINE THE EFFECT OF CLEARANCE

No. of 0.0025-In. Shims in Joint	Uultimate Strength, Lb./Sq.In.	Average Ult. Str., Lb./Sq.In.	Per Cent of Surface Brazed
None	30,510	.....	85
None	36,470	.....	95
None	30,370	.....	92
None	36,360	.....	98
None	32,430	33,230	95
1	29,720	.....	94
1	29,560	.....	90
1	27,740	.....	60
1	28,230	.....	90
1	34,630	29,980	95
2	28,820	.....	80
2	22,240	.....	55
2	31,130	.....	96
2	27,610	.....	75
2	31,560	28,270	98
3	25,560	.....	75
3	31,560	.....	90
3	28,810	.....	85
3	28,920	.....	90
3	30,320	29,030	90

It is evident that a very small clearance is best. Of course it is possible on a closely fitted joint, put together with a great deal of pressure, to prevent penetration of the brass, but in general a thin crack fills better than a thick one. An explanation of this probably lies in the fact that the brass enters the crack by capillary attraction, and the smaller the capillary the greater the attraction becomes.

Heat-Treatment of Shear Joints

Twenty-one carbon steel specimens and the same number of S.A.E. 2330 nickel steel specimens were prepared. Following the best results obtained in the previous work, no clearance was used, and the brazing temperature was maintained at 1,850 deg. F. as nearly as possible. Borax flux and a boric acid cooling bath were used. Heat-treatment consisted of a quench in oil from 1,625 deg. F. for the carbon steel and 1,500 deg. F. for the nickel steel, followed by a draw to 1,000 deg. F. in saltpeter for all specimens. Half of the specimens made from each steel were heat-treated and the remainder were tested without heat-treatment. The machine work was all completed on these specimens before heat-treatment. Results are shown in Table VI.

The results from the heat-treated specimens were so poor that it was decided to braze some 6-in. specimens that had been spot-welded with the acetylene torch to hold them together. They were made of carbon steel, six of ¼-in. strips and six of ⅛-in. strips. These were heat-treated (quenched from 1,600 deg. F. and drawn to 1,000 deg. F.) after brazing and then tested with a chisel and hammer to determine whether the

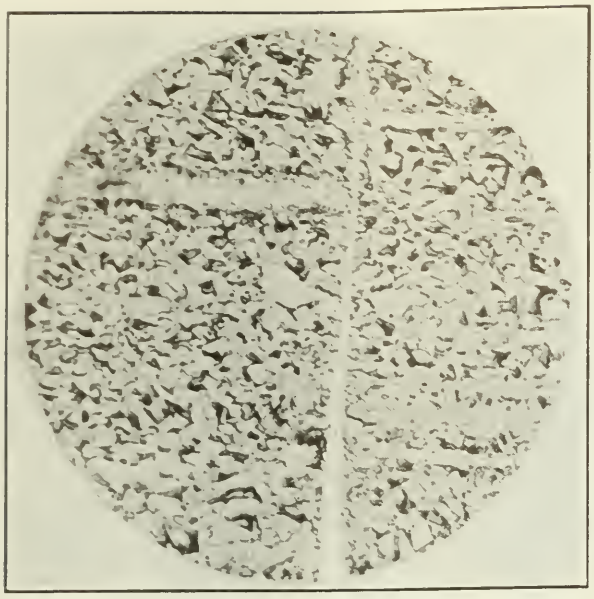


FIG. 2—BUTT JOINT IN LOW-CARBON STEEL, WITH BRASS ENTERING A MICROSCOPIC CRACK. × 100

joint had been injured by the treatment. They were found to be in good condition and three shear specimens were cut from two of the specimens made of ¼-in. stock. Ultimate strength of these specimens was 27,520, 31,820 and 23,660 lb. per sq.in. respectively. The latter showed incomplete brazing, but the two others held until the steel bent—testing was done with one end of shear knife unsupported. Evidently these larger, more rigid specimens were not so badly damaged by the heat-treatment.

TABLE VI—SHEAR TESTS TO DETERMINE EFFECT OF HEAT-TREATMENT

Low-Carbon Steel		Nickel Steel	
Not Heat-Treated Ultimate Strength Lb. Sq.In.	Heat-Treated Ultimate Strength Lb. Sq.In.	Not Heat-Treated Ultimate Strength Lb. Sq.In.	Heat-Treated Ultimate Strength Lb./Sq.In.
29,000	2,080	27,480	12,440
31,360	36,490	29,740	20,400
9,640		32,650	8,590
29,440	20,060	26,390	5,820
26,700	26,130	32,060	7,280
26,640	27,080	34,610	8,650
29,940	11,620	29,670	17,750
33,060	640	38,270	7,040
28,160	360	32,160	9,590
27,120	28,530	20,200	9,540
Av. 29,100	16,990	30,320	10,710

TABLE VII—SHEAR TESTS ON BRAZED CARBON AND NICKEL-STEEL

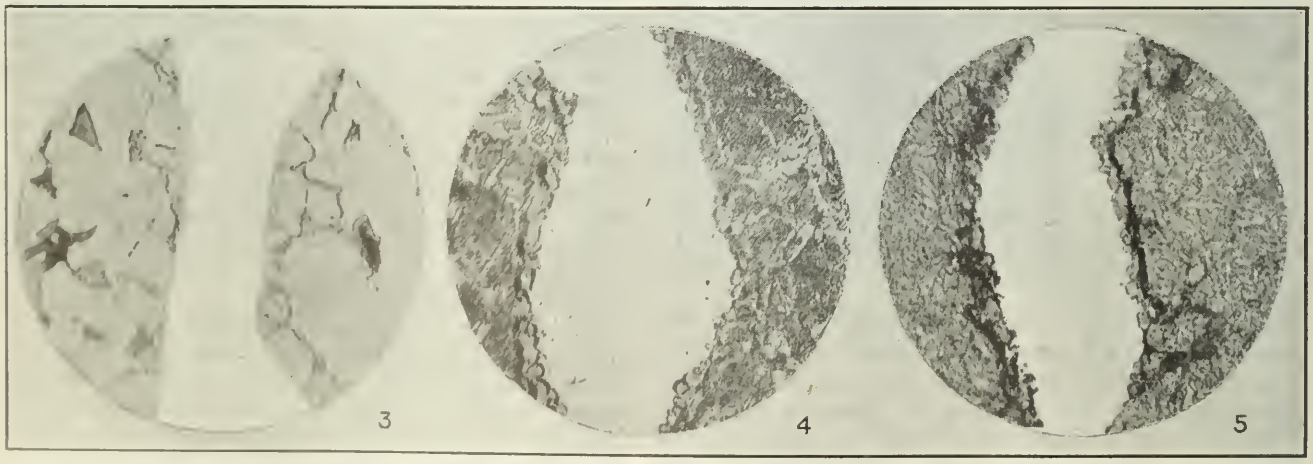
Low-Carbon Steel		Nickel-Steel	
Ultimate Strength Lb./Sq.In.	Character Of Fracture	Ultimate Strength Lb./Sq.In.	Character Of Fracture
495	Oxide	5,630	Oxide—¼ brazed
23,010	¼ brazed	30,280	¼ brazed
18,240	¾ brazed	36,550	$\frac{9}{10}$ brazed
19,900	¼ brazed	1,370	$\frac{1}{10}$ brazed
660	Oxide	22,420	¾ brazed
		25,000	¾ brazed

Thereupon another set of six each of nickel-steel and carbon-steel shear specimens was made, brazed and heat-treated. The final machining of this set of specimens was left until after the heat-treatment in order that the joints might be supported by the rivets during that operation. No shims were used in the joint. Brazing was done at 1,850 deg. F. under a deep flux of boric acid, and no cooling bath was used. Carbon steel was quenched from 1,600 deg. F., nickel steel from 1,500 deg. F. in oil, and all drawn back to 1,000 deg. F. after brazing but before machining. The results of this test are shown in Table VII.

Failure at low strength of nearly all of the heat-treated shear specimens cannot be satisfactorily accounted for, inasmuch as specimens of the same dimensions cut from the 6-in. spot-welded specimens gave good results. That the heat-treatment of first specimens weakened the bond cannot be doubted; since these were taken at random from the whole series, all brazed at the same time and under the same conditions, producing unheat-treated specimens which were uniformly good. Even heat-treating these last shear specimens with the rivets in both ends of each seemed to have somewhat of the same effect as it did on those that were machined before heat-treatment. But on none of the other types of specimens was there any detrimental effect from heat-treatment. It must be concluded, therefore, that the particular type of specimen that was used for shear tests was especially susceptible to deterioration. Just how extensive this may prove to be in airplane fittings cannot at present be stated, but no such trouble has thus far been experienced on brazed and heat-treated fittings made of nickel steel.

Metallography

Figs. 2 to 9, inclusive, are microphotographs taken of several representative brazed joints, all etched with 5 per cent HNO_3 in alcohol. Fig. 2 shows how the brass flows into a microscopic crack and it also demonstrates

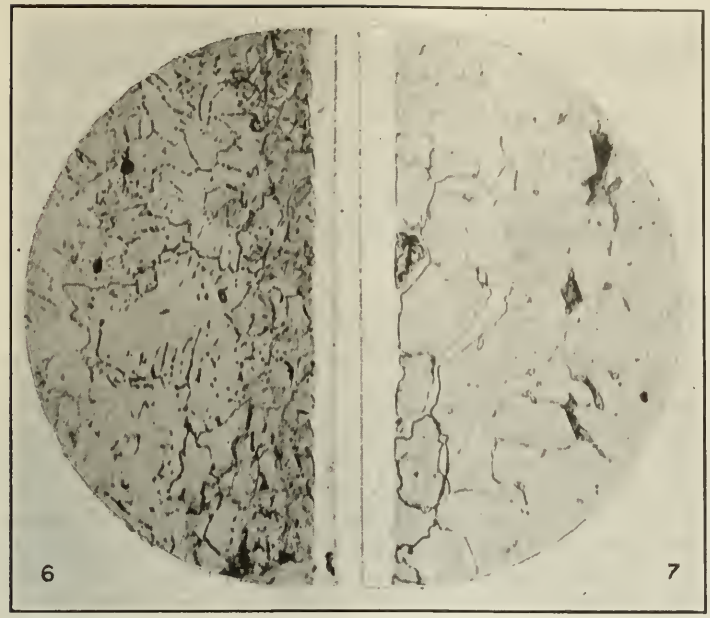


FIGS. 3 TO 5—SPECIAL INTERGRANULAR CONSTITUENT. × 350

Fig. 3—Low-carbon steel, no heat-treatment.

Fig. 4—Nickel-steel, no heat-treatment.

Fig. 5—Nickel-steel after heat-treatment.



FIGS. 6 AND 7—LAP JOINT IN CARBON STEEL, RESPECTIVELY BEFORE AND AFTER HEAT-TREATMENT. × 500

that this low-carbon steel does not develop large grains when brazed at 1,850 deg. F. Fig. 3 shows the same joint at a higher magnification, and reveals a constituent at the boundaries of the ferrite grains which has formed out of the brass in association with the iron. This constituent does not reveal itself to the eye on the unetched surface of the specimen, but after a light etch of nitric acid in alcohol it is clearly differentiated from the brass and the normal constituents of the steel.

Fig. 4 shows a similar constituent in a nickel-steel specimen. Here it presents a brownish tint when etched with HNO_3 instead of the gray color of Fig. 3, suggesting that the nickel in solid solution with the ferrite has also entered the substance which encroached upon the ferrite grain boundaries. In Fig. 5, heat-treated after brazing, this constituent shows a darker shade of brown, but with indistinct boundaries as in Fig. 4. All the remaining microphotographs show this constituent either in the light gray color or in the fuzzy brown. Note Fig. 7, in which it shows light colored with distinct boundaries, and Fig. 6, in which it is brown and fuzzy after heat-treatment. Note also that in all carbon steels, heat-treatment is necessary to cause diffusion of this constituent, while in the nickel steel the diffusion takes place before heat-treatment, and that the diffusion is accompanied by a change in color from gray to brown. As mentioned above, a very light etch is necessary to bring out any difference in color between the special constituent and the steel. There is apparently no tendency for the steel to diffuse into the brass, which is reasonable, since the steel remains solid, while the brass is molten.

The fact that all well-brazed joints which fail while being tested or otherwise do so by severing the brass and not by separating the brass from the steel is readily explained by the interlocking of the two by means of an intermediate constituent, which is undoubtedly stronger than the brass.

Summary and Conclusions

Preheating to a dull red just before brazing is found desirable, but a higher temperature or continued heating should be avoided on account of oxidation of the surfaces to be brazed. It is found advisable to coat the parts to be brazed with a paste made of borax and boric acid to prevent oxidation during preheating.

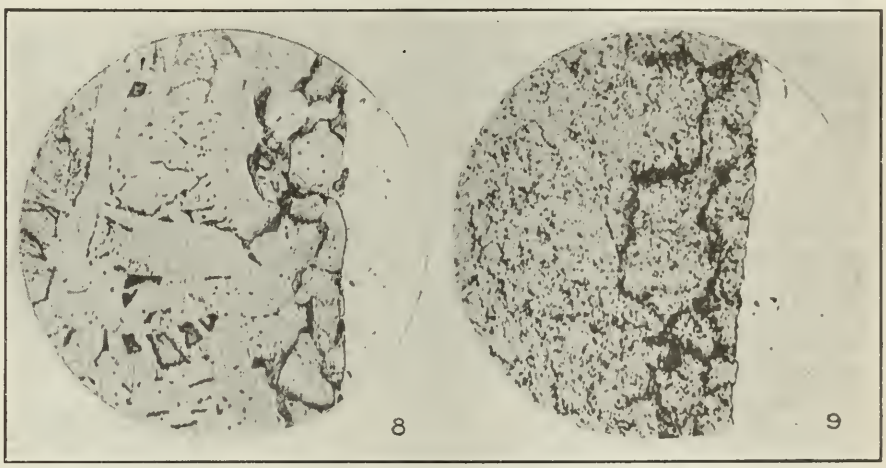
Borax gives the best joints when brazing with 80:20 brass, but should be used in connection with a cooling flux, preferably boric acid, in order to prevent surface oxidation of the specimen.

The proper brazing temperature is found to be 1,850 deg. F.

The best joints are obtained when the surfaces to be brazed are fastened close to each other by any suitable means without the use of shims or spacers.

The strength in pure tension of joints made with carbon steel, untreated, is approximately equal to the strength of the brass in tension. That of the nickel steel joints, heat-treated, is nearly twice the strength of the brass. The strength of joints in pure shear is approximately equal to the shearing strength of the brass. The shearing strength is also approximately equal to the tensile strength of the brass.

Nickel steel joints tested in shear give approximately the same results as carbon steel joints tested in shear.



FIGS. 8 AND 9—LAP JOINT IN NICKEL STEEL, RESPECTIVELY BEFORE AND AFTER HEAT-TREATMENT. × 350

Heat-treatment of brazed parts is shown to deteriorate certain types of joints brazed with 80:20 brass.

Metallographic study of brazed joints shows that low-carbon steel is not overheated by dip-brazing, and reveals an intermediate constituent between the brass and the steel which serves to hold the brass and steel together in the joint.

Aluminum Production in 1921

The value of the aluminum produced in the United States in 1921 was $10,906,000, as compared with $41,375,000 in 1920. This great decrease was due not only to a decrease in the price of the metal but to the large curtailment of its use in the automotive industries. Imported aluminum could be bought throughout the year at 2 to 3 cents below domestic prices.

The Lead Plate Test as Applied to Commercial Detonators

A Description of the Test and Series of Experiments Demonstrating Its Value in Grading Commercial Detonators According to Well-Defined Standards and Discussion of Various Factors Influencing the Efficiency of Commercial Detonators

By Bennett Grotta
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In THE entire realm of commercial explosives, no more important rôle can be found than that played by the seemingly insignificant detonator. The best explosive on the market will not function properly, if at all, with an improperly designed or defective detonator, while, on the other hand, comparatively low-grade explosives, ordinarily incapable of application, may be rendered most useful by employing specially constructed detonators. In short, the detonator is the brain and nerve system at whose command the brawn of high explosives is converted into useful work. It is doubtful if Nobel's invention of dynamite in 1864 would have been a memorable contribution to the development of commercial explosives had he not also, 3 years later, suggested the use of fulminating mercury detonators. Since that time numerous other explosive compounds have been proposed for a similar purpose, but as yet the advisability of wholly dispensing with fulminate of mercury has not been fully demonstrated.

That particular property of fulminate of mercury which renders it so well suited for initiating high explosives is difficult to describe; to devise an absolute test or means of measuring this property in fulminate of mercury or other compounds is still more difficult. Yet the need for such a test which is capable of application and interpretation, by either the maker or user of explosives, is urgent. The user could avoid many costly and dangerous misfires if he would only ascertain whether his detonators were efficient and in good condition. Manufacturers of commercial explosives would be spared many unjustified complaints if the use of inefficient and defective detonators could be eliminated.

Numerous tests have been proposed during the history of commercial detonators, but of these there is one which has survived the trial of more than a quarter of a century of extensive application and which is today the most widely known and universally used of all. It is known as the lead plate test and consists of firing a detonator while supported in a vertical position, its base resting on the center of a lead plate about 1½ in. square by $\frac{3}{8}$ in. thick. The purpose of this article is to describe the application of the lead plate test, the interpretation of results in terms of ability to initiate commercial explosives, and also to describe some of the factors which affect the efficiency of detonators as revealed by this test.

Device Used for Test

A very satisfactory lead plate testing apparatus is shown in Fig. 1. As many as seventy tests per hour have been made with this machine. Another modification is shown in Fig. 2. It should be observed that the essential feature of both types is a hollow support for the lead plate and a device for supporting the detonator, crimped onto a short section of fuse in a vertical position and in the center of the lead plate. The tester in Fig. 1 may be adjusted for various sizes of detonators by changing the position of the cotter pins in the upright standards. The tester in Fig. 2 may be adjusted by merely sliding the horizontal bar up or down on the two vertical standards. A complete tester could be made by any blacksmith in an hour's time and would be ready for immediate use in any well-barricaded location.

Lead plates may be cut from 12-lb. sheet lead, but it is more convenient and economical to buy the plates ready cut.[1] Tape fuse may be purchased in 2-in. lengths, which are convenient when a large number of tests are to be made.[2] Ordinary safety fuse, however, is entirely satisfactory. The barricade should be either of wood at least 2 in. in thickness or of sheet iron at least $\frac{1}{8}$ in. in thickness. Lighter lumber may be used if the barricade is steel lined. Obviously, the same tester may be used for testing electric detonators, the only difference being that the lead wires, instead of the fuse, are threaded through the guide, and the detonator is fired from a safe distance by means of an electric battery.

Interpretation of Plate Tests

The appearance of the lead plate after the detonator is fired furnishes a pictorial representation of the explosive action of the detonator charge. In the center

[1]Ready cut lead plates may be obtained from the United Lead Co., Philadelphia.

[2]Two-inch lengths of fuse may be obtained from the Ensign Bickford Co.

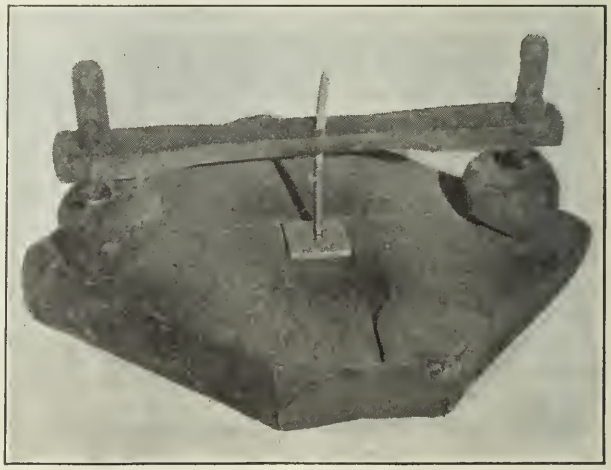


FIG. 1—DEVICE USED FOR LEAD PLATE TEST, SHOWING PLATE AND DETONATOR IN PLACE

of the plate at the point of contact with the base of the detonator there occurs a depression which is dependent for depth both upon the size and quality of the detonator. Radiating from this central depression or perforation, as the case may be, are numerous striations of fine dotted lines. These striations constitute the real index to the quality of the detonator and the explosive effect of its composition. Each dotted line is the result

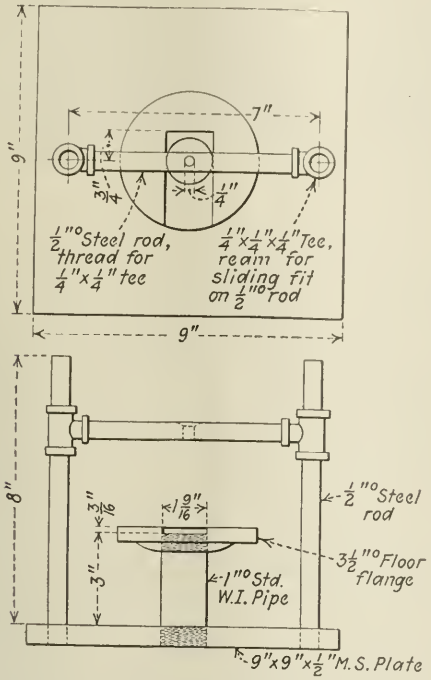


FIG. 2—TESTING DEVICE MADE FROM STANDARD PIPE FITTINGS

of a glancing blow inflicted by a single particle of the detonator shell.

The detonation of a good quality fulminate of mercury charge bursts the shell wall into innumerable concentric rings, each of which is, in turn, shattered into numerous small fragments. As the quality of a fulminate of mercury detonator is lowered, the size of the shell fragments becomes larger, due to a less brusque

TABLE I—TABULATED DESCRIPTION OF LEAD PLATES

Classification	Quality of Detonator	Indentation	Back Side of Plate	Radiations	Pittings	Remarks
A	Good	Deep, very often penetrating plate	Peeled	Fine Uniform	None	
B	Good	Deep, very often penetrating plate	Peeled	Practically uniform	Few Small	
C	Fair	Deep, very often penetrating plate	Peeled	Practically none	Large and deep	
D	Bad	Broad shallow	Not peeled	None	Large and deep	
E	Bad	Small, shallow	Not peeled	None	Large and deep	Often broad ribbon-like markings on face of plate.
F	Bad	Small, shallow and covered by remains of shell	Not peeled	None	Large and deep	Bottom and part of shell wall left on plate

action of the explosive charge, and radial striations on the lead plate tend to be replaced by large pittings or splotches at irregular intervals on the face of the lead plate, these pittings being caused by the larger fragments. If the detonator is of a very low quality, due to prolonged exposure to moisture, a defective grade of fulminate, a faulty mixture or any other cause, so that it may be practically worthless for detonating commercial powders, it will not shatter the shell into numerous small fragments, but will merely rupture the casing into a small number of broad strips. Consequently, with this detonator there are neither striations nor pittings, but instead, a few broad, ribbon-like impressions radiating from an almost imperceptible depression where the detonator was in contact with the lead plate.

Standards for Lead Plate Tests

As a matter of convenience, the various graduations of quality are classified according to six different standards, which are, in turn, designated by the first six letters of the alphabet, A being taken as 100 per cent and F as zero per cent quality. Fig. 3 shows a set of standards which represents the best judgment avail-

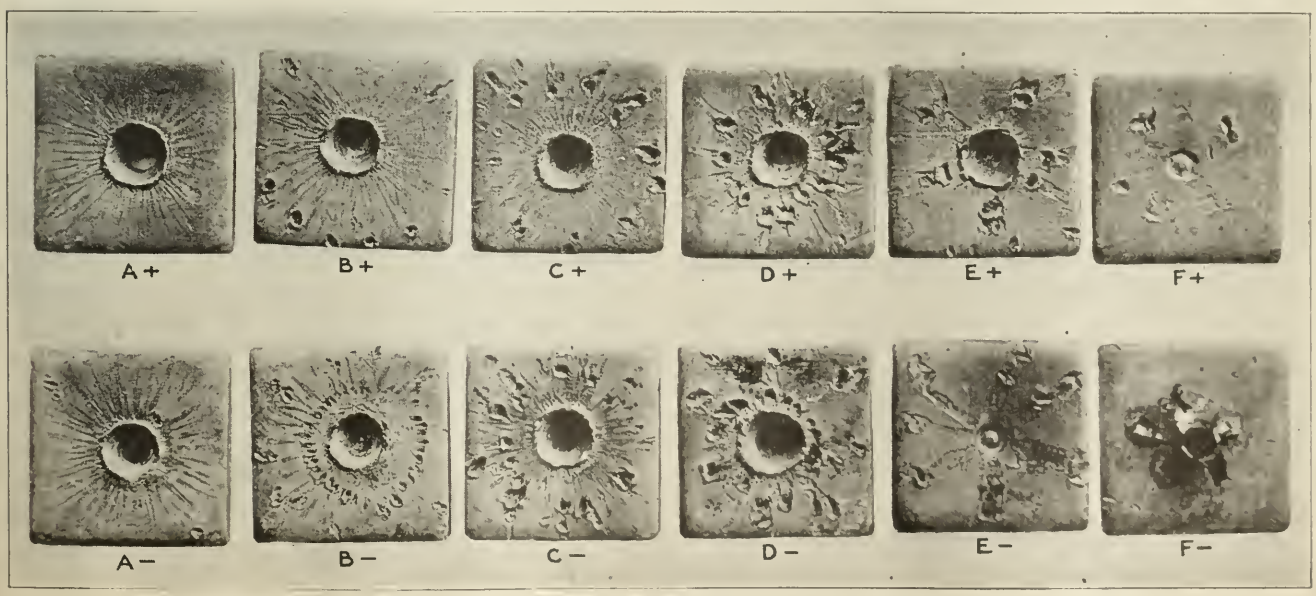


FIG. 3—SET OF STANDARD LEAD PLATES

able from several years of both intensive experience with fulminate detonators and also rather extensive experimental work with numerous other initiating compounds.

It will be observed that two plates are given for each designation, the upper plate being designated as "plus" (+), and the lower plate as "minus" (—). This is merely for the purpose of simplifying the application of the standards. Obviously, but few of the plates obtained in practice might exactly coincide in appearance with any one of a set of six hard and fast standards. Therefore, rather than a set of fixed averages, the upper and lower limits of each classification have been given. Equipped with a set of these standards and a tabulated set of descriptions as given in Table I, any one, no matter how unversed in the technique of explosives, should be able to determine the quality of the detonators he is using.

In recent years, plates made of aluminum instead of lead have become popular with salesmen, demonstrators and others who are in a position to appreciate the lightness of aluminum as compared with lead. A critical comparison of aluminum and lead plates for testing detonators has indicated that approximately similar results are obtained with both metals. Aluminum being a much harder metal, however, the impressions are not nearly as well defined as on lead plates, and it is therefore impossible to judge as closely the quality of the detonator. While lead is preferable, in general what applies to lead plates also holds true for aluminum plates.

Tests of Initiating Detonation of Explosives

It is axiomatic that the ultimate test for any detonator is its ability to initiate the detonation of commercial explosives. While, however, it is self-evident that the ideal detonator test is the detonation of dynamite, it is also obvious that such a test would involve a large number of trial shots which would make it too cumbersome and too costly for general application. In order that the results of the lead plate test might be capable of interpretation in terms of initiating value, it has been carefully calibrated by a direct comparison with several different series of dynamite detonating tests. The lead plate test has been described from time to time,[3] but as yet the actual significance of its results has not been demonstrated.

The initiating value of commercial No. 6 detonators, both as received and from lots representing two different stages of deterioration, as indicated by the lead plate test, was ascertained by using these detonators with several different lots of commercial explosives of various degrees of sensitiveness. The results of these tests are given in Table II.

The explosive used in series A consisted of a mixture of 92 parts of TNT and 8 parts of iron oxide (Fe_2O_3). This is an insensitive mixture that is frequently used by explosives manufacturers to establish various degrees of insensitiveness. By varying the iron oxide content, the susceptibility of the mixture to detonation may be closely controlled. The explosive used in series B was a straight nitroglycerine high-freezing dynamite giving an unusually high sensitiveness value. In series C, D and E, inclusive, commercial low-freezing explosives of various degrees of sensitiveness were used. Sensitiveness of the various explosives was determined as follows:

A standard cartridge of the explosive, 8 in. long by 1¼ in. in diameter is cut into two 4-in. sections. These two sections are then placed in a snugly-fitting paper cylinder, made of several layers of heavy wrapping paper, with the cut ends adjacent to each other. The detonator is fitted into one section and the maximum distance at which the two sections may be separated and still obtain propagation of the explosive wave from the first to the second section is determined by trial.

In test 1, No. 6 commercial detonators were used throughout. These detonators were supplied by a well-known manufacturer of detonators and were of the same type as the large majority of detonators now on the market. The explosive charge consisted of 1 g. (15.43 grains) of a mixture of 80 parts of fulminate of mercury and 20 parts of potassium chlorate. The detonators were of a regular run and were aged for several weeks in ordinary magazine storage before being used.

In test 2, No. 6 commercial detonators which showed partial deterioration due to wet storage were used. Ordinary detonators were placed in a humidor containing water, a small number were tested on lead plates every day and when B to C lead plates were obtained consistently the remaining caps were used for dynamite-detonating tests. In test 3 the deterioration was carried on until the detonators gave E to F lead plates consistently.

Typical lead plates of the above three lots of detonators are shown in Fig. 4. Interesting additional information on the disruptive effect on the shell of various detonators was obtained by firing the detonator in a bomb filled with ordinary salt. The salt was then dissolved in water, leaving behind the fragments of the detonator shell. From 92 to 98 per cent of the weight of the shell was accounted for in this way. The fragments from detonators used in dynamite-detonating tests 1 and 3 are shown in Figs. 5 and 6. It might be well to note that detonator shells from the same lot were used throughout in the manufacture of these detonators. This would preclude any assump-

[3] H. Bigg-Wither, *Trans.*, Am. Inst. Mining Met. Eng., 1900-1901, p. 442. A. Langhans, *Z. ges. Schiess-Sprengstoffw.*, vol. 13, pp. 97, 119, 172, 192, 208, 227, 249, 269, 289, 328, 431 (1918), C. S. Hurter, *Eng. & Min. J.*, vol. 113, p. 322 (1922).

TABLE II—DYNAMITE-DETONATING TESTS

No. of Test	Detonator Used	Series A 92 Per Cent TNT 8 Per Cent Fe_2O_3 Shots	Series A Results	Series B 50 Per Cent High-Freezing Dynamite Shots	Series B Results	Series C 40 Per Cent Low-Freezing Dynamite Shots	Series C Results	Series D 40 Per Cent Low-Freezing Dynamite Shots	Series D Results	Series E 40 Per Cent Low-Freezing Dynamite Shots	Series E Results
1	No. 6 commercial detonators. As received	15	4 D 11 F	10	Sensitive at 36 in.	10	Sensitive at 18 in.	10	Sensitive at 10 in.	10	Sensitive at 1 in.
2	No. 6 commercial detonator from wet storage. B to C lead plates	10	3 D 7 F	..	.....	..	.....	..	.....	..	.....
3	No. 6 commercial detonators from wet storage. E to F lead plates	..	..	10	10 D 0 F	10	2 D 8 F	10	0 D 10 F	10	0 D 10 F

D represents detonation of explosive. F represents failure to detonate.

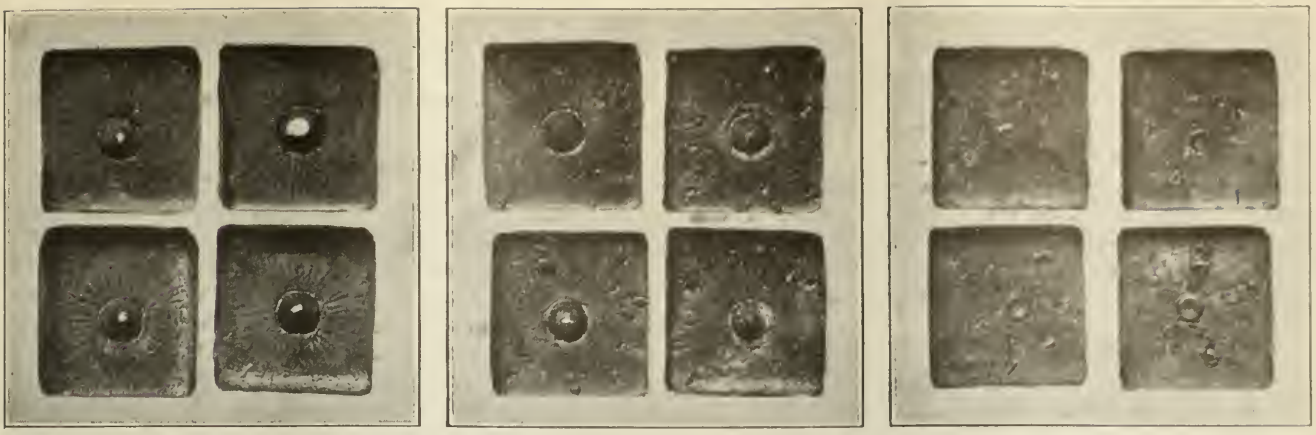


FIG. 4—REPRESENTATIVE LEAD PLATE TESTS OF COMMERCIAL DETONATORS USED IN DYNAMITE DETONATING
Test 1 Test 2 Test 3

tion that the variations in fragmentations could be attributed to variations in hardness or in the degree of annealing of the shells—a point which is further considered in a later section of this article.

The significant result of the various dynamite-detonating tests may be summarized as follows:

1. Detonators, giving A to C lead plates inclusive, are suitable for detonating commercial explosives. Although it was not possible to distinguish between these classifications in detonating value, there is no doubt that detonators giving A plates are somewhat superior to C detonators. A possible explanation of the difficulty in distinguishing between the efficiency of these classifications is given later. At any rate, a preponderance of C plates in a lot of detonators indicates a general state of deterioration which may soon lead to a lower quality detonator, of questionable efficiency.

2. Detonators giving E to F lead plates may detonate extremely sensitive dynamites, but are useless for ordinary grades of commercial explosives. Furthermore it is doubtful if even the most sensitive explosives may be detonated to their maximum efficiency with a detonator of this classification.

3. Detonators of the intermediate classification of quality, giving D lead plates, should be classed with E and F lead plates with respect to initiating value.

FIG. 5—DETONATOR SHELL FRAGMENTS FROM NO. 6 COMMERCIAL DETONATOR USED IN DYNAMITE-DETONATING TEST 1

Several attempts were made to prepare D detonators, but it was found that when D quality was attained the lot would also contain a large number of E to F detonators and it was impossible to confine the deterioration to the D stage. Therefore, if for no other reason, D detonators may be condemned because of bad company.

Factors Influencing Detonation of Explosives

It is not within the scope of this article to discuss the theory of detonation, but in order to indicate an agreement between the lead plate test and the modern conception of the mechanics of detonation, reference will be made to a few generally accepted theories.

Commercial explosives are brought to a state of explosion by the generation of a sudden impulse by the detonator. In its ultimate analysis this impulse consists of an enormous local application of heat, but for practical purposes it may be observed that two distinct factors enter into the development and application of this impulse. These are quickness or brisance, and strength. In a well-designed detonator it is impossible to isolate these two factors, but both properties must be present in correctly balanced proportions, otherwise an inefficient detonator will be obtained.

Velocity of the chemical reactions involved is a function of quickness, while the total volume of the gaseous combustion products is a function of strength. Of these two properties quickness is by far the more important. In fact, it is conceivable that the element of strength is of importance only in that it sustains for an instant the concussion produced by the initiating impulse, and thereby tends to compensate for the dissipation of explosive energy up to and during that instant of application. Many compounds might be cited which excel fulminate of mercury in strength but which are useless for detonating purposes; also many compounds might be mentioned which excel in quickness but which are vastly inferior to fulminate in initiating value.

The lead plate test is essentially a measure of quickness. Strength may be estimated by either the modified Trauzel block[4] test or the sand test.[5] The reduced efficiency of detonators having impaired brisance or quickness is clearly demonstrated in the dynamite-detonating tests above in which E to F detonators were

[4]Colver, "High Explosives," p. 552 (1918).

[5]Storm and Cope, "The Sand Test," Bureau of Mines Technical Paper 125 (1916).

used. A reasonable explanation of the inability to distinguish between the efficiency of A and C detonators is that in an ordinary No. 6 detonator there is always a great excess of the strength element. Formerly, detonators containing but a fraction of a No. 6 charge were used extensively. The presence of this great excess of strength tends to mask any slight diminution in the element of quickness. Without doubt, a similar series of dynamite-detonating tests on No. 3 detonators (containing 0.54 g. of a fulminate-chlorate mixture) would reveal a lowered initiating efficiency with

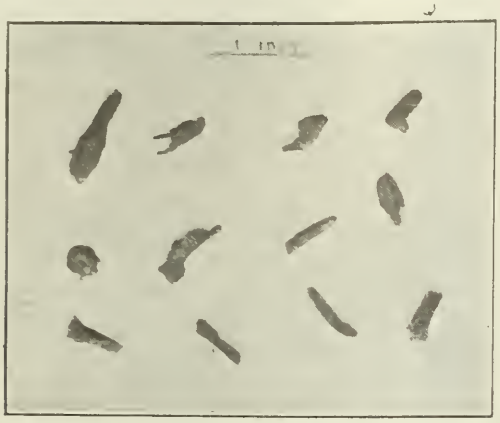


FIG. 6—DETONATOR SHELL FRAGMENTS FROM NO. 6 COMMERCIAL DETONATOR (WET) USED IN DYNAMITE-DETONATING TEST 3

each descending classification of lead paste. Since, however, No. 6 detonators comprise the bulk of the commercial article (in many countries it is illegal to market a detonator weaker than No. 6) all tests were confined to this grade.

Factors Affecting Efficiency of Detonators

An intensive study of the lead plate test would be incomplete without a consideration of the various factors which affect the efficiency of detonators as revealed by the lead plate test. The more important of these factors will be briefly reviewed in the following order:

1. Size of charge.
2. Moisture.
3. Potassium chlorate content.
4. Indentation of shells.
5. Hardness of detonator shells.

As was pointed out in a previous section of this article, the lead plate test is a measure of quickness rather than strength. The element of quickness in fulminate of mercury detonators does not vary greatly with the size of charge. Therefore the lead plate test does not indicate variations in weight of charges. This is demonstrated by the lead plates of No. 8 commercial detonators in Fig. 7. A No. 8 detonator contains just twice the charge of a No. 6 detonator.

It is true that, all other conditions being the same, the indentation in the center of the plate increases in size with the size of the charge. As the indentation is dependent on other factors also, and since the most pronounced variations are but slight, this is not a reliable index of weight of charges even in the hands of the explosives expert. It is gratifying to note, however, that under modern conditions of manufacture the tendency to produce undercharged detonators is rather remote. Reliable manufacturers build their charging machinery to deposit a standard charge and, when once constructed, it is practically impossible to operate these machines so as seriously to "short-weight" the detonator. Thus it is evident that this limitation of the lead plate test does not constitute an objection to its universal application.

Effect of Moisture

Moisture is universally admitted to be the greatest enemy of efficient detonators. This one factor is without doubt responsible for a very large majority of all detonator ills. An almost imperceptible moisture content is sufficient to impair seriously the ability to detonate commercial explosives. The E to F detonators used in the above dynamite tests were taken from a lot in which the explosive charge contained less than 1 per cent of moisture, while the moisture content of B and C detonators is scarcely weighable. Although the hygroscopicity of the potassium chlorate content is usually blamed for any tendency to take up moisture, the presence of a deliquescent salt is not a prerequisite for deterioration in wet storage. A fulminate charge absorbs sufficient moisture from condensation and capillary action to cause a rapid decline in efficiency under certain conditions. F detonators have been produced in two days storage in a humidor during certain summer seasons when there have been extreme changes between day and night temperature. Similar conditions prevail in many mines and most mining engineers are beginning to realize the importance of the "gospel of dry detonators." In addition to being urged to keep his detonator in a dry place, the blaster should be provided with facilities for making lead plate tests and encouraged to check up the efficiency of his detonators from time to time. Such a program would eventually yield big returns for the user, and also, indirectly, for the manufacturer of explosives.

Effect of Potassium Chlorate Content

Straight fulminate of mercury is seldom if ever used for detonator charges. This is due to the fact that, by itself, this compound is deficient in certain elements necessary to produce the maximum volume of combustion products, or, in other words, the maximum strength. Potassium chlorate is now used almost exclusively for the purpose of supplying this deficiency and it has been shown, both by chemical equations and actual experiments, that the most efficient mixture, from a standpoint of strength, is approximately 80 per cent fulminate of mercury and 20 per cent potassium

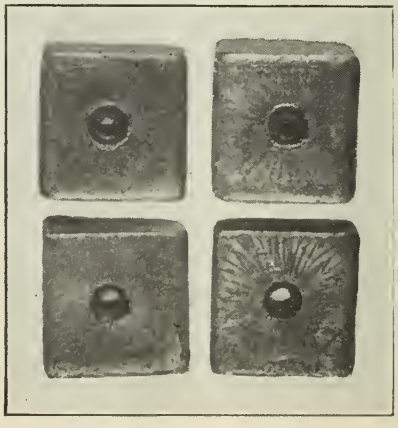


FIG. 7—LEAD PLATES FROM TESTS OF NO. 8 COMMERCIAL DETONATORS

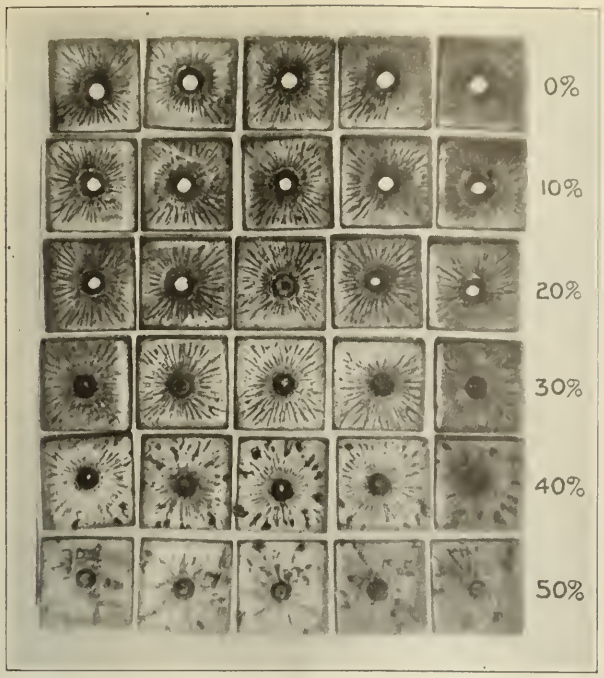


FIG. 8—EFFECT OF VARYING POTASSIUM CHLORATE CONENT (0 TO 50 PER CENT) IN NO. 6 DETONATORS

chlorate. The admixture of potassium chlorate in large quantities tends to detract from the element of quickness as indicated by the lead plate test, but without doubt the considerable increase in strength from the admixture of 20 per cent potassium chlorate more than compensates for any diminution of brisance. Fig. 8 shows the effect on detonators, as indicated by the lead plate test, of varying the chlorate content from 0 to 50 per cent.

Effect of Indentation of Shells

It is quite generally admitted by manufacturers of detonators that the efficiency may be modified by the shape of the detonator shell base. The shells of most commercial detonators bear a conelike indentation which tends to improve the quality of the lead plate both by rendering the radiations finer and more uniform and by causing a deeper indentation. Numerous explanations have been proposed for this improvement. Most of these explanations have been vague and fanciful and probably justly so, because it is very difficult to make accurate conjectures on such minute details in the mechanics of explosives.

In order to ascertain whether or not this indentation actually effected a more pronounced explosive action, or if the improvement were only superficial, several experiments were made which yielded rather interesting results. Two cartridges of 60 per cent gelatine dynamite 2x8 in. were placed on end on steel plates 5 in. square by 1 in. thick. Each steel plate was supported on a short section of wrought-iron pipe 2 in. in diameter, which, in turn, was placed on a rock foundation. A conelike indentation about $\frac{3}{4}$ in. in diameter by 3 in. deep was made in the lower end of one cartridge and the other cartridge was left intact. Both were detonated with No. 6 detonators.

The appearance of the steel plate after the shot indicated that the explosive effect had been greatly concentrated at the base of the "indented" stick of dynamite. In Fig. 9 *A* and *B* show the upper sides of the plates on which the indented and unindented sticks of dynamite, respectively, were detonated, while *C* and *D* show the reverse sides of the same plates in the same order.

In another series of tests made in connection with the effect of the detonator indentation, a number of commercial detonators were tested on lead plates, one half tested as received and the other half with the indentation filled with putty. The results (see Fig. 10) indicate that even though the indentation be filled with a plastic material, as is the case when the detonator is imbedded in a cartridge of dynamite, the advantage of this indentation is not abrogated.

But even after demonstrating that the indentation does effect a more concentrated explosive effect the task of presenting a suitable explanation remains. The diagram in Fig. 11 is intended to illustrate the lines of explosive force radiating from the interior surface of the indentation at the instant of detonation. These lines of force, or "explosive waves," always travel from the surface of the explosive by the shortest route—i.e., at right angles with respect to the surface of the explosive. Thus it is evident that in a perfect indentation—i.e., a 45 deg. cone, every line of force must collide with another line of force coming from the other side of the cone, the place of collision being the line of center. The result of these countless collisions, taking place simultaneously, is an added concussive effect or a greater concentration of explosive effect. A well-known example of a similar effect may be found in the ordinary Dautriche lead bar method of determining the velocity of detonation of powders.[9] An explosive wave is induced at the opposite ends of a small column of TNT. At the point where these waves collide a tremendous

[9]Dautriche, *Compt. rend.*, vol. 143, p. 641 (1906).

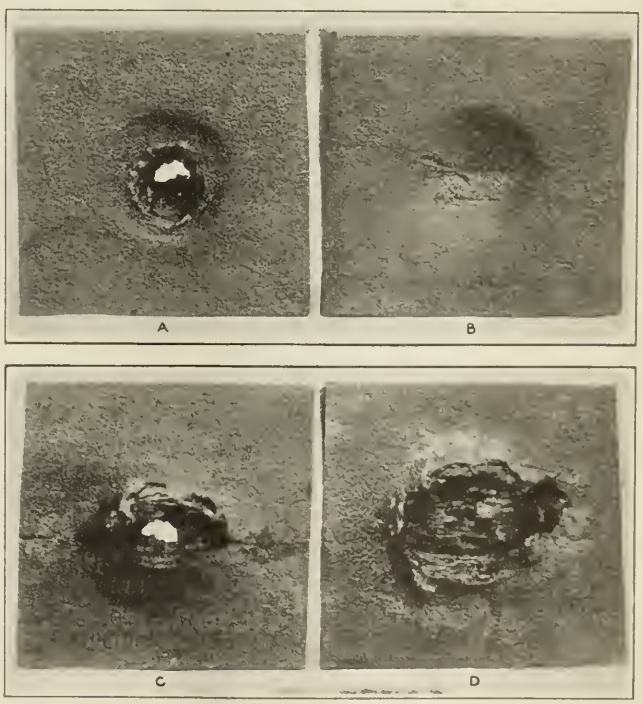


FIG. 9—COMPARATIVE EFFECT OF TWO CARTRIDGES OF 60 PER CENT GELATIN DYNAMITE ON STEEL PLATES. 1 x 5 x 5 IN.
A and B—Indented and unindented cartridges, respectively.
C and D—Reverse sides of plates, in same order.

concussion is produced, the effect of which may be discerned even on the reverse side of a lead bar ½ in. in thickness.

Effect of Hardiness of Shell

One of the very few objections which have been advanced against the lead plate test, and this is merely an imagined fault, is the belief that the quality of the test plate is greatly affected by the hardness or the softness of the detonator shell, thereby making possible the masking of a defective explosive composition by

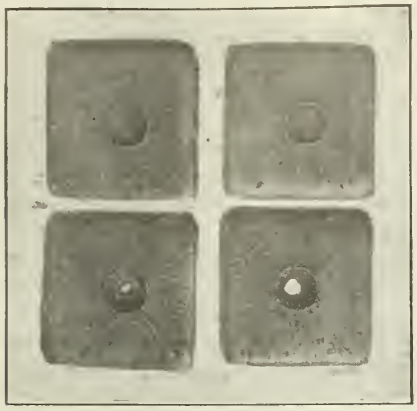


FIG. 10—LEAD PLATE TESTS ON NO. 6 DETONATORS WITH INDENTATION FILLED WITH PUTTY

using shells that are slightly harder or softer than normal. The fallacy of this assumption was demonstrated by the following experiment:

No. 6 commercial detonators were prepared using (*a*) gilding metal[1] shells that had not been annealed during any of the drawing operations and which represented an unusually high degree of hardness, giving a Shore scleroscope value of 58 to 60, and (*b*) shells of the same metal but which had been specially annealed to produce a soft shell, giving a scleroscope value of 36 to 38. Lead plates from both lots of detonators are shown in Fig. 12. These lead plates indicate that in a good quality detonator the resistance offered by the shell wall to the explosive force is so nearly negligible that the widest possible variations in shell hardness do not noticeably affect the disruptive action.

FIG. 11 — DIAGRAM ILLUSTRATING THE CONCENTRATED EXPLOSIVE EFFECT AT BASE OF INDENTED DETONATOR

In order to determine the range of variations in hardness between shells of commercial detonators a large number of scleroscope tests were made on a number of shells from detonators of the four leading manufacturers. The following four averages were obtained: 40, 41, 43, 44.

An attempt has not been made to cover the entire field of commercial detonators. Many points of theoretical interest might be included, but it has been the aim of this article to give only actual experimental data which would be helpful to explosives engineers and others who are interested in results rather than theories. Without doubt, a more intelligent and a more extensive application of a reliable detonator test will

[1]Gilding metal is the term applied to a copper alloy of approximately 90 per cent copper and 10 per cent zinc, which is used almost exclusively for detonator shell casings.

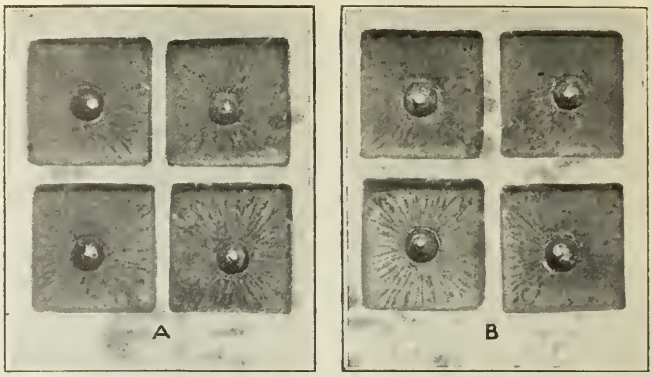


FIG. 12—TEST PLATES FROM NO. 6 COMMERCIAL DETONATORS
A—Annealed shells B—Unannealed shells

do much to promote efficiency and safety in the use of explosives.

"Know your detonator" should be the adopted slogan of every user of industrial explosives.

Acknowledgments

R. L. Hill and R. M. Cook have given much valuable aid in preparing the material for this article. Particularly the writer is indebted to Mr. Hill for helpful suggestions in conducting the various tests and in coordinating the results, and to Mr. Cook for the dynamite-detonating tests.

Liquid Soaps From Coconut Oil

By Michael Doniger

LIQUID SOAP may be described as an aqueous solution of soap, more particularly of a neutral potash soap. Its normal ingredients are water, glycerine and the potash soap of coconut oil. To be sure, liquid soap can be prepared from oil other than coconut, but it may be safely said that in most of these products consumed at the present time coconut oil is the fatty base, either singly or as the major component. This is not only because the properties of coconut oil fit it admirably for this purpose, but also because its cost is generally below that of any competing oil.

Ordinary solutions of soap in water are cloudy; properly made liquid soaps are clear, transparent and sparkling. These desirable properties depend to a large extent upon the presence of glycerine, alcohol or cane sugar in the finished product, but there are also certain important steps in the manufacture of this product which materially affect these characteristics.

Preparing a Clear Product

A liquid soap prepared from coconut oil and containing 35 or 40 per cent of anhydrous soap will remain clear and transparent for an indefinite period at a temperature of or above 60 deg. F. If 40 or 50 deg. F. is maintained for a few weeks, however, soap crystals will gradually be forced out of the solution. These flocculent crystals, consisting largely of the soaps of lowest solubility, rise to the top rather slowly. Under these conditions the solution acts like one that is supersaturated, and by the agency of heat alone it is difficult to dissolve the crystals and thus re-form a clear solution. As long as the temperature stays at summer heat and the proportion of glycerine naturally occurring in the soap is sufficiently great, a liquid soap that

will remain clear and transparent can be prepared without the aid of any alcoholic clarifier. The first-named condition, however, is generally impracticable and the manufacturer is forced either to add glycerine or alcohol or else turn out a cloudy product. Glycerine is a valuable addition, since it has emollient properties; alcohol is of additional value because it commonly serves as the perfume carrier. Cane sugar, on the other hand, with its total lack of detergent properties, and its stickiness, should be used only in the cheapest goods.

Cause of Cloudiness

Another cause of cloudiness is the presence of insoluble soaps, more particularly the lime soaps. In contradistinction to the turbidity caused by the precipitation of soda and potash soaps, the insoluble soaps sink to the bottom of the liquid and must be separated by filtration or sedimentation rather than by the use of an alcoholic clarifier. If the manufacturer uses distilled water, practically no insoluble lime soap will be formed. The expense is generally prohibitive, however, and the best procedure is to use a good soft water, and if a clear product is wanted, to filter the liquid soap or permit it to settle in a tank.

Other Manufacturing Requirements

It is essential that a good quality of caustic potash be used. The commercial 88 to 92 per cent grade is dissolved in the proper proportion in a covered iron tank and the insoluble impurities permitted to settle. After a short while the clear, supernatant liquid can be siphoned off and used.

Operations in Liquid Soap Manufacture

Liquid soap manufacture may be said to involve two operations: Preparation of the soap paste and the solution of this paste in the liquid. The paste soap, which is made by the usual procedure of the soapmaker, resembles bleached petrolatum in appearance. If a pale liquid soap is desired, only the best raw materials are permissible and the soap paste should be made by the so-called cold process. This manner of treatment requires great care in order to insure complete saponification; otherwise the soap paste will gradually turn yellow.

Selection of Oil Important

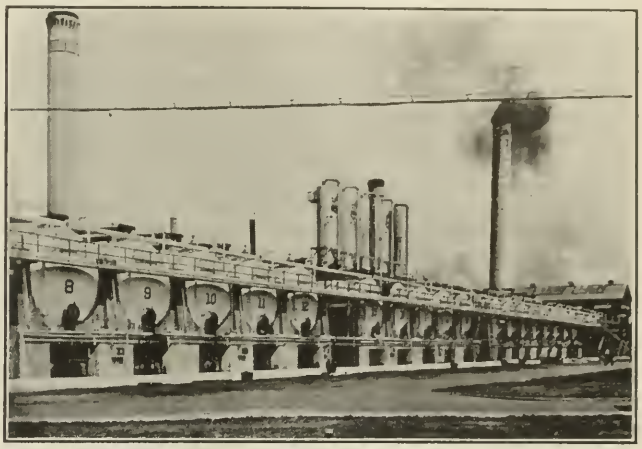
Since the oil used is one of the most important considerations, care should be taken in its selection. A good grade of coconut oil is of light color, free from objectionable odor, low in fatty-acid content, and contains practically no impurities. The ordinary Manila grade of oil, which is dark in color and has a strong empyreumatic odor, serves very well for the cheapest grade of liquid soap. Better qualities of oil are used, however, for the higher grade products. An oil of Cochin quality will furnish the base for such a product. A very superior liquid soap, practically water-white, clear and transparent, with an anhydrous soap content of 40 per cent and quite viscous, is made of an oil, the fatty-acid content of which has been reduced to about 5 per cent. Such an oil is pale yellow in color—ten yellow and one and a half red—on the color tester. Some soapmakers prefer to use refined edible oil for the highest grade goods, but this serves no better purpose than the cheaper oil and, in addition, is harder to saponify.

Brooklyn, N. Y.

Synopsis of Recent Chemical & Metallurgical Literature

Recovery of Gasoline From Uncondensed Still Vapors.—D. B. Dow, petroleum engineer of the Bureau of Mines, has recently completed a study of the different processes for the recovery of gasoline from uncondensed still vapors. This has been published in mimeographed form as Serial 2,344, *Reports of Investigations*, April, 1922. He estimates that 50,000,000 gal. of gasoline was recovered from uncondensed still vapors at refineries in 1921. Application of the system to all refineries would give a possible gasoline recovery by this method of 170,000,000 gal. yearly. Space limitation prevents giving a detailed account of this interesting, illustrated report, but an attempt is made in the following paragraphs to summarize briefly its salient features.

In the distillation in refineries appreciable amounts of the vapors are not condensed by the ordinary condensing equip-



BATTERY OF TWENTY CRUDE OIL STILLS CAPABLE OF HANDLING 10,000 TO 25,000 BBL. PER DAY. COSDEN & CO., TULSA., OKLA. (Photo by Bureau of Mines)

ment. The amount of vapor remaining uncondensed depends upon the following factors: (*a*) The amount of uncondensed vapors is proportional to amounts of gasoline produced. Other conditions being equal, more uncondensed vapor will be lost from a refinery which has increased the gasoline yield from crude by installing cracking stills than in a skimming plant which obtains only the gasoline present in the natural state. (*b*) A crude oil which gives a very volatile gasoline will lose more from uncondensed vapors than will a crude which contains gasoline of low volatility. (*c*) Summer losses due to uncondensed vapors are higher than winter losses. (*d*) The higher the temperature of the stream the greater will be the amount of uncondensed vapor. The stream temperature is directly dependent upon the temperature of cooling water and coil surface.

Experiments show that with stream temperatures exceeding 85 deg. F. the volumes of uncondensed vapors become increasingly large. Experimental data and plant data are given in the report which show effects of varying conditions of temperature.

A survey of 13 refineries of the United States which recover the gasoline from uncondensed vapors shows: A total crude charge for these refineries of 355,486 bbl. per day; a recovery of gasoline from uncondensed vapors of 128,651 gal. per day, which gives an average recovery of 0.444 gal. of gasoline per barrel of crude, or a recovery of 1.05 per cent of crude as gasoline which would otherwise be lost.

In operating a recovery plant on uncondensed vapors, one of the methods used for collecting vapors is as follows: A small vacuum is held on run-down lines where the vapors are

trapped off by means of goosenecks. This gas passes through traps which remove any condensate carried in the lines. The vacuum is held by either the intake of a compressor or in larger installations by means of an exhauster. When gas of high sulphur content is encountered, a unit for the removal of sulphur must be installed. This is accomplished by scrubbing the gas with a solution of caustic soda or suspended solutions of oxides of iron or lime.

In recovering gasoline from still vapors several different processes can be used: (*a*) The compression process is the more common, and consists of compressing the gas to a high pressure and cooling. This condenses the gasoline vapors and does not materially affect any permanent gas which may be present. (*b*) The absorption process consists of absorbing gasoline from the gas by passing it through a lower gravity distillate. When naphtha is used as the absorbent the naphtha is raised in gravity to the point where it may be marketed as gasoline. When a heavy gas oil distillate is used, the gasoline is separated from the gas oil by distillation. (*c*) Combination of the two methods is made use of when the gas after compression is passed through absorption towers.

Atmospheric temperature is an important factor in the production of gasoline from uncondensed refinery vapors. It is found that during winter months, due to more complete condensation of the vapors, the production of the "gas" plant will fall off to some extent. An unusual example of this is a certain skimming plant which produces about 6,000 gal. of compression gasoline daily through the summer months, but drops to as low as 500 gal. per day in the winter. Ordinarily, the difference is far less, but there is always a tendency for production to drop in cooler weather.

The cost of installing recovery plants will necessarily vary with different plants, depending on local conditions such as the distances between different stills which are sources of gas, the nature of gas, especially in regard to sulphur content, and the plant efficiency. However, a cost of approximately $15 per gallon of gasoline (daily capacity) should be sufficient. The operating cost of the gas plant is relatively low.

Refining of Corn Oils.—The preparation of edible oil from crude corn oil is described fully by A. F. Sievers and J. H. Shrader of the Bureau of Plant Industry, Department of Agriculture, in Department Bulletin 1010, which was issued during April. Extended experimental results are given on refining by treatment with caustic, bleaching with fullers earth and deodorizing with steam.

Two methods of refining average corn oil are found to be about equally satisfactory. The soapstock obtained in refining corn oil is soft and slimy, and special means are necessary to harden it. In one of the proposed methods a large excess quantity of caustic is used, while in the other the same result is obtained by adding soda ash after the break. A maximum temperature of 55 deg. C. is recommended in the refining of corn oil.

The value of the chemicals used and the oil lost in the treatment is 0.628 cent per pound of neutralized oil with method 1 and 0.564 cent with method 2, of which more than 80 per cent is represented by the loss of oil.

The oil is bleached with fullers earth according to the method generally used. Not less than 5 per cent of earth must be used. Corn oil does not bleach as much by this treatment as some of the other vegetable oils. The cost of the materials used and the oil lost in this bleaching process is about 0.22 cent per pound of bleached oil, of which approximately half represents the value of the oil lost.

The oil is deodorized by being blown with steam for several hours at temperatures above 400 deg. F. under reduced pressure.

The general arrangement of a refinery equipped to handle two batches of 25,000 lb. of oil a week is described and the passage of the oil through the several processes is discussed.

The cost of refining corn oil in such a plant as here described is found to be approximately 1.6 cents a pound. This cost figure was obtained by determining as nearly as possible the several charges for chemicals, oil losses, fuel, labor and overhead. The cost of the equipment, exclusive of the building, is estimated at $40,000.

Book Reviews

A DICTIONARY OF APPLIED CHEMISTRY. By *Sir Edward Thorpe*, assisted by eminent contributors. Revised and enlarged edition. Vol. 2, Calculi-Explosion. 717 pp., illustrated. New York and London: Longmans, Green & Co. Price $20.

The second volume of the new edition of Sir Edward Thorpe's Dictionary of Applied Chemistry is compiled by many of the same eminent contributors who have made the previous edition justly famous. There are some new names which would be known better in Great Britain than here. To the American reader that is, I think, a most disappointing thing about the admirable collection. There are not many names well known to the American chemical engineer, and this brings us to a point in which we find ourselves in agreement with the reviewer of the first volume. It is not unnatural that the contributors should be unfamiliar with American practice in chemical engineering, but from the American point of view it is one significant lack in the book.

The editor of such a series of essays must find himself in a very difficult position in endeavoring to accord proper weight to some of the contributions. To disagree with such weighting in certain instances is, of course, inevitable and merely the expression of an opinion that such and such a subject should not receive so much importance. In illustrating this particular point, there is a course in a certain college, part of which is devoted to a very special research problem carried out by the professor in charge while he was a student in Europe. The particular subject has very little to do with the general subject matter of the course but receives undue emphasis because of the peculiar make-up of the professor's ego. The Dictionary of Applied Chemistry is peculiarly fortunate in having a man whose experience is so wide and whose judgment is so sane as Sir Edward Thorpe. It would be difficult to find a man better qualified to proportion the space necessary for adequate discussion.

A general and gentle criticism may be suggested that too little space is given over to types of equipment and too much to theoretical chemical discussion. Specifically, it would seem to be more desirable in a Dictionary of Applied Chemistry to devote much more space to the subject of evaporation and evaporators and somewhat less to the general subject of carbohydrates. Evaporators as examples of chemical equipment have a tremendously wide use in almost every industry, and the dictionary discusses only the principles lying back of three designs now on the market. Considerable work, particularly in this country, has been done on the improvement of evaporator design, and it would seem that such discussion could be included desirably in the dictionary. Similarly, some of the discussion on carbohydrates has to do with rare sugars and their properties, the use of which is extremely limited and the general interest in which is rather negligible.

In like manner the American reader will be a little confused by the article on chlorine, for example, wherein the British methods of manufacture alone are taken up and no American operations are discussed. The technical discussion of the processes for chlorine manufacture is, however, entirely adequate.

It is to be sincerely hoped that the reader of this review will understand that my enthusiasm for this great work is very real. Consulting and operating chemical engineers who are not familiar with this would do well to look it up at once. In my experience, which has been confirmed by several acquaintances, the dictionary will supply a very adequate basis for a preliminary search on a subject upon which much information is desired and will frequently supply all the information that is necessary.

Some one has run off with the fourth volume of the older edition and I am extremely anxious to have the new edition come out and supply that missing link. That will only indicate my affection for the "mag. op."

CHARLES WADSWORTH, 3d.

LEHRBUCH DER METALLOGRAPHIE. By *Prof. Gustav Tammann.* Second Edition, 1921. 420 pp. 219 illustrations. Leipzig: Leopold Voss. 110 marks.

It cannot but be regarded as significant of a definite trend in metallography that in the new edition of "Lehrbuch der Metallographie," by Dr. Gustav Tammann of Göttingen, an entirely new viewpoint has been maintained. Like the first edition, it contains an extraordinary compilation of information concerning physical metallurgy. There are many of the chapters of the earlier edition which are again presented in substantially the same way; the additions are not alone in the form of appended or inserted chapters, but one finds the new material very effectively distributed throughout the whole treatise.

The new viewpoint is concerning the atomic arrangement in metals and alloys. Much of the actual data introduced is contained in an article entitled "The Chemical Properties of Alloys," which appeared in *Metallkunde* in September, 1921.

Tammann's own preface to the second edition may be read as follows: "The recent advance in the atomistics of crystalline substances does not deserve to remain unremarked in a domain which of late has leaned exclusively toward thermo-dynamic equilibria. Accordingly, the chapter on recrystallization is presented with a new atomistic principle and the chapter on the chemical and electrochemical properties is based on an atomistic concept of the arrangement of two kinds of atoms in a space lattice."

The metallurgist familiar with the metallography of useful metals might possibly expect a discussion of atomic arrangement to be uninteresting and impractical, but he will find these new chapters attractive because of the logical manner in which the "atomistics" of metals are associated with well-known properties—particularly chemical and electrochemical behavior—which, of course, constitute the basis of corrosion.

The mention of atomic arrangement instantly calls to mind the crystallograms made by the diffraction of X-rays by atomic planes. Prof. Tammann really has had available very little crystallographic data resulting from the application of Röntgen rays to metallography. Yet his inferences from other sources of information have been so accurate that in general they are in perfect accord with the X-ray data obtained in this country. At any rate, after reading the book the student will have a much more realistic impression of the state of existence of the metals in alloys and many words which now call to mind only microscopic appearance or physical properties will take on a mechanical significance.

The mechanism of solidification from the melt is lucidly described, and even if one does not feel inclined to agree entirely with the presentation, it nevertheless is an attractive hypothesis. Prof. Tammann says that the atoms of the melt are isotropic, but become anisotropic upon cooling. This change is prerequisite to their alignment in a space lattice. The rate of formation of the anisotropic nuclei and the rate of crystal growth from the nuclei determine the grain size. In the case of amorphous glasses the rate of formation of nuclei is so very low that before an appreciable number are started the temperature may be dropped to a range where none whatever form. Reheating in such cases either starts new nuclei or may reduce the viscosity so that an ordinary liquid results.

It is in the discussion of solid solutions that the matter of atomic distribution is chiefly stressed. The picture of the inherent nature of solid solutions offered in this country by one of the present writers is corroborated entirely by Prof. Tammann. The atoms of the solute replace atoms of the solvent in its lattice with only a change in the size or parameter of the lattice. Upon solidification of a binary solution the atoms of both metals betatke themselves to certain lattice positions, but they are not arranged in the same proportion in all parts of one grain nor are two adjacent grains necessarily of the same constitution. Above the recrystallization range of temperature a rearrangement or "place-interchange" occurs, and the two kinds of atoms become distributed as symmetrically as possible. When several modes of symmetrical arrangement are possible for a given composition, that one which gives the greatest number of atomic lines containing both kinds of atoms is built up. By this method of arrangement the smallest possible portion of the lattice will show the average composition of the whole mass of alloy. Obviously there are some ratios which will produce relatively simple distributions, notably in the regular system 12.5, 25.0, (37.5), 50.0, (62.5), 75.0 and 87.5 atoms per cent.

The proof of this is ingeniously shown by the very abrupt change in electrochemical behavior in many alloys at these compositions. Reagents which vigorously attack one constituent and are inert toward the other usually show action up to a certain content of the more noble metal and almost no action for higher concentrations. A great variety of reagents in contact with many alloys are cited and the results are tabulated. As an example, nitric acid does not attack silver-gold alloys with more than 50.0 atoms per cent of gold, but completely removes all the silver from those with less than 37.5 atoms per cent. Between these percentages of gold content the action is linear with the composition. The 25.0 per cent composition limit holds for the action of weak oxidizing agents and palladium chloride on the gold-copper series. (Palladium chloride is decomposed by the gold-silver series up to 50.0 atoms per cent.) The matter of valence is most important in the location of these composition limits, and this fact is very logically explained. If the atoms of the two metals were distributed in the lattice at random, we should have the protective action of the noble metal conforming to the law of probability and there would be no abrupt steps in the function. This "composition-for-reaction-limit" study has resulted in what is probably the most plausible explanation of the absorption of hydrogen by palladium.

The possible space distributions for various compositions are comprehensively charted in the book. It is interesting to note that the regular arrangement of two kinds of atoms in a solid solution was discovered by X-ray analysis within the past year in this country. There is, of course, no very simple space distribution for a composition corresponding to 37.5 atoms per cent (ratio 3 to 8), and indeed this value rarely marks a reaction limit. Metals deposited simultaneously from an electrolyte do not possess the regular distribution of the two kinds of atoms (unless heated to the recrystallizing temperature) and consequently do not show the normal composition limits for reaction, but, like the amorphous glasses, do not possess this interesting property.

In discussing the possibility of the formation of an uninterrupted solid-solution series between two metals Tammann states definitely that they must both have the same type of space lattice. Since he accepts the evidence for the usual statement that copper and manganese, chromium and nickel, and alpha iron and nickel form completely isomorphous series, he includes all these metals in the face-centered cubic series. Actually it has been proved that chromium and alpha iron are body-centered cubic, unlike nickel, and that manganese is not isometric at all, but is of a complex type, probably hexagonal. In this country one of the present writers has shown that certain compositions in these so-called continuous solid-solution series are built up of the two distinct crystal types belonging to their component metals.

It is to be regretted that Prof. Tammann had not available a more complete knowledge of the verified space lattices of the elements, such as given by Hull. The choice of nomenclature used in connection with the description of the known types of isometric lattices of metals is unfortunate. The simple cubic is called the 8 point, the body-centered the 9 point, and the face-centered the 14 point. These numbers refer to the actual number of lattice points in any way involved in the arbitrarily chosen elemental cube of the structure. As a matter of fact, the three types respectively contain 1, 2 and 4 atoms per unit cube. The descriptive names used in English writings on atomic structure are certainly much better chosen.

A point which appeals to English-speaking readers is the remarkable freedom of the work from the ponderous, involved style found so frequently in German scientific writings. Altogether, the book is an admirable presentation of the physical chemistry of metals and the metallographist cannot shun the new viewpoint without hampering himself in his attempt to generalize the properties of metals.

EDGAR C. BAIN and STANTON UMBREIT.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Bills Before House Embody Acceptance of Ford Muscle Shoals Offer

The recommendations of a majority of the members of the Committee on Military Affairs of the House of Representatives in the matter of the Henry Ford proposal for the Muscle Shoals property is embodied in a bill introduced June 5 by Representative McKenzie, acting chairman of the committee.

The bill authorizes the sale of Plants No. 1 and No. 2 and the Waco quarry to Henry Ford and the lease of dams 2 and 3, including power houses and all hydro-electric and other equipment except the locks, for a period of 100 years.

Included in the property of the sale are all the lands, buildings and equipment of plants 1 and 2, the right to use all the patents, processes and designs which have been acquired and the sulphuric acid units now in storage on the premises. Mr. Ford would not be bound, however, to operate Plant No. 1 as a nitrogen fixation plant. The payment of $5,000,000 may be spread over 5 years, the first payment of $1,000,000 to be made on acceptance of the offer.

The annual rental for the plants is fixed at 4 per cent of the actual cost of acquiring land and flowage rights and completing dam and power houses. This amount does not include expenditures incurred prior to the approval of the proposal. Rental payments are to be made annually, the amount for the first 6 years after the development of 100,000 hp. being fixed at $200,000 per year. The annual rental for dam No. 2 is placed at $35,000 per annum, upkeep to be borne by the company.

Would Bind Lessee to Work on Fertilizers

The bill specifically states that the company must agree to manufacture commercial fertilizers at Plant No. 2 or such other plants as may be constructed, the annual production to have a nitrogen content of at least 40,000 tons of fixed nitrogen—the present capacity of Plant No. 2. It is also stipulated that the company will determine by research whether there may be produced on a commercial scale fertilizer compounds of higher grade and at lower prices than farmers and other users of commercial fertilizers have in the past been able to obtain, and to determine whether in a broad way the application of electricity and industrial chemistry may accomplish for the agricultural industry of the country what they have economically accomplished for other industries. If such methods be found they are to be reasonably employed.

As will be noted, the 100-year lease period which was the basis of much opposition to Ford's original proposal is retained, as is the original purchase price.

The main change in the terms of the offer is the exclusion of the Gorgas steam plant. Mr. Ford has expressly stated that he will stand or fall on his offer and that the exclusion of the Gorgas plant would be interpreted by him as the rejection of his offer.

Additional Bills

The minority of the committee's membership, which favors the unqualified acceptance of Mr. Ford's offer as amended on May 31, will submit its bill and report the latter part of the week. The majority report on its bill also will be submitted at that time. Two bills already have been introduced, proposing the acceptance of the Ford offer. One was introduced by Representative Wright of Georgia, a member of the committee but acting independent of the minority. The other was introduced by Representative Almon of Alabama, in whose district the property is located.

The Senate amendment to the War Department appropriation bill, by which $7,500,000 would be granted for the completion of Dam No. 2, aroused some discussion in the House. Several members argued for its direct consideration by the House instead of by conference. The point at issue seemed to be an uncertainty in the minds of the Representatives as to the bearing of such an appropriation on the lease proposals which are now before the House. Representative Byrns of Tennessee held that the amendment would not affect the consideration of the lease offer. Others, notably Representative Green of Vermont, who is a member of the Military Affairs Committee, felt that a question of government policy is involved. The amendment was sent to conference, with prospects of open debate on the floor of the House upon its return.

Ford's "Secret" Fertilizer Process May Be Federal Phosphorus Co.'s Method

According to recent reports, the Federal Phosphorus Co., headed by Theodore Swann of Birmingham, is contemplating the removal of its plant from Birmingham to Jacksonville. T. L. Long, representing Mr. Swann, recently appeared before the city commission of Jacksonville and asked that Jacksonville give the company power concessions for the establishment of a factory on what he intimated would be a 10-acre site.

The electric furnace process for the manufacture of phosphorus from phosphate rock, coke, sand and iron borings[1] is supposed by many to be the "secret" electrical process to which W. B. Mayo, Henry Ford's chief engineer, referred when before the Senate committee, when he said that Ford could make cheaper and better fertilizer for the farmers of the nation. Certainly Mr. Long's statements to the Jacksonville commission gave this impression very pointedly.

It is claimed that the new process will give from 35 to 40 per cent of plant food, compared to about 14 per cent secured from phosphate rock by the old acid treatment.

Jacksonville's power rate is 2 cents per kw.-hr., with a downward sliding scale for large consumers. While the commission has not yet gone into a full consideration of the application it will probably be considered in the near future.

Edison Working on Potash Extraction

Some light on experiments which it is rumored are being made by Thomas Edison with potash, from deposits in east Tennessee, is shed by a letter from Mr. Edison to State Geologist Wilbur A. Nelson and made public by Mr. Nelson. The letter dated May 16, follows:

> Your letter of May 10 has been received. Since I got some of the Cartersville potash slates the experiments have never ceased. One line of experimentation shows very promising results. The only trouble is, Can we manufacture on a large scale so as to compete with German potash? So far, it looks as if we could and also go them a little better. If we cannot quote a price at which they (the Germans) cannot sell, it will help the farmer very little. What is required is that he can get it very cheaply.
>
> Can you send me a colored geological map of the region, say covering 250 miles in diameter, with Muscle Shoals as a center? If this map could not be furnished as a single map, it would do in sections.

Mr. Nelson explains that the Cartersville slates are named from the town of Cartersville, Ga., near which they are found. The deposit extends into Tennessee.

[1] See Chem. & Met. Eng., vol. 26, p. 726 (April 19, 1922).

Testimony Before Dye Investigation Committee Ends With Defence of Textile Alliance

Hearings before the Senate judiciary sub-committee conducting the dye investigation were concluded June 3 when A. M. Patterson, president of the Textile Alliance, appeared to rebut certain statements made by W. Paul Pickhardt of Kuttroff, Pickhardt & Co. At the close of this session Chairman Shortridge announced that at the present time there was no intention of holding further hearings and that the committee stood adjourned to meet again at the call of the chairman.

Says Importer Hindered Alliance

Mr. Patterson attacked testimony delivered previously before the committee by William Paul Pickhardt, of Kuttroff, Pickhardt & Co. and criticised that firm for hindering in every way possible the efforts of the Textile Alliance, as the officially designated agency of the United States Government, to secure German dyes needed by American dye-consuming industries.

The German cartel had offered to sell its dyes to the Textile Alliance as a private concern, Mr. Patterson testified, but this offer was immediately rejected. The Alliance, he said, never had attempted to substitute German dyes for American dyes in use by consumers.

Petitions "ostensibly signed" by thirty mills which had been presented to the Senate Finance Committee at hearings held by that committee two years ago, Mr. Patterson said, had been prepared and circulated by Kuttroff, Pickhardt & Co., in "spite of numerous denials." "As a matter of fact," he added, "this was nothing more than a part of Kuttroff, Pickhardt & Co. propaganda."

"In carrying out our task for the government and the consumers," he said, "we had assistance of many importers, particularly Mr. Metz, but never of Kuttroff, Pickhardt & Co."

The petition in question, he continued, had been a "dead issue" for two years and is pertinent to the present discussion only because Mr. Pickhardt had introduced it in his previous testimony before the committee. "It purports to be a spontaneous expression of opinion of consumers, but it is not what it is supposed to be," he added. The petition protested against importation of dyes through any other than the "regular commercial channels."

The Reparation Commission had refused to deal with the Textile Alliance, or any importer as a private concern, the committee was told. The Department of State had terminated the arrangement whereby the Alliance was its officially designated agent to receive these dyes. This action was taken because the Department of State believed it did not have the power to continue the Alliance or any other organization as its agent. The Reparation Commission had notified this country that unless it designated some agency to receive such dyes as accrued to it under the treaty it could not continue to supply them after June 30, 1922.

"If nothing is done in the face of this situation," Mr. Patterson said, "the German monopoly will again be a monopoly as far as the 10 per cent of dye consumption needs which we must import."

Pickhardt Presents German Offer

An offer of the German cartel has been made by him to the State Department and the Commerce Department, Mr. Pickhardt told the committee. This offer provided that the German cartel should supply the United States the needed quantity of dyes, not covered by the reparation dyes, at prices as low as if they had been secured under the present arrangement.

Chairman Shortridge questioned the efficacy of such an agreement and asked how it would be enforced. Mr. Pickhardt said he assumed it would be enforced in the same manner the treaty provisions were enforced. He denied a statement by Chairman Shortridge that the German cartel was controlled by the German Government.

Mr. Patterson declared that it was distinctly to the benefit of the American people to receive the reparations dyes and expressed the view that the Department of Commerce should be designated as the agency to receive them. He stated that unless the government takes action, the supply will be cut off on the thirtieth of June.

There followed some discussion between Mr. Patterson and Mr. Pickhardt as to what would be the loss to the country in such event. Mr. Pickhardt repeated his previous statement that no loss would be incurred by the consumer inasmuch as the German cartel had authorized him to state that it would agree to supply at low prices whatever dyes might be lost through termination of the present arrangement. Mr. Patterson insisted that this proposal did not solve the problem. The Textile Alliance did not wish to continue as the officially designated importing agency for these dyes and it had repeatedly urged that this be taken over by the government itself, but that in all events, in order to safeguard consumers' interests, some action that will make continued receipt of the dyes certain should be taken prior to June 30.

Table of Dye Prices Shows Steady Decline

Of interest in connection with the original purpose of this investigation—the alleged existence of an American dye monopoly, is a table recently issued by the Synthetic Organic Chemical Manufacturers' Association. The fact that no substantiation of the monopoly charges developed during the hearing is strengthened by the additional evidence of competition shown in the steady decrease in the price of nearly all American dyes in the past five years.

The table comprises 67 dyes of American manufacture, the tonnage production of which aggregates over 82 per cent of the total American production for the calendar year 1920.

It is particularly worthy of note that the depression in the prices of American dyes has taken place over a period during which competing dyestuffs of German manufacture were prohibited entry. The table shows the average price of each dye, each year, for a period of approximately five years, from January 1, 1917, through April 27, 1922. It also shows the percentage of decrease in the American prices over this period.

The vividness of these reductions is particularly emphasized in connection with the reduction in prices of the following colors produced in large quantities:

Indigo, produced by 12 American manufacturers, and which in 1917 had an average price of $1.42 per lb., on April 27, 1922, sold for 30 cents per lb., a decrease of 79 per cent.

Sulphur black, produced by 3 American manufacturers, and which sold in 1917 at 60 cents per lb., on April 27, 1922, sold around 18 cents per lb., a decrease within that period of 70 per cent.

Direct black, EW, produced by 14 American manufacturers, and which sold in 1919 at $1.04 per lb., on April 27, 1922, sold at 42 cents per lb., a decrease of 60 per cent.

Malachite green, produced by 6 American manufacturers, and which sold in 1917 for $6.28 per lb., on April 27, 1922, sold for $1.50 per lb., a decrease of 76 per cent.

Declines in the prices of other dyes range downward to one per cent in the price of acid yellow G. This dye, produced by two American manufacturers, was not put on the market in commercial quantities prior to 1921, when its average price was $1.21 per lb. The market price of this dye on April 27, 1922, was $1.20 per lb.

The comparatively small decreases in the prices of these newer American dyes as against those which have been produced for a longer time seems to indicate clearly that increased efficiency and lower costs result from extended experience in manufacture.

Japanese Trade in Fertilizers

Fertilizers imported into Japan during the fiscal year ended March 31 were valued at 121,800,000 yen. This was a decrease of 110,000,000 yen compared with the preceding year. The export trade also suffered a decline and in the past twelve months amounted to only 320,000 yen. This figure was over 2,000,000 yen less than in 1920.

Sentiment Strong for Dye Embargo—Manganese Put on Free List

While all plans had been made by Senate leaders to dispose of the dye embargo matter before the week of June 5, the discussion was permitted to go over for a week on the insistence of Senator King that he had been led to believe that paragraph 26 of the chemical schedule would be considered separately. Senator McCumber is at a loss to know just how such an impression was created, but in his desire to accommodate Senators and give ample time for such investigation as they are desirous of making, he granted the extension of time. It is regarded as practically certain, however, that the dye embargo will have been voted on before the end of the week of June 12.

At the time of this writing, it seems practically certain that the committee has the votes to retain the embargo provision in the bill. It is significant that Senator King is the only Democrat who has spoken against the measure. The Democratic opposition is lukewarm and it is known that some members of that party will vote for the embargo.

Perhaps the most significant development in recent weeks in the embargo situation came when Senator Frelinghuysen revealed that President Harding is squarely behind this proposal. Senator Frelinghuysen has led the fight for the embargo and in addition to his very convincing speeches on the floor of the Senate is credited with having convinced Senator Moses that there is more merit in the proposition than the latter formerly believed. The chances of the embargo were improved greatly when Senator Moses withdrew his active opposition.

Chemical Warfare Drawn Into Discussion

Gas was brought into the debate only once. Senator Borah, in condemning a continuance of chemical warfare activities, admitted that other nations are going ahead with their scientific studies of the application of gas to warfare. Senator King attempted to prove that there was no connection between dyes and the national defense. His attention, however, has been called to the British report which points out and proves the exact part which the German dye plants contributed to military prowess. The point also will be made in defense of the embargo that the Chemical Warfare Service of our own army, without any thought of its application to a dye embargo, long has been studying the exact details of converting specific American dye plants to military uses in time of war.

King's Attack Without Influence

Senator King's five-hour set speech and his numerous but less lengthy tirades against the domestic dye industry in no way influenced the vote on paragraph 26, which was adopted just as soon as an opportunity was offered for the vote. In the course of the discussion Senator McCumber pointed out that Republicans do not believe in embargoes, but that an exceptional situation had arisen—so exceptional that even a Democratic President had recommended a chemical and dye embargo.

Paragraph 25, covering dyes, which was adopted some time ago, was returned to in order to permit Senator King to offer an amendment which was rejected, placing the duties on dyes in that paragraph at 50 per cent ad valorem, and 3½ cents per pound on dyes valued at not more than 10 cents a pound and 30 per cent ad valorem and 7 cents a pound on those valued at more than 10 cents a pound. The paragraph was then adopted as recommended by the committee.

Senator King offered an amendment changing from 60 per cent ad valorem and 7 cents per pound the duties in paragraph 26 as follows: 35 per cent ad valorem and 3 cents per pound on those valued up to 25 cents a pound; 35 per cent ad valorem and 5 cents a pound on those valued up to 50 cents a pound, and 35 per cent and 7 cents a pound on those valued at more than 50 cents a pound. The amendment was rejected after debate.

Senator King opposed the committee rates, saying they were the same on intermediates as on finished products and would amount to duties of 400, 500 or 600 per cent and on other allied products 100 per cent. He objected to the same duty on dyes of varying prices. He had no objection particularly to the ad valorem duties, except that they were too high, but criticised especially the specific rate. His amendment readjusting the duties was rejected by a vote of 18 to 40, and the committee rate was than approved.

Senator King offered an amendment to strike out the provision that any article in paragraphs 1, 5, 35, 37, 56, 63, 79, 1578, 25, 26 and 1546 shall be assessed for duty or exempt from duty under paragraphs 25, 26 or 1546. The effect of this amendment would take out medicines and compounds from the paragraph giving the articles a duty of 20 or 25 per cent. Senator Smoot opposed the motion, saying the duties were recommended by the Tariff Commission, and the King amendment was rejected. The Utah Senator also offered an amendment fixing the highest instead of the lowest strength as the standard for dyes. It was opposed by Senator Smoot, who said the change would work an injustice. Senator King admitted the amendment might work an injustice and withdrew it with the understanding that he might renew it after consultation with those familiar with the dye industry. Paragraph 26 was then adopted.

Manganese Put on Free List

The Senate again overrode its Finance Committee on the amendment which carried manganese ore to the free list. The vote was 19 to 35. The effect of the vote was to restore to the bill the House rates of 1 cent a pound on manganese ore or concentrates, carrying in excess of 30 per cent metallic manganese. The amendment was offered by Senator Nicholson of Colorado, who delivered a long speech in behalf of protection to the American manganese industry, which he said had been developed during the war and which should be protected against deposits of foreign countries which were worked more cheaply than in this country. The debate largely revolved around the question as to whether American deposits of manganese were sufficient to meet the requirements of the steel industry.

Potash Paragraph Faces Fight

It is becoming increasingly apparent that the duties on potash will not be accepted by the Senate without a fight. Propaganda against the duties is afoot and farmers in large numbers are writing to their Senators asking that they oppose the duty.

Some of those favoring the potash provision of the tariff bill contend that the German syndicate is back of the propaganda. On the other hand, the paragraph has the strength which goes with hearty committee endorsement and it squares with the Republican protection policy.

A new element has been interposed in the situation by the promising discoveries of potash in Texas. The farmers and business men in southwestern Texas are acting in a united and active manner in their support of the potash duty. Each member of the Senate and of the House of Representatives has been mailed a brief signed by "owners of potash beds in the State of Texas," in which the point is made that foreign producers have effected an international combination in restraint of trade and that the consumers in the United States will suffer in the end unless American sources of potash are developed.

Chemical Warfare Service Appropriation Increased in Senate Amendment

The Senate passed the War Department appropriation bill with the committee amendment increasing the appropriation for the Chemical Warfare Service from $500,000 to $750,000. Senator Borah of Idaho opposed the increased appropriation on the ground that it was not keeping faith with the armament conference in barring poison gas. By a vote of 46 to 22 the Senate adopted the increased appropriation and the measure now goes to the House for action on this and other Senate amendments.

An amendment was proposed by Senator Wadsworth of New York, chairman of the Military Affairs Committee, providing for the employ of draftsmen, chemists and chemical engineers in the office of the chief of the Chemical Warfare Service at Washington.

Mellon Institute Annual Report Shows Value of Scientific Research to Industry

The ninth annual report of the Mellon Institute of Industrial Research of the University of Pittsburgh brings out the extent of the valuable experimental work that is being conducted by the Institute. Although the Institute has never aspired to largeness in size, there are now forty-nine industrial fellowships, and additional fellowships will begin operation just as soon as the necessary facilities can be provided.

The total amount of money contributed by industrial firms to the Institute for the eleven years ended March 1, 1922, was $1,995,922. During the eleven years the Institute itself expended approximately $477,600 in taking care of overhead expenses. Eleven of the fellowships have been founded by associations, thus enabling the Institute to be of direct service to groups of industrial concerns instead of to individual companies.

Demonstrating Value of Research to Industry

By the application of its system, the Institute has been able to demonstrate to American manufacturers and associations that industrial research, properly carried out, is profitable to them. It would be interesting to give here a statement concerning the financial gains which have been derived by donors as a result of the Institute's activities in their behalf. The executive staff is not privileged to release this information at the present time; but it may be noted in passing that 85 per cent of the problems accepted by the Institute for study from 1911 to 1922 have been solved satisfactorily from the donors' standpoints.

Among the investigations completed and under way at the Institute may be mentioned the following: Physical properties of glass; bread technology; citrus products; electrical precipitation; smoke investigation; pressed glassware; chemistry of petroleum; manufacture of carbon dioxide, carbon monoxide, hydrogen and nitrogen; composition flooring; fractional distillation; hydrometallurgy of copper; olefine gases; flotation of ores; dental cements; chemistry of laundering; natural gas; refractories; byproduct coking; fiber containers; heat insulation; glue; insecticides; food and beverage flavors; inks; protected metals; sulphur, and galvanizing.

During the past year the Institute has contributed to science and technology two books, forty research reports and thirty-one other scientific papers and has issued thirty-five United States patents.

Department of Commerce and Engineering Societies Co-operate on Standardization

At the request of Secretary of Commerce Hoover, the American Engineering Standards Committee will undertake at once a canvass to determine what simplification in manufactured products is most needed and most desirable. This canvass will be conducted through the engineering and technical bodies having representatives on the committee or co-operating in its work. The survey of simplification or standardization needs and possibilities will extend into almost every industry in America.

This assignment to the American Engineering Standards Committee is one of Mr. Hoover's steps to retrieve for American industry part of the waste which was pointed out by the well-known report on waste in industry which was made by a committee also appointed by Mr. Hoover while he was chairman of the Federated American Engineering Societies. The latter committee found that waste in industry was due largely to an overmultiplicity in number of products as well as to inefficiency in processes.

There has been considerable discussion as to what should be the relationship between the simplification work of the Department of Commerce and the standardization work of the American Engineering Standards Committee. An arrangement has been made for permanent exchange of representatives between the two organizations so that there may be the closest possible co-operation between the Commerce Department's division of simplified practice and the American Engineering Standards Committee, and duplication or overlapping will be avoided.

Former Alien Property Custodian Would Welcome Investigations of Activities During War

During the debate in the House on war frauds, Representative Garrett of Tennessee read a letter from former Attorney-General Palmer, expressing the hope that Congress would appoint a committee to investigate all contracts and expenditures made by the War and Navy Departments and the Alien Property Custodian. Mr. Palmer said charges and insinuations now being made with respect to the Chemical Foundation and the Bosch Magneto case have been repeated many times, although they were investigated by two Senate committees, but that until final disposition of German property is made by the Alien Property Custodian and Congress it was expected that these charges would be constantly reiterated. He stated that the Bosch Magneto Co. was German to the core and that before the United States entered the war its management violated our neutrality in a most flagrant fashion. He explains that sale of the company by the Alien Property Custodian was approved after careful investigation as to the adequacy of price and character of purchasers.

Defends Chemical Foundation

Mr. Palmer pointed out that the Chemical Foundation is a non-profit corporation, formed to take over nearly 5,000 American patents owned by Germans in the chemical industry, which had been originally taken out by Germans to make it impossible for the chemical industry to develop in this country.

"Today by reason of the Alien Property Custodian's plan of Americanizing these German patents and distributing them to the American producers through a semi-public institution like the Chemical Foundation, having for its purpose only the development of the chemical science in America, it has become apparent that the world can never again be caught in the clutches of a German control of the chemical industry." said Mr. Palmer. "I have no hesitation in saying that the biggest achievement of the Alien Property Custodian for the benefit of our country and its future welfare and security was the formation of the Chemical Foundation and the sale of these German patents to it. The Germans recognize its transcendent importance and would now resort to any device to set aside that sale and have the patents restored finally to their German owners in the hope that they could thus again dominate the chemical industry of the world. Their present plan seems to be to discredit the Alien Property Custodian and thus persuade the government of the United States, either through Congress or the executive departments, to take such action as will restore to Germany the stranglehold upon American industry and commerce in many important lines of industry which the Alien Property Custodian loosened as a part of the government's policy in prosecuting the war."

Bureau of Mines Investigates Sands Used in Aluminum-Alloy Foundry Practice

The Bureau of Mines, as one of the governmental agencies directly co-operating in a general research of all foundry sands organized by the American Foundrymen's Association and the National Research Council, is collecting data on sands for molds and cores in aluminum-alloy foundry practice.

There is pressing need of collated information on sands used in aluminum-alloy founding, and it is hoped, as a result of the investigation, to aid in disseminating knowledge on the subject. A questionnaire is being sent by the Bureau of Mines to aluminum-alloy foundries in the United States in order to obtain data to be used in the preparation of a report. It is possible that some foundries of this kind are not upon the bureau's mailing list, and it is hoped that any such plants that do not receive the questionnaire will apply for one. While the replies to the questionnaire will be summarized for publication, the contents of individual communications will be held strictly confidential. Communications in regard to the matter should be addressed to R. J. Anderson, metallurgist, U. S. Bureau of Mines Experiment Station, Pittsburgh, Pa.

International Congress on Liquid Fuels to Be Held in Paris in October

An international congress for the discussion of general problems in the rapidly growing field of liquid fuels is being arranged by the Société de Chimie Industrielle. The meeting will be held in Paris during October, 1922. Prof. Paul Sabatier will preside over the sessions, which will be devoted to discussions on two main topics—namely, terminology for liquid fuels and methods of analysis. The organizers of the congress have asked a number of specialists in the liquid fuel industries for suggestions as to the detailed points to be discussed. All the suggestions are to be grouped into six sections as follows: Petroleum, shale oil, lignite and peat, tar and benzene, alcohol and vegetable oils.

The honorary committee of the organization consists of Prof. Paul Sabatier, of Toulouse, president, Profs. D. Bertholet, le Chatelier, Lindet and Moureau. The active committee is composed of Profs. d'Arsonval, Baumé, Brylinski, Charpy, Duchemin, Demarais, Gerard, Mailhe, Matignon and Willems. The committee feels that the present interest in liquid fuels in America will warrant the attendance of numerous Americans and extends a cordial invitation to those interested. A liquid fuels exposition will be held in Paris during the entire month of October in connection with the congress, the exact date of which has not been definitely announced.

Enamel Division, American Ceramic Society, Plans Research on Enameled Cast Iron

The Enamel Division of the American Ceramic Society is undertaking an investigation of cast iron for enameling purposes. At a recent meeting of the committee delegated with this research, a comprehensive program was drawn up, particular attention being paid to the blistering of enamels applied to cast iron. This investigation will be conducted in co-operation with the enameled metal section of the Bureau of Standards and it is hoped to actively interest all cast iron enamelers of the division.

The research sub-committee on sheet iron and steel has planned an investigation of the warpage and buckling of iron and steel sheets in the enameling process. It is planned to conduct the preliminary studies at the Bureau of Standards and to follow this by co operative work in several of the enameling plants engaged in the enameling of flat sheets.

The bylaws of the division have been revised to conform with revisions in the rules of the society.

International Union of Pure and Applied Chemistry Announces Topics for Discussion at Lyon

Announcement is made of the principal subjects to be discussed by the congress of the International Union of Pure and Applied Chemistry which is to meet in Lyon, France, June 27 to July 2. Among the topics to be considered are the following: Chemical elements, reform of nomenclature, bibliographic abbreviations, unification of chemical abstracts, international institute of chemical standards, thermochemical standards, tables of constants, international laboratory for food products, national and international laboratories for ceramics and for combustibles, international patents, industrial hygiene in the chemical industry.

Several points will be laid before the congress for further study, among which are: Signs of potentials of electrodes, international definition of the term ceramics, conservation of foods by physical and chemical processes.

Helium Appropriation Reduced

The recommendation of the Military Affairs Committee on the helium provisions of the War Department appropriation bill was adopted by the Senate. The committee recommended the reduction of the appropriation for experimental work on helium from $400,000 to $300,000, as proposed by the House. In spite of opposition from Senator Sheppard of Texas, the Senate adopted the recommendation.

American Electrochemical Society Officers Appointed—Symposiums Planned for Spring Meeting

At a recent meeting of the board of directors of the American Electrochemical Society, Dr. J. A. Mathews was appointed to fill the unexpired term of C. G. Schluederberg as vice-president and George K. Elliott was appointed to fill the unexpired term of C. G. Fink as manager. F. A. J. FitzGerald was reappointed chairman of the publication committee and H. A. Hinckley was appointed chairman of the membership committee.

William G. Horsch of the Massachusetts Institute of Technology was appointed chairman of a committee to arrange a symposium for the spring, 1923, meeting on the subject of Electrode Potential. Members of the society and others desiring to participate in this symposium are requested to communicate with Professor Horsch. The symposium will cover the following studies: Reversible electromotive force, overvoltage, ion activities and dissociation, electro-titration and pH determinations.

The Electrothermic Division has prepared a symposium on industrial heating for the fall meeting at Montreal, Sept. 21 to 23.

British Parliament Moves to Protect Trade Marks

An important bill amending the present merchandise marks act, which prescribes the requirements for the marking of goods imported into the United Kingdom, has been submitted to the British Parliament.

Part 1 of this measure relates to merchandise marks and provides that an order may be made requiring an indication of origin if the Board of Trade is of opinion that a false impression as to the origin of any class of imported goods is likely to arise. Section 2 of part 1 authorizes the Board of Trade to prohibit the application to imported goods of any national or other public device reasonably calculated to lead any person to believe that the goods are of British origin. Section 4 prohibits the importation into the United Kingdom of goods to which there is applied a forged trade mark or false trade description, or to which a trade mark is falsely applied within the meaning of the act and of any goods to, or in connection with which, a national or other public device is applied in contravention of the provisions of an order under the act, unless the device is accompanied by an indication of origin.

Gas and Fuel Section New Feature of Next American Chemical Society Meeting

A gas and fuel section of the American Chemical Society has been authorized for the next meeting, which is to be held in Pittsburgh the first week in September. Among other subjects discussed will be the general topic: "Combustion." This special symposium will be under the chairmanship of Prof. R. T. Haslem of Massachusetts Institute of Technology. It will include a program of papers on chemical methods underlying fuel utilization.

Officers of the new section are: Chairman, Dr. A. C. Fieldner, Bureau of Mines, Pittsburgh, and secretary, R. S. McBride, Colorado Building, Washington. Any members of the society having papers to present at the meetings of this section should forward them in full or in abstract form to the chairman or secretary or should notify these officers regarding their intention to prepare the paper later.

Safety Institute Starts Film Service

The Safety Institute of America has inaugurated a safety film service for members and others particularly interested, it is announced at the headquarters of the Institute, 141 East 29th St., New York City. This service was made possible by an initial gift from the department of safety, sanitation and welfare of the United States Steel Corporation. The Safety Institute will endeavor to build up its collection of moving pictures to the proportions of its stereopticon safety slide collection, which is now probably the largest in existence.

Explosion in Synthetic Ammonia Plant of Atmospheric Nitrogen Corporation

Four persons were injured in an explosion on June 11 at the new Haber process plant of the Atmospheric Nitrogen Corporation at Solvay, just west of Syracuse, N. Y. Officials of the Allied Dye and Chemical Corporation, of which the Atmospheric-Nitrogen Corporation is a subsidiary, were not able to explain the cause of the accident or to estimate the damage. It was stated, however, that operation will be normal within a few days. The damage was confined to the interior of the process building, the walls remaining intact.

Tungsten, Molybdenum and Vanadium Discussed at New York Section, A.C.S., Meeting

Tungsten, molybdenum and vanadium, metals which are immediately associated with high-speed tool steels, were discussed from a different angle at the New York Section of the American Chemical Society on June 9. C. W. Balke, of the Fansteel Products Co., and B. D. Saklatwalla, of the Vanadium Corporation of America, presented papers dealing with the preparation of these metals in a pure state and their applications other than in the special steels.

One of the most interesting points brought out by Dr. Balke was his mention of the work that is in progress on the metal tantalum. He showed samples of tantalum powder, rods and plates and predicted that this unusual metal will find unique uses in the chemical and other industries, due to its remarkable resistant properties. It was stated that tantalum is absolutely unaffected by boiling aqua regia or any other acid except hydrofluoric. This property makes it ideal for the manufacture of dental instruments. It absorbs gases with avidity, taking up 750 times its own volume of hydrogen. This property is desirable in wireless bulbs where high vacuum is essential.

The preparation of pure tungsten and molybdenum is very similar, the only differences in the process being due to the lower melting point of molybdenum.[1] Tungsten melts at 3,350 deg. C., the highest melting point of any known metal while molybdenum melts at 2,500 deg. C. The extremely high fusing temperature of tungsten makes it unique among the metals in that it is never melted in the course of its preparation and exhibits properties at room temperature which correspond to those of ordinary metals at very low temperatures. At higher temperatures tungsten has the highest tensile strength and the lowest coefficient of expansion of any known metal.

The metal is prepared from wolframite, an iron, manganese tungstate, by fusion with soda ash in a reverbatory furnace and the formation of soluble sodium tungstate. This is leached from the fusion mass and converted to the oxide. The physical and chemical properties of the oxide have a decided effect on the grain size of the metallic tungsten prepared from it. A fine fluffy oxide yields a fine metallic powder, while a dense oxide yields a coarser powder. The oxide is reduced in an electrically heated quartz tube in an atmosphere of hydrogen. About 9 cu.ft. per minute of hydrogen is passed over each charge of 2 kg. The metallic tungsten powder is compressed into an ingot at a pressure of 50 tons per sq.in. The bar is then placed in a sintering furnace and heated by electric resistance almost to its melting point in an atmosphere of hydrogen. The sintering operation causes the crystallization of the metal. The bars are then heated and swaged or hammered at a temperature of about 1,500 deg. C., during which process the crystals become elongated. Finally, the swaged rods may be drawn into wire.

An interesting point was brought out by Dr. Balke's mention of the function of thoria in tungsten for lamp filaments. The thoria fuses, forming minute globules between the tungsten grains, thus retarding their growth. When the tungsten is drawn into wire, the thoria globules are drawn into little rods which prevent the crystallization and breaking of the filament.[2]

[1]See Jones, CHEM. & MET. ENG., vol. 22, p. 15 (Jan. 7, 1920).

[2]See Jeffries and Archer, CHEM. & MET. ENG., vol. 26, p. 406 (March 1, 1922.)

Dr. Balke stated that ten times as much pure tungsten is used for contact points for electrical equipment as for lamp filaments. He showed a large number of slides including photographs of the plant and apparatus and photomicrographs of the grain structure of numerous samples.

The freakish properties of vanadium, the history of its development and the modern process of extracting it from its ores were described by B. D. Saklatwalla. The element remained a laboratory curiosity for over a hundred years because no commercial deposits had been found. Studies of its effect in steel in 1900 may be said to mark the beginning of its commercial importance. Several processes of extracting the metal from its ores were described, the roasting and dry smelting process and the aluminum thermic reduction. The ordinary smelting processes are inefficient, because the oxides of vanadium are extremely refractory and combine with the flux and are lost. The Goldschmidt process overcomes this difficulty as it accomplishes instantaneous reduction by intense local heating. It is necessary however, to fix a very definite balance of ingredients in order to form the proper slag and to liberate the right amount of heat. The electric furnace method which is now being used duplicates this effect. The charge is fed continuously into the small space between the electrodes. A very high current density is used and the result is instantaneous reduction by the intense local heat.

Short Courses in Practical Paper Making Offered This Summer by University of Maine

During the period of six weeks beginning June 26 the chemistry department of the University of Maine will again conduct a summer school course in pulp and paper chemistry and technology. The University of Maine was the first institution to offer such a course in America and now has over ten years' experience in determining the nature of the courses offered and the content of each. In Maine today there is more capital invested in pulp and paper mills than in any other industry, and this fact alone means ever increasing co-operation between the pulp and paper courses of the university and the mills. Within a short distance of Orono are to be found pulp and paper mills of all kinds, soda, sulphite, sulphate and mechanical pulp mills, newsprint, bag, wrapping, tissue, novelty and writing paper mills.

Among the courses offered are the following: Paper testing and analysis; pulp manufacture, soda and sulphite processes; pulp bleaching and general, organic and physical chemistry.

The university library with its large collection of foreign and domestic pulp and paper journals, books and theses will be open daily. The paper and chemical work will be carried on in Aubert Hall under the same conditions as apply during the regular session.

Paint Works on Antimony Field in Australia

A new company has acquired the interests of the antimony and gold mines near Heathcote, Victoria, and intends to use the antimony sulphides for the manufacture of a metallic, non-poisonous paint. New works will be erected at a cost of £20,000, states the *Industrial Australian*, for the manufacture of paint and the production of refined antimony. Hitherto the antimony has been shipped to Yorkshire for treatment. The output is about 300 tons a month. The lodes have been proved to carry good values to a depth of over 900 ft.

Water Pollution Resolution Passes House

The Appleby resolution on pollution of navigable waters has been passed by the House. The resolution requests the President to call a conference of maritime nations with a view of adopting means to prevent the pollution of navigable waters by oil-burning and oil-carrying vessels. Representative Stafford, of Wisconsin, sought to have the resolution apply to the Great Lakes, but it was decided that this matter should be considered in a separate resolution.

Pan-Pacific Conference to Foster International Relations

The fourth conference called by the Pan-Pacific Union, of which Wallace R. Farrington, Governor of Hawaii, is president, will meet in Honolulu, Oct. 25, 1922. This is the fourth in the series of conferences which the Pan-Pacific Union is calling. The first was a conference of scientists from about the Pacific; the second, of educators; and the third, of journalists. The most valuable result coming from these gatherings of the leaders of the Pacific is the forming of interracial friendships—friendships which may have a vital influence in developing and preserving cordial relations among the nations themselves.

The conference will cover a period of 2 weeks, one of which will be devoted to sightseeing and entertainment features through Hawaii and Hilo. The business sessions will include discussions on communication, transportation, development of natural resources, finance and investments and international relations in the Pan-Pacific area. One day will be devoted to a discussion of significant Pan-Pacific commercial problems, one speaker from each country represented having been chosen to present the problems of his own country.

Bureau of Chemistry Book on Dust Explosions

"Dust Explosions," a book containing the results of 7 years of investigation by the United States Department of Agriculture, is soon to be issued by the National Fire Protection Association, Boston, Mass., in the interest of reducing fire and explosion losses. The book was prepared by David J. Price and Harold H. Brown of the Bureau of Chemistry of the department, and is expected to be a welcome addition to the meager literature on a subject that has been found of great economic importance to divers industries.

Chapters are devoted to nature and theory of dust explosions, industries producing dust and their extent, elimination of sources of ignition, prevention of explosions by control of explosive mixtures, phenomena of explosions, dust collection and removal, static electricity, explosions in grain-threshing machines, plant construction, cotton gin fires, coal dust explosions, and review of explosions.

Cotton Manufacturers' Association Indorses Dye Embargo

Continuance of the "qualified embargo on foreign dyes" was indorsed and approved by the American Cotton Manufacturers' Association in a resolution adopted at its twenty-sixth annual convention held in Washington. The resolution recommends to Congress passage of the provisions of the regular tariff bill providing for protection of the American dye and organic chemical industry.

Without protection, the resolution said, the "American dye industry would be crushed out and destroyed by the disastrous competition that would ensue." It is pointed out that all possibility of establishing an independent American dye industry will be lost for all time to come if the present development is destroyed.

Personal

FRANK W. DAVIS, who has been a metallurgist for a large part of the past 9 years with the Alan Wood Iron & Steel Co., is to be ferrous metallurgist of the Bureau of Mines. Mr. Davis will begin work on July 1 with headquarters at the Minneapolis station of the bureau. Under the direction of D. A. Lyon, chief metallurgist, he will be immediately responsible for co-ordination of the ferrous metallurgy research of the bureau.

T. H. EDWARDS, superintendent of the steel department at the Benwood, W. Va., plant of the Wheeling Steel & Iron Co., has resigned, following a service of 50 years in the industry. He will take up a residence at Denver, Colo.

DR. COLIN G. FINK has been appointed lecturer in electrochemistry and will have charge of that division of the department of chemical engineering, Columbia University, beginning July 1. He will continue his services as secretary of the American Electrochemical Society, office facilities having been arranged at Columbia for this.

F. S. HARVEY, engineer for the American Sugar Refining Co., gave an interesting address before a recent meeting of the Engineers' Club, Baltimore, Md., on the subject of the new local refinery of the company.

HARLAND M. JOSEPH, Midway, Del., has been appointed manager of the Lewes Fertilizer Co., Lewes, Del., succeeding William C. Lofland, deceased.

J. A. LECLERC has resigned from his position as chief chemist of the Miner-Hillard Milling Co., Williamsport, Pa. He is continuing his work on the problems of export of corn products, to which subject he has devoted himself for the past several months, largely working under the Bureau of Foreign and Domestic Commerce, for which he made a trip to Europe recently. Further effort in this field will be directed toward co-ordination among those who are interested in export of degerminated corn products, for which large foreign markets are expected.

PAUL LEONI, president of the Iron & Ore Corporation, 11 Broadway, New York, recently sailed for Europe on a business trip.

DORSEY A. LYON, chief metallurgist of the Bureau of Mines, had conferred upon him the degree of Doctor of Science by the University of Utah, in recognition of his services in developing metal research in this country.

WILLIAM J. MERTEN, metallurgical engineer of the Westinghouse Electric & Manufacturing Co., has been elected vice-chairman of the Pittsburgh chapter of the American Society for Steel Treating.

T. A. MITCHELL, consulting chemical engineer of Rogers, Brown & Co. of New York, returned May 22 from a trip to England, France and Belgium.

DR. CHARLES L. PARSONS, secretary of the American Chemical Society, sailed from New York June 13 to attend the conference of the International Union of Pure and Applied Chemistry, which will be held at Lyons, France, June 27 to July 2. Dr. Parsons also will attend the meeting at Marseilles of the society of French industrial chemists. He will address that gathering on "The Application of Chemical Research in Industry in America." Dr. Parsons is vice-president for America of the International Union of Pure and Applied Chemistry. Other delegates to the Lyons conference are: E. W. Washburn, H. S. Washington, Edward Bartow, Edward S. Chapin and R. B. Moore. Dr. Atherton Seidell, of the U. S. Public Health Service, also will attend the Lyons conference.

DAVID J. PRICE, chief of the dust explosions investigations of the Bureau of Chemistry, spoke before the Millers' National Federation convention in Kansas City on June 1. His address, entitled "Progress Made by Flour Milling Industry in Dust Explosion Prevention," related not only to the problems of prevention of explosions in cereal industries, but also to the general problem of preventing the hazards attendant upon the presence of industrial dusts. Special mention was made of several recent explosions where sulphur powder used in making lime sulphur insecticide had caused disastrous explosions.

Obituary

MICHAEL E. CLAFFEY, superintendent of the Monroe-Taylor Chemical Co., died at his home, 14 Stephens Court, Brooklyn, N. Y., May 27, aged 85 years.

H. T. OXNARD, for the past 10 years vice-president of the American Beet Sugar Co. and prior to that time president of the company, died at the University Club, New York, June 8, of heart disease. He was 62 years of age and resided at Upperville, Va.

Market Conditions

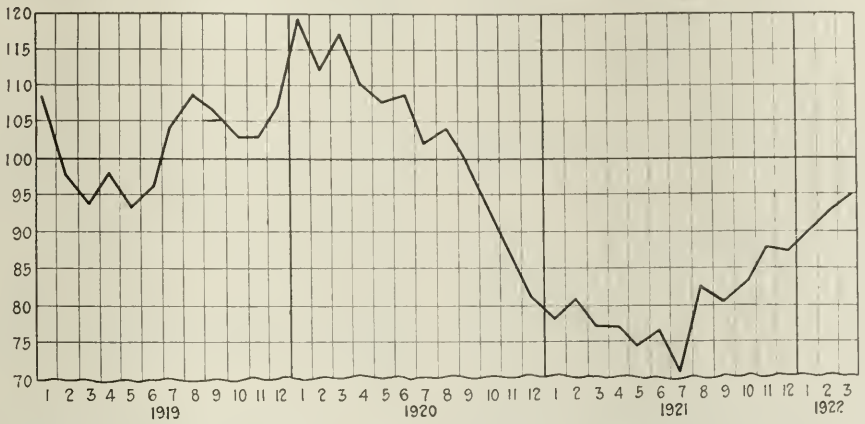
IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

The Increasing Volume of Manufacture

Some time ago the Harvard Economic Service constructed an adjusted volume index to follow the trend of production in the United States. In this index an attempt was made to eliminate both long-time and seasonal variations. In other words, the Committee on Economy Research sought to evaluate (1) the seasonal influences to which practically every industry is subject and (2) the long-time movement resulting from increasing population and industrial development.

As is evident from the accompanying chart, this index number is gradually approaching its normal value of 100, having risen from a low of 75 last July. In commenting on this improvement in the index in the weekly letter of May 27, the Harvard service makes the following significant statement: "The steady upward movement of production during the intervening months (July, 1921, to June, 1922) has afforded one of the most solid bases for optimism, since this increase in output has been in response to a definite increase of demand. This stimulus is more and more manifest."



THE HARVARD ECONOMIC SERVICE ADJUSTED INDEX OF THE VOLUME OF MANUFACTURE
(Normal = 100)

It is unfortunate that so few data are available on the volume of production in the chemical and allied industries. Current figures for a limited number of these commodities are normally compiled by certain governmental agencies and by the trade associations within these industries. On the whole, however, chemical production statistics are practically non-existent. The May number of the *Survey of Current Business* for the first time includes data on the monthly output of two important wood chemicals—acetate of lime and methanol, or wood alcohol. These figures show a very interesting trend, but it would of course be hazardous to intimate that they are indicative of production in all lines of chemical manufacture. The percentage comparisons with the preceding year are most striking. During the first quarter of 1922 there was produced 27,570,000 lb. of calcium acetate—a 50.6 per cent increase over production in the same period of 1921. The output of methanol during this period was 1,473,652 gal. as compared with 1,262,760 gal. in Jan.-Feb.-March, 1921. This is an increase of 16.7 per cent. In March, 1922, the production of methanol was 587,928 gal., while in the corresponding month in the preceding year it was but 403,838 gal.

Other production and consumption statistics of interest to the chemical industries are shown in Table I. These are from the "Trend of Business Movements" section of the Department of Commerce *Survey of Current Business*. It is to be hoped that the organization of a chemical commodity division in the Bureau of Foreign and Domestic Commerce will be followed by an intensive effort to compile and promptly present current production statistics on such basic chemical commodities as sulphuric and the other mineral acids, caustic soda and the alkalis, and ammonium sulphate and other fertilizer materials.

TABLE I—THE TREND OF PRODUCTION IN CERTAIN OF THE CHEMICAL AND RELATED INDUSTRIES

Production of—	Feb., 1922	Mar., 1922	First 3 Months of 1921	First 3 Months of 1922	Percentage Increase or Decrease In 1922
Acetate of lime, thous. of lb.	7,942	11,134	18,309	27,570	+50.6
Alcohol (wood), gal.	433,024	587,928	1,262,760	1,473,652	+16.7
Cement, thous. of bbl.	4,278	6,685	15,240	15,254	+0.1
Coke, byproduct, thous. of short tons	1,795	2,137	5,938	5,835	—1.7
Coke, beehive, thous. of short tons	549	732	2,577	1,777	—31.0
Cottonseed oil, thous. of lb.	91,321	72,237	483,222	264,264	—45.3
Leather, sole, thous. of sides	1,466	1,473	3,720	4,593	+23.5
Leather, finished upper, thous. of sq.ft.	70,296	77,510	118,827	222,369	+87.1
Linseed oil*, thous. of lb.	6,647	7,232	20,631	20,336	—1.4
Metals:					
Pig iron, thous. of long tons	1,630	2,035	5,949	5,303	—10.9
Steel ingots, thous. of long tons	2,072	2,816	6,560	6,781	+3.4
Copper, thous. of lb.	37,416	61,867	251,564	125,131	—50.3
Zinc, thous. of lb.	45,026	53,064	118,852	145,502	+22.4
Paper and pulp:					
Wood pulp, chemical, sh. tons	144,568	170,995	379,749	473,309	+24.6
Newsprint, sh. tons	97,786	117,507	334,402	321,101	—4.0
All other paper, sh. tons	404,031	475,353	934,809	1,280,771	+37.0
Petroleum:					
Crude oil, thous. of bbl.	40,814	46,916	114,230	130,871	+14.6
Gasoline, thous. of gal.	398,223	.....	†848,620	†842,846	—0.7
Kerosene, thous. of gal.	167,220	.....	†368,457	†340,137	—7.7
Rubber:					
Crude‡, thous. of lb.	18,467	26,771	26,524	66,418	+150.4
Pneumatic tires, thous.	2,084	2,646	2,686	6,875	+152.6
Sugar:					
Imports, raw, long tons	448,321	571,836	753,606	1,335,096	+77.2
Meltings, raw, long tons	415,723	535,357	825,482	1,242,681	+50.5

* Shipments from Minneapolis.
† Includes January and February only.
‡ Consumption by tire manufacturers.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week 157.93
Last week 158.12

June, 1917	222	June, 1918	272
June, 1920	274	June, 1921	147
April, 1918 (high)	286	April, 1921 (low)	140

This week's index number reflects the slightly lower prices for barium chloride and linseed oil. Higher prices noted in the case of benzene and copper sulphate were insufficient to offset the decline. Since May 24 this index number has fallen almost 3 points.

Davison Chemical Co. Reports Six-Million Dollar Surplus in 1921

The annual report of the Davison Chemical Co. and its subsidiaries, the Davison Sulphur & Phosphate Co. and the Silica Gel Corporation, is notable in that it is one of the few fertilizer manufacturing companies to have met the deflation of 1921 without seriously impairing its surplus. The profit and loss surplus at the end of 1921 stood at $1,804,336, to which has been added $4,425,709 as capital surplus value of ore blocked out, giving a total surplus of $6,230,045. This compares with $6,641,984 in 1920 and $6,273,926 in 1919.

According to an analysis of the consolidated balance sheet which has been made by the *Wall Street Journal*, the company retired $604,000 of Davison Sulphur & Phosphate bonds in 1921 at a cost of $579,451. Prior to March 1, 1922, bonds of $1,122,000 par value were converted into 18,700 shares of stock in the Davison Chemical Co., so that the only funded debt now is $2,000,000 of 8 per cent gold debentures.

Investment in the Silica Gel Corporation (200,000 shares) is carried at $24,795, while $408,479 is due from the corporation in accounts receivable. Presumably this is the money advanced for experimental and research work and in constructing the experimental plant for oil refining. The total accounts receivable are $860,262, compared with $540,928 last year. Cash and inventories show little change from the previous report. Current liabilities are $1,153,691, including $703,331 notes and $331,156 accounts, as against $526,758 in notes and accounts last year. Reserves for depreciation amount to $804,345, against $799,919. Working capital is $1,152,150, as against $1,957,363 last year.

The New York Market

NEW YORK, June 12, 1922.

Trading so far during the month of June has been without significant developments. The chemical market has been colorless and except for the merest routine, business has been unusually quiet.

Consumers, it would appear, are showing no inclination to lay in large stocks and are buying in small lots—often in the spot and resale markets. Manufacturers, on the other hand, believe that the bottom of the market has been reached and therefore are inclined to wait for the enactment of pending tariff legislation in the hope that it will bolster up prices.

From the long-time viewpoint the dye people have reason to be encouraged, first by the higher scale of duties recently approved in the Senate and second by the resumption of activity on an increasing scale in the textile centers. Unfortunately, however, neither of these factors is having immediate effect and with the exception of higher prices asked by the producers for a few crudes, the coal-tar products market remains stagnant.

INDUSTRIAL CHEMICALS

Alums—The alum group is being quoted at somewhat lower prices notwithstanding reports of production difficulties. Imported potash alum is quoted at $3.75@$4 per 100 lb., but in some quarters prices as low as $3.10 were heard. Chrome alum is being handled at 5¼@6c., as compared with a price of 7c. a few weeks ago. Ammonia alum is unchanged at 3½@3¾c. for sizable orders.

Ammonium Sulphate—The market for this and most other fertilizer materials has been without change, although announcement of next season's price is expected soon. It is rumored that on ammonium sulphate the new price will be in the neighborhood of $3 per 100 lb. At present trading is at $3.25@$3.40 per 100 lb. in double bags f.a.s. New York.

Arsenic—Importers report a fair inquiry for Japanese white arsenic. In carlots this is quoted at 6¾@7c. per lb.

Barium Chloride—Trading in this article has eased up a bit of late and the tendency is toward lower prices. Imported material for June arrival is being offered at $88@$90. Spot supplies are held at $97@$100, the latter being the price asked by the domestic producers.

Caustic Potash — The market remains unchanged at $5.75@$6 for sizable orders and shipment material is held at slightly lower prices.

Caustic Soda—Inquiries from abroad are being received in fair volume, according to the exporters, and the 76 per cent in drums is quoted at $3.85 f.a.s. The domestic prices are $3.75@$4 for contracts, carlots, ex-works. The ground and flake caustic can be bought in drums at the producer's plant for 3¾@3⅞c. per lb.

Copper Sulphate—The scarcity of blue vitriol is as yet unrelieved and spot material is difficult to purchase under 6c. per lb.

Oxalic Acid—Although business in oxalic is slow, the recent high prices still prevail, principally because this material is scarce in the New York market.

Prussiate of Potash—Red prussiate of potash is back in the market again this week, but supplies are comparatively small. The yellow salt is in somewhat better supply, but prices are showing an upward tendency. Red prussiate is quoted at 80@85c. and the yellow at 32@33c.

Prussiate of Soda—The market is at a standstill and goods on hand are moving at 21½@22c., with lower prices offered for future delivery.

Shellac—Slight advances in price have been applied all along the line due both to the strengthening sterling exchange and recent information that foreign supplies are not too abundant. T. N. is quoted for shipment, June arrival, at 78c., but the price in the spot market has been 80@82c. Orange superfine is selling for 84@86c. per lb., and the A. C. garnet at 66@68c.

Sodium Nitrate—Crude saltpeter is somewhat lower in the spot market, with $2.50@$2.75 covering the general range of quotations.

Sodium Silicate—New contract prices for the 40 deg. material are said to be 75c. per 100 lb. in tank cars, f.o.b. works, 80c. in drums for carlots and less than carlots at $1.05.

Tartaric Acid—The market for tartaric acid is somewhat firmer and during the week advances of ½@1c. were reported. Imported crystals now sell for 28½@29c. and the powdered at 29½@30c.

VEGETABLE OILS

Cottonseed Oil—There have been few developments in the local oil market during the past week. Cottonseed oil exports have fallen to practically nothing. Crude oil was not offered in any quantity and what transactions took place were at 10c. per lb., buyers' tanks, f.o.b. mills.

Linseed Oil—The market for linseed oil has been comparatively quiet, with a tendency toward lower prices. Domestic crushers maintained 82@84c. per gal., but quotations as low as 80c. were heard during the week. The imported oil for June shipment was quoted at 78@80c.

The St. Louis Market

ST. LOUIS, June 8, 1922.

The St. Louis market for industrial chemicals was somewhat stagnant last week, due in all probability to the holiday intervening. There is more activity this week, however, and prices in general are very firm. In fact there is more stability to the market today than there has been for many months past. Domestic manufacturers do not feel the effects of imported material as severely as they did some time ago, although at times the foreign material still upsets the market temporarily. The volume of business transacted during the month of May was very appreciable with favorable indications for continuance.

ALKALIS

Contrary to our prediction in the May 23 report, *caustic soda* did not advance, but has remained the same or been shaded slightly in one or two instances. The *soda ash* mar-

ket has been very quiet recently, but prices have held up to former levels. *Sodium bicarbonate* is moving freely and maintaining a steady price. *Sal soda* is selling in good volume, but competition has caused some decline in recent prices.

General and Special Chemicals

The *sulphuric, nitric and muriatic acid* group is moving very well and prices are somewhat firmer today. *Citric acid* remains in good demand, with limited stocks in some localities. The advance which was expected some time ago has not as yet materialized. There has been very good inquiry for *oxalic acid*, but we do not believe that the actual buying has been in proportion with the volume of inquiry. *White arsenic, powdered*, today is quoted at 7½c. per lb. f.o.b. St. Louis, with a strong market. *Carbon bisulphide* is moving quite freely and orders of large volume are being placed. Prices are firm. *Epsom salts* is in fair demand and being quoted at $2.50@$2.60 per 100 lb., f.o.b. St. Louis. *Glycerine* apparently has reached rock bottom. We had predicted a decline, but so far it has failed to materialize, and since quite a few contracts are renewed about this time a decline now is hardly to be expected. The demand for *potassium ferricyanide* is far in excess of available stocks. *Sodium cyanide* is in good demand, and with the imported material gradually disappearing, the demand for domestic goods is much better. *Sulphur* has not changed in price and the volume of business on this item continues heavy. *Zinc sulphate, technical*, is moving freely with a strong market at 3c. per pound, f.o.b. St. Louis.

Vegetable Oils and Naval Stores

Linseed oil has suffered a slight decline since our last report and is now quoted at $1.01, basis raw oil. *Turpentine* continues around $1, with the usual daily up and down fluctuation. *Castor oil* shows no tendency to weaken and the price of 12¾c. in 200-gal. lots seems to be absolutely rock bottom.

Paint Materials

The paint grinders in this locality are kept very busy and the result is plainly evident in their purchases. So far no dealer has developed sufficient courage to advance prices, so we have no changes to report.

The Iron and Steel Market

PITTSBURGH, June 9, 1922.

The monthly report of the American Iron and Steel Institute, giving the steel ingot production of the thirty steel companies that make monthly returns, indicates that the industry as a whole produced steel ingots in May at the rate of about 38,250,000 tons per annum, against a rate of about 36,600,000 tons in April. The rate at the end of March, when the coal strike began, was about 35,000,000 tons. The rate at present is probably a trifle above the average rate during May. Thus there has been an increase of something like 10 per cent in steel production since the coal strike started, following an increase of about 75 per cent in the 3 months preceding.

The Coal Strike and Its Effects on Steel Production

The steel market is still a strong one and this fact, taken in connection with the increased production of steel in the first 2 months of the coal strike, makes it difficult to follow the theory that the strength of the steel market in the past few months has been due chiefly to the coal strike because the strike made buyers of steel anxious to pile up stocks against a possible interruption in shipments. Had buyers been actuated chiefly by such a motive, they would by this time be in such position as to be forced to begin liquidating the stocks thus accumulated.

That the coal strike has had a favorable influence upon the steel market in the matter of tonnage demand and in the prices obtainable for steel cannot be denied, but it cannot be maintained that the coal strike has been the chief factor.

On the other hand, it cannot be denied that the movement begun in the steel market will not last forever. The longest movement, outside of the war period, lasted 3 years, from late in 1904 to late in 1907. The shortest movement lasted more than a year, from the time buying became fairly active to the time mills had to begin curtailing production on account of orders running short. The present is a regular movement, not a little burst of activity due to the incident of the coal strike. Those who have the least respect for the movement expect it to run well through autumn.

On April 1, when the coal strike started, steel production was at about two-thirds of capacity. It looked then as if the idle third was taken out by the coal strike, the analysis on this basis being that the steel market was as strong with a two-thirds operation as it used to be with a full operation. Now the operation is nearly if not quite three-fourths and it would be quite rash to assume that the ending of the coal strike would make the other one-fourth effective. Labor shortages began appearing at a few points several weeks ago, and transportation shortage would probably prevent a 100 per cent operation of the steel industry, apart from other considerations. There is nothing weird about such suppositions. It is true that before the war the steel industry was always able to operate at its capacity when it had the necessary orders, except during the winter of 1902-3, when the first transportation breakdown in the history of American railroading occurred, but the situation today seems to be that the steel industry, with an actual capacity in ingots of 50,000,000 or 55,000,000 tons, is too big for the rest of the country.

Steel Prices

Steel prices are very firm all along the line, and in several products the minimum prices are made only by the Steel Corporation subsidiaries and then only to regular customers for delivery at mill convenience, other inquiries being turned down, whereupon the business goes to independents at higher prices. Along this line bars, shapes and plates are quotable at 1.60@1.80c., depending on the buyer, the tonnage, the specifications and the time of delivery.

A feature of the market situation is that steel is steel. The bottle neck is ingots. It is a detail what the steel is finished into, there being plenty of finishing capacity. Bars, shapes and plates are therefore on a level with each other. Likewise billets, small billets and sheet bars are all equally quotable at $35 Pittsburgh or Youngstown. Sales of sheet bars at $35 are now being made for July delivery.

Plates, Sheets and Steel Products

The American Sheet & Tin Plate Co. has opened its order books for tin plate for second half delivery to manufacturing consumers and third quarter to jobbers, these being the usual periods. The price remains at $4.75. Some of the independents had been talking of an advance to $5, but $4.75 is considered high enough. In sheets the company opened its books for July only, this being an innovation. Likewise the prices are unchanged, at 2.40c. for blue annealed, 3.15c. for black, 4.15c. for galvanized and 4.50c. for automobile sheets. Most independents, who had sold more or less for July at old prices, are now asking $2 a ton more for blue annealed, $3 more for black and galvanized, and $5 more for automobile sheets.

Hoops, bands and hot-rolled strips are now commonly quoted at 2.40c., but the old price of 2.25c. can perhaps be done with the Steel Corporation by some regular customers. Cold-rolled strips have been advanced by independents to 4c., the American Steel & Wire Co. remaining at 3.75c. The wire company remains at $2.40 on nails and independents have been forced to recede from their $2.50 price, made about the middle of April, in the case of the most attractive orders.

The steel industry seems fortified to continue its present rate of production almost indefinitely despite the coal strike, which shows no material change.

The local pig iron market remains stagnant, the quotable level, largely nominal, remaining at $25 valley for bessemer and basic and $24 for foundry.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride	lb.	..... –	$0 38 – $0.40
Acetone	lb.	$0 08 – $0 09	09¼ – .10
Acid, acetic, 28 per cent	100 lbs.	2 25 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	8 50 – 9 00	.50 – 9.75
Boric, crystals	lb.	.11 – .11½	.11¾ – .12
Boric, powder	lb.	.11 – .11½	.11¾ – .12½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – .12
Lactic, 44 per cent tech	lb.	.09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3 00 – 3 25	3.30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg	lb.	.06 – .06½	.06¾ – .07
Nitric, 42 deg	lb.	.06½ – .06¾	.07 – .07½
Oxalic, crystals	lb.	.14 – .14¾	.14¾ – .15
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08¾ – .09½
Picric	lb.	.22 – .24	.24½ – .30
Pyrogallic, resublimed	lb.	..... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	15 00 – 16 00	..... – .....
Sulphuric, 66 deg., drums	ton	19 00 – 20.00	20.50 – 21 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22 50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32 00	33.00 – 34 00
Tannic, U. S. P	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.28½ – .29
Tartaric acid, imported, powdered	lb.	..... –	.29½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1.00 – 1 10
Alcohol, ethyl (Cologne spirit)	gal.	..... –	4 75 – 4 95
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.26 – .30
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.26 – .30
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03¾ – .04	.04½ – .05
Alum, chrome lump	lb.	.05¼ – .05¾	.06 – .06½
Aluminum sulphate, commercial	100 lb.	1 50 – 1.65	1 70 – 2 25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06¾ – .07½	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.30½ – .31
Ammonium carbonate, powder	lb.	.07 – .07½	.07½ – .08
Ammonium nitrate	lb.	.06 – .06½	.06¾ – .07½
Amylacetate tech	gal.	..... –	2.00 – 2 25
Arsenic, white, powdered	lb.	.06¾ – .07¼	.07½ – .08
Arsenic, red, powdered	lb.	.12 – .12¼	.12½ – .13
Barium carbonate	lb.	.03 – .04	.04½ – .05
Barium chloride	ton	90.00 – 95.00	100 00 – 105 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.06½ – .07	.07½ – .08
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .04¾
Blanc fixe, dry	lb.	.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	1 70 – 1.85	1 90 – 2 75
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24.75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02¼
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.79 – .83
Carbon bisulphide	lb.	.06½ – .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04¼ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.05¾ – .06
Chloroform	lb.	..... –	.30 – .32
Cobalt oxide	lb.	..... –	2.00 – 2 10
Copperas	ton	20.00 – 22 00	23.00 – 30 00
Copper carbonate, green precipitate	lb.	.19 – 20	.20¼ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	6.00 – 6.15	6 25 – 6.50
Cream of tartar	lb.	..... –	.24 – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.08½ – .08¾	.09 – .09¾
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32.00	..... – .....
Fusel oil, ref	gal.	..... –	2 25 – 2 65
Fusel oil, crude	gal.	..... –	1 30 – 1 50
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.15 – .15½
Iodine, resublimed	lb.	..... –	4 20 – 4.25
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09½ – .12
Lead arsenate, powd	lb.	.14 – .14½	.14¾ – .15½
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07¾ – .08	.08¾ – .09
Magnesium carbonate, technical	lb.	.08½ – .08¾	.09 – .09½
Magnesium sulphate, U. S. P	100 lb.	2 50 – 2 60	2.65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1 80
Methanol, 95%	gal.	..... –	.57 – 58
Methanol, 97%	gal.	..... –	.59 – 60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.10 – .10¼
Phogene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	..... –	.40 – .45
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.09¾ – .10	.10¾ – .10
Potassium bromide, granular	lb.	..... –	.17 – .20½
Potassium carbonate, U. S. P	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80-85%	lb.	.05 – .05½	.05½ – .06
Potassium chlorate, powdered and crystals	lb.	.06½ – .07	.07¼ – .08
Potassium cyanide	lb.	..... –	.45 – .50
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6 25 – 6.50
Potassium iodide	lb.	..... –	3.30 – 3.40
Potassium nitrate	lb.	.07⅞ – .07½	.08 – .09
Potassium permanganate	lb.	.14 – .14½	.14½ – .15½
Potassium prussiate, red	lb.	.....	.80 – .85
Potassium prussiate, yellow	lb.	.32 – .32½	.32½ – .33
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.07 – .07½	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .07⅝	.07¾ – .08⅛
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	20.00 –25.00	..... – .....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1 90 – 2 00	2.10 – 2.50
Soda ash, dense	100 lb.	1.95 – 2.05	2.10 – 2.60
Sodium acetate	lb.	.05 – .05¼	.05½ – .06
Sodium bicarbonate	100 lb.	1.80 – 1.90	1.95 – 2.40
Sodium bichromate	lb.	.07¼ – .07½	.07¾ – .08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P	lb.	.04¼ – .04½	.04¾ – .05¼
Sodium chlorate	lb.	.06 – .06½	.06½ – .07
Sodium chloride	long ton	12 00 –13 00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.09 – .09½	.09¾ – .10
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.85 – 3.90	–3.95 – 4.25
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	–4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	–4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03¼	.03¾ – .04
Sodium nitrite	lb.	.08½ – .09	.09¼ – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.22 – .24	.24½ – .25
Sodium silicate, (40 deg. in drums)	100 lb.	.85 – 1.00	1.05 – 1.25
Sodium silicate, (60 deg. in drums)	100 lb.	2.35 – 2.50	2.55 – 2.90
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.05	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.03½ – .04¼	.04½ – .05
Sodium sulphite, crystals	lb.	.03½ – .03⅝	.03¾ – .04¼
Strontium nitrate, powdered	lb.	.09½ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05¼ – .06
Sulphur, crude	ton	18.00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18 00 –25 00	..... – .....
Tin bichloride	lb.	.09 – .09¼	.09½ – .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14¾ – .15½
Zinc chloride, gran	lb.	.05¼ – .05½	.05¾ – .06½
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$1.00 — $1.05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.14 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P	lb.	1.25 — 1 30
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.80 — .85
Benzoic acid, U.S.P	lb.	.60 — .65
Benzoate of soda, U.S.P	lb.	.50 — .55
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.23 — .26
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.53 — .55
Cresylic acid, 95-97%, dark, in drums	gal.	.48 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.80 — .95
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.05 — 1.25
Naphthalene crushed, in bbls	lb.	.06 — .06¾
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08
Naphthionate of soda	lb.	.58 — .65
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
N-W acid	lb.	1.15 — 1.30
Ortho-amidophenol	lb.	.40 — 2.50
Ortho-dichlor-benzene	lb.	2.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	$0.10 —	$0.13
Ortho-toluidine	lb.	.14 —	.18
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.17 —	20
Paranitroaniline	lb.	.75 —	.77
Para-nitrotoluene	lb.	.55 —	.65
Para-phenylenediamine	lb.	1.55 —	1.60
Para-toluidine	lb.	.90 —	1.00
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
R-salt	lb.	.60 —	70
Salicylic acid, tech., in bbls	lb.	.25 —	.25½
Salicylic acid, U. S. P.	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	.27 —	.32
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.18
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	35
Xylidines, drums, 100 gal	lb.	.40 —	45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax	lb.	$0.20 —	$0.21
Beeswax, refined, dark	lb.	.26 —	.28
Beeswax, refined, light	lb.	.30 —	.32
Beeswax, white pure	lb.	.35 —	.40
Candelilla, wax	lb.	.35 —	.36
Carnauba, No. 1	lb.	.45 —	.46
Carnauba No. 2, North Country	lb.	.25 —	.25½
Carnauba, No. 3, North Country	lb.	.16 —	.16½
Japan	lb.	.16½ —	.17
Montan, crude	lb.	.04 —	.04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ —	....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02¾ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.02¾ —	.03
Paraffine waxes, refined, 125 m.p.	lb.	.03 —	.03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.04¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05¼
Stearic acid, single pressed	lb.	.09 —	.09¼
Stearic acid, double pressed	lb.	.09½ —	.09¾
Stearic acid, triple pressed	lb.	.10½ —	.10¾

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.45 —	$5.70
Rosin E-I	280 lb.	5.90 —	6.10
Rosin K-N	280 lb.	6.40 —	6.90
Rosin W. G.-W. W	280 lb.	7.75 —	8.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	.96 —	96½
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.10
Pine oil, pure, dest. dist	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y.	100 lb.	3.25 —	3.40
Blood, dried, f.o.b., N. Y	unit	3.55 —	3.65
Bone, 3 and 50, ground, raw	ton	27.00 —	28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate of soda	100 lb.	2.50 —	2.75
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	3.75
Tennessee, 78-80%	ton	7.00 —	7.50
Potassium muriate, 80%	ton	33.50 —	35.00
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0.18 —	.18½
Upriver coarse	lb.	.12¾ —	.13
Upriver caucho ball	lb.	.13¼ —	.13¾
Plantation—First latex crepe	lb.	.14¼ —	.15¼
Ribbed smoked sheets	lb.	.14¼ —	.15¼
Brown crepe, thin, clean	lb.	.13¾ —	....
Amber crepe No. 1	lb.	.14¼ —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.11 —	$0.11½
Castor oil, AA, in bbls	lb.	.12 —	.12½
China wood oil, in tanks	lb.	.13¾ —	14
Coconut oil, Ceylon grade, in bbls	lb.	.08¾ —	.09
Coconut oil, Cochin grade, in bbls	lb.	.09¼ —	.09¾
Corn oil, crude, in bbls	lb.	.11¼ —	.11¾
Cottonseed oil, crude (f. o. b. mill)	lb.	$0.10 —	$0.10½
Cottonseed oil, summer yellow	lb.	.12 —	.12½
Cottonseed oil, winter yellow	lb.	.13 —	.13½
Linseed oil, raw, car lots (domestic)	gal.	.82 —	.84
Linseed oil, raw, tank cars (domestic)	gal.	.80 —	.82
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.87 —	.90
Olive oil, denatured	gal.	1.15 —	1.17½
Palm, Lagos	lb.	.07¼ —	.07½
Palm, Niger	lb.	.06¼ —	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.13
Rapeseed oil, refined in bbls	gal.	.83 —	.84
Rapeseed oil, blown, in bbls	gal.	.85 —	.86
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.11½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	....

FISH

Light pressed menhaden	gal.	$0.48 —	....
Yellow bleached menhaden	gal.	.53 —	.54
White bleached menhaden	gal.	.55 —	.55
Blown menhaden	gal.	.61 —	....
Whale Oil, No. 1. crude, tanks, coast	gal.	.45 —	.48

Ores and Semi-finished Products

Quotations have not changed since June 7 report

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00–20.00
Antimony, wholesale lots, Chinese and Japanese	5.25–5.30
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	29.00–32.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	32.25
Lead, New York, spot	5.65–5.75
Lead, E. St. Louis, spot	5.35
Zinc, spot, New York	5.65
Zinc, spot, E. St. Louis	5.30–5.35

All other quotations are unchanged

Refractories

Prices are unchanged since June 7 report

Miscellaneous Materials

All f.o.b. New York, Unless Otherwise Stated

Asbestos, crude No. 1, f.o.b., Quebec, Canada	short ton	$900.00	$1200.00
Asbestos, shingle stock, f.o.b., Quebec, Canada	short ton	90.00	—125.00
Asbestos, cement stock, f.o.b., Quebec, Canada	short ton	22.00	— 28.00
Barytes, ground, white, f.o.b. mills	net ton	17.00	— 23.00
Barytes, ground, off color f.o.b. mills	net ton	13.00	— 21.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	— 24.00
Barytes, crude f.o.b. mines	net ton	8.00	— 9.00
Casein	lb.	.14	— .15
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.00	— 8.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	8.00	— 9.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	12.00	— 70.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	— 12.00
China clay (kaoli n)ground, f.o.b. Virginia points	net ton	13.00	— 20.00
China clay (kaolin), imported, lump	net ton	14.00	— 20.00
China clay (kaolin), imported, powdered	net ton	30.00	— 35.00
Feldspar, No. 1 pottery grade	long ton	6.40	— 6.75
Feldspar, No. 2 pottery grade	long ton	5.75	— 5.90
Feldspar, No. 1 soap grade	long ton	7.00	— 7.50
Feldspar, No. 1 Canadian, for mill	long ton	21.00	— 22.00
Graphite, Ceylon lump, first quality	lb.	.06	— 07
Graphite, Ceylon chip	lb.	.04½	— .05½
Graphite, high grade amorphous crude	ton	15.00	— 30.00
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—
Kieselguhr, f.o.b. N. Y.	per ton	55.00	— 60.00
Magnesite, calcined (crude)	per ton	8.00	— 12.00
Pumice stone, imported	lb.	.03	— .05
Pumice stone, domestic, lump	lb.	.05	— .05½
Pumice stone, domestic, ground	lb.	.06	— .07
Shellac, orange fine	lb.	.81	— .82
Shellac, orange superfine	lb.	.84	—
Shellac, A. C. garnet	lb.	.62	— .63
Shellac, T. N.	lb.	.80	—
Silica, glass sand, f.o.b. Indiana	per ton	1.25	— 2.25
Silica, sand blast material, f.o.b. Indiana	per ton	2.25	— 4.50
Silica, amorphous, 250 mesh, f.o.b. Illinois	per ton	16.00	— 16.00
Silica, building sand, f.o.b. Pa.	per ton	2.00	— 2.75
Soapstone	ton	12.00	— 15.00
Talc, 200 mesh, f.o.b. Vermont	ton	7.00	— 12.00
Talc, 200 mesh, f.o.b. Georgia	ton	7.50	— 12.00
Talc, 200 mesh, f.o.b. Los Angeles	ton	16.00	— 20.00

Ferro-Alloys

Ferrocerium, Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferrouranium, and Ferrovanadium are unchanged from the prices published June 7.

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$2.58	$2.48
Soft steel bars	2.48	2.38
Soft steel bar shapes	2.48	2.38
Soft steel bands	2.98	2.98
Plates, ¼ to 1 in. thick	2.58	2.48

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

CERAMIC—The Hazleton Brick Co., Hazleton, Pa., has adopted a capacity schedule at its plant, and is said to have orders on hand to insure continuous production throughout the summer.

The Star Porcelain Co., Trenton, N. J., manufacturer of electrical porcelain products, is operating under regular production with full working force. The plant is now running heavy on specialties for radio service.

The Perth Amboy Tile Works, Perth Amboy, N. J., is operating at full capacity with regular working force. The company has orders on hand for a number of months to come. Extensions are being made for increased capacity.

RUBBER—The Electric Hose & Rubber Co., Wilmington, Del., manufacturer of heavy hose and other rubber goods, is running under day and night shifts. Orders are well in excess of production.

The Amazon Rubber Co., Akron, O., is planning to double its present capacity of 100 tires a day before the close of June. Additions are being made to the working force.

The Firestone Tire & Rubber Co., Akron, O., is maintaining production at maximum capacity, and has advanced the wages of all employees in the factory from 9 to 12 per cent. The wages of office workers have been increased 10 per cent.

The rubber industry at Akron, O., is now employing close to 50,000 workers, as compared with about 35,000 employees a year ago, and 80,000 in February, 1920, the peak period.

The Republic Rubber Corp., Youngstown, O., is operating on a two-shift basis at its local plant, giving employment to about 1,000 men. The belting and inner tube branches have recently advanced their schedules to a three-shift basis.

Offers are being made for the plant of the Batavia Rubber Co., Batavia, N. Y., which recently went into the hands of a receiver, and it is expected that operations will be resumed at an early date.

The Studebaker-Wulff Rubber Co., Marion, O., is arranging for a further increase in production from 100 casings and tubes each per day, to 150 each daily.

IRON AND STEEL—The Sloss-Sheffield Steel & Iron Co. has blown in its stack at Florence, Ala., after a suspension of a number of months, making a total of five blast furnaces of the company now in operation.

The Reading Iron Co., Reading, Pa., is increasing operations at its North 9th St. plant, and has placed the universal mill in service, following a suspension since last September. The unit will give employment to about 100 additional men.

The Brier Hill Steel Co., Youngstown, O., has blown in another blast furnace at its plant, following an indle period of a number of months. All stacks at this plant are now in service.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., is completing repairs on three furnaces at its plant and expects to place two of the units in operation at an early date for the production of foundry iron.

The Nagle Steel Co. is increasing operations at its Pottstown Pa., plant. The Glasgow Iron Co., in this same section, is running at its mill and has twelve of its fourteen puddling furnaces in service.

Steel manufacture in the Mahoning Valley section of Ohio and in the Cleveland (Ohio) district is now about 75 per cent of capacity, being held at this basis on account of the coal strike and consequent fuel shortage at certain plants.

The Central Steel Co., Massillon, O., is operating at close to 100 per cent at its different plants, including the National Pressed Steel Co. and the Massillon Rolling Mill Co., recently merged with the Central company. A wage advance of 10 per cent has been made at the mills, effective June 1, affecting about 2,000 employees.

The Robesonia Iron Co., Ltd., Robesonia, Pa., is arranging to blow in its blast furnace on low-phosphorus iron about the middle of June.

LEATHER—The Benz Kid Co., Lynn, Mass., is increasing production at its local tannery to handle heavy incoming orders.

The Sparrowbush Tanning Co., Sparrowbush, near Port Jervis, N. Y., is developing an increased output at its plant, comprising the former Hammond tannery, recently acquired. It has a capacity of 1,200 sides a day and will soon be running at maximum.

Six of the largest of the twenty-two tanneries at Chicago, Ill., are curtailing production, due, it is stated, to lack of orders. The total decrease in output approximates 40,000 sides a week.

OIL—The Chickasaw Refining Co. is arranging for the early resumption of operations at its Ardmore, Okla., oil refinery, following a shutdown for the last six months.

The Dale Refining Co. has completed the remodeling of the old oil refinery at Humble, Tex., and is now running on a basis of about 350 bbl. of oil daily.

MISCELLANEOUS—The Owens Bottle Co., Pittsburgh, Pa., is making repairs at its Clarksburg, W. Va., plant, and will place the works in operation at an early date.

The Sherwin-Williams Co., Cleveland, O., is running all of its paint and varnish plants at normal capacity. Other paint manufacturers in this district have also adopted full-time operating schedules, with regular working forces.

The United States Cast Iron Pipe & Foundry Co., East Burlington, N. J., is now operating at about 70 per cent of capacity at its different plants throughout the country, as compared with a 55 per cent production basis two months ago.

The Spanish River Pulp & Paper Mills, Ltd., Montreal, Que., has developed a maximum output of 307 tons a day at its Espanola plant, or about 50 tons greater than originally planned.

Construction and Operation

Arizona

MORENCI—The Stargo Mines, Inc., is completing plans for the construction of a new cyanide plant, with initial capacity of about 75 tons a day, estimated to cost close to $80,000. The General Engineering Co., Salt Lake City, Utah, is engineer.

California

REDLANDS—J. H. Strait & Co. have plans and specifications under way for the construction of a new fruit dehydrating plant in the vicinity of their present work.

Delaware

WILMINGTON—The Wilmington Sugar Refining Co., Christiana Ave. and B St., has foundation work under way for the main building at its new local sugar mill, comprising a 5-story structure, 100x200 ft., estimated to cost about $800,000, including equipment. W. J. Wayte, Inc., 125 East 46th St., New York, N. Y., is engineer.

WILMINGTON—The Charles Warner Co., Wilmington, has acquired the plants and properties of the American Lime & Stone Co., Tyrone, Hollidaysburg and Bellefonte, Pa., comprising chemical limestone land totaling about 7 miles long, with fluxing stone sites and other mineral properties. The holdings are valued at $3,000,000. The new owner plans extensive operations at the mills, primarily for lime production, and is said to be arranging for a number of extensions and improvements. The company has disposed of a bond issue of $1,100,000, the proceeds to be used in connection with the project.

Florida

GAINESVILLE—The Standard Fertilizer Co. is planning for the rebuilding of the portion of its plant destroyed by fire, May 23, with loss estimated at about $30,000, including equipment.

Georgia

COLUMBUS—The Armour Fertilizer Co., 209 West Jackson Blvd., Chicago, Ill., will commence the immediate construction of a new local plant to replace the portion of its works recently destroyed by fire.

PORT WENTWORTH—The Atlantic Paper & Pulp Co. is planning for the rebuilding of the section of its works, recently destroyed by fire with loss approximating $50,000, located at Port Wentworth, a suburb of Savannah.

Indiana

INDIANA HARBOR—The Steel & Tube Co. of America, 111 West Washington St., Chicago, Ill., has authorized the immediate preparation of plans for the construction of two new mills at its local works, to be equipped for an annual capacity of about 100,000 tons. To carry out the details of the project a stock issue of $6,000,000 is planned. Herbert H. Springford is president.

Kentucky

ASHLAND—The Pittsburgh Brick & Tile Co. has been organized under state laws, to construct and operate a plant for the manufacture of brick, tile and other burned clay products. A tract of about 400 acres of land has recently been acquired at Summitt, and plans for the initial plant units are nearing completion. The company is headed by A. C. Bailey, W. L. Bybee and S. S. Willis, Ashland.

Louisiana

COVINGTON—A new company is being organized, it is said, to take over and operate the plant of the Covington Moss Works, Inc., soon to be offered at a public sale to satisfy creditors. The plant is equipped for the manufacture of artificial moss, and will be extended and improved by the new owner.

NEW ORLEANS—The Armour Fertilizer Works, 209 West Jackson Blvd., Chicago, Ill., has awarded a contract to Hugger Brothers, Montgomery, Ala., for the rebuilding of the portion of its plant at Shrewsbury, near New Orleans, destroyed by fire late in April with loss approximating about $250,000, including equipment. The new structures will cost close to this amount.

SWARTZ—The Huber Carbon Co. has completed plans for extensions in its local mill to double the present capacity, and will commence work at an early date. A new gasoline extraction plant will also be constructed.

NEW ORLEANS—The Richardson Co., Cincinnati, O., manufacturer of composition paper roofing and kindred products, has plans under way for the construction of an addition to the plant of the Century Roofing Co., New Orleans, an affiliated organization, to cost about $500,000, including equipment.

MONROE—The Constantin Refining Co., Monroe, is completing the construction of a new gasoline-absorption plant in Union County, Ark., and plans to place the mill in service at an early date. It will have an initial capacity in excess of 4,000 gal. a day, and this output will be increased in the future.

Maryland

BALTIMORE—The Patuxent Clay Products Co., 210 Equitable Trust Bldg., will call for bids before the end of the month for the construction of its proposed new plant on property recently acquired at Patuxent. It will be equipped for the manufacture of brick, tile and other burned clay products, and is estimated to cost close to $100,000 with machinery. I. P. Mills is head.

BALTIMORE—E. J. Callahan & Co., manufacturers of glass products, have leased property at 14-16 West Barre St., for a new local works.

Massachusetts

BOSTON—Fire May 30 destroyed a portion of the building of the Acme White Lead & Color Co., with loss estimated at about $13,000.

New Jersey

NEWARK—D. E. Evarts, 134 Gifford Ave., Jersey City, has acquired the plant of the Schofield Oil Co., Ave. R, Port Newark district, at a receiver's sale for a consideration of $160,500, and is organizing a company to operate the business. The plant consists of three main buildings, on site

aggregating about 5½ acres of land, and will be improved by the new owner.

GARWOOD—The Federal Foundry Co. has acquired the local plant of the Garwood Bronze & Iron Co., North Ave., for a new foundry. George H. Cross is president.

LAMBERTVILLE—The Jesperson Newsprint Corp. is planning for the early operation of its local plant, comprising the former mill of the Perseverance Paper Co., lately acquired, for the manufacture of newsprint from used stock by a special process. The equipment is being remodeled and the plant improved, and it is expected to give employment to a large working force. Henry Weeks is treasurer and general manager.

PERTH AMBOY—The Perth Amboy Oil & Terminal Co., recently organized, has acquired a site near the city for a new oil distributing plant, estimated to cost about $125,000, including equipment. The company is affiliated wth the Able Refining Co., Houston, Tex. Luke Mooney, Sewaren, N. J., is president; and A. L. Baker, 25 Broad St., New York, N. Y., treasurer.

New York

YONKERS—The Arlington Chemical Co., 100 Hamilton St., has authorized the preparation of plans for the erection of a new 4-story plant, in the vicinity of Herriott St., estimated to cost in excess of $50,000. Timmis & Chapman, 315 5th Ave., New York, are architects. John E. Andrus is president.

NIAGARA FALLS—The Defiance Paper Co., Walnut Ave., will soon commence the erection of an addition to its plant to cost about $200,000, including equipment. The extension will be equipped to give employment to about 100 men.

BINGHAMTON — The F. E. Harris Co., North Chenango St., manufacturer of flavoring extracts, etc., has broken ground for the erection of a 1-story addition, 175x175 ft., estimated to cost about $42,000, including equipment. The general contract has been let to B. L. Gabriel, Security Mutual Bldg.

LITTLE FALLS—The Barnet Leather Co., 81 Fulton St., New York, has excavations under way for the erection of a 3-story addition to its plant, estimated to cost about $100,000, including tanning and operating machinery.

LONG ISLAND CITY—The Nichols Copper Co., 25 Broad St., New York, is considering plans for the rebuilding of the portion of its plant on Newtown Creek, destroyed by fire May 27, with loss reported at close to $200,000, including equipment.

LOCKPORT—The A. W. Jack Corp., Mill St. and North Transit Road, manufacturer of asbestos mill board and kindred products, has awarded a contract to the J. W. Cowper Co., Fidelity Bldg., Buffalo, for the erection of its proposed new 1-story plant, 128x500 ft., estimated to cost close to $400,000, including machinery. George F. Hardy, 309 Broadway, New York, is engineer.

North Carolina

WAYNESVILLE—The American Mica Mining Corp. is planning for the establishment of a new mica mining and conversion plant. A list of machinery for installation is being arranged. Harry M. Hall is secretary.

Ohio

AKRON—The National Sulphur Co., Constable Hook, Bayonne, N. J., has construction well under way on a new plant at Bettes Corners, comprising a series of seven large buildings and a number of smaller structures. It is purposed to remove the Bayonne works to this location. The new plant will cost about $400,000, and is expected to be ready for service at an early date. It will give employment to about 350 men.

CLEVELAND—The Colonial Steel Co., Keystone Bldg., Pittsburgh, Pa., has plans under way for the erection of a new building on property recently purchased at 2121 St. Clair Ave., to be equipped as a heat-treating plant.

Oklahoma

HUGO—The local Chamber of Commerce is interested in a plan for the establishment of a local acid and dye plant, utilizing the bois d'arc wood materials from Choctaw County. A company will be organized, according to tentative arrangements, to operate the works.

TULSA—The Sinclair Oil & Gas Co. has arranged an appropriation of $1,000,000, for the construction of new gasoline extraction plants in the Mid-Continent field, and improvements in its present plants. H. B. Bernard, superintendent of gasoline plants, is in charge.

Pennsylvania

ROCHESTER—The American Borax Co., E. L. Dawes, president, care of the Standard Sanitary Mfg Co., Bessemer Bldg., Pittsburgh, has awarded a contract to the Austin Co., 16116 Euclid Ave., Cleveland, O., for the erection of a new addition to the plant building of National Glass Co., recently acquired. It will be 50x100 ft., and is estimated to cost close to $100,000. The existing buildings will be remodeled and improved to accommodate the new works.

LOCK HAVEN—The General Refractories Co., Oliver Bldg., Pittsburgh, is negotiating for the purchase of the plant of the Pennsylvania Fire Brick Co., Beech Creek, near Lock Haven, and upon acquisition, will merge the company with its organization. The plant will be continued in operation and improvements made. The company is also reported to be arranging for the purchase of the plants of the Hiram Swank's Sons Co., at Johnstown and vicinity.

LANCASTER — The Armstrong Cork Co., Liberty and Mary Sts., will soon break ground for the erection of a 1-story addition, 60x60 ft.

PHILADELPHIA—H. Swoboda & Son, Inc., 1027 North Bodine St., manufacturer of leather products, has awarded a contract to the John N. Gill Construction Co., 112 South 16th St., for the erection of a 1-story addition.

SINNAMAHONING—Fire May 26 destroyed a portion of the local powder works of the Grasselli Chemical Co. An official estimate of loss has not been made. The plant is operated in the name of the Grasselli Powder Co. Joseph S. Burton is president.

READING—A new 1-story foundry will be erected at the plant of the Reading Knob Works, about 30x50 ft. C. B. Mongel, 1122 Pennsylvania Ave., Wyomissing, Pa., is architect.

MONTROSE—The Binghamton Limestone Co., Binghamton, N. Y., has preliminary plans under way for the erection of a local plant, estimated to cost in excess of $50,000, including buildings and equipment. E. E. Kellogg, care of the Kellogg-Jones Co., O'Neil Bldg., Binghamton, is treasurer.

Tennessee

KNOXVILLE—The Kinney Chemical Co. will soon break ground for the erection of a new plant. F. L. Kinney is vice-president and general manager.

Texas

FORT WORTH—The Magnolia Petroleum Co. is reported to be planning for the rebuilding of the portion of its distributing plant, destroyed by fire May 28, with loss estimated at close to $300,000.

GRAND PRAIRIE—The Prairie Refining Co. is planning for the early operation of its new local oil refinery, now nearing completion. The plant will have an initial output of 300 bbl. per day, including lubricating oils, grease, asphalt, paints, etc., and at a later date will be increased. I. B. Walker is president.

Virginia

COVINGTON—The Town Council will construct a new mechanical filtration plant in connection with the installation of a waterworks system. C. P. Barnett, Covington, is consulting engineer.

LYNCHBURG — The Lynchburg Pigment Corp., P. O. Box 128, has leased the local plant of the National Pigment & Chemical Co. for the establishment of a works for the manufacture of ochre, talc and kindred specialties. Operations will be commenced at an early date. John A. Weinman is president.

West Virginia

KENNILWORTH—The Globe Brick Co. is reported to be planning for the rebuilding of the tunnel dyring department at its plant, recently destroyed by fire.

LUMBERPORT—The Mound City Glass Co., manufacturer of tumblers and other plain blown glass products, will commence the immediate erection of an addition to its plant to double, approximately, the present output. It will cost in excess of $40,000.

NITRO—The Carrier Chemical Co., recently organized, has plans under way for the establishment of a local plant for the manufacture of a line of finished chemical products. M. T. Davis, Jr., is president.

HUNTINGTON—The Bishop Sons Co., New Cumberland, W. Va., has plans under consideration for the establishment of a new branch plant for the manufacture of lamp chimneys and kindred products.

Wisconsin

NEENAH—The Valley Paper Mills, Wisconsin Ave., will take bids at once for the erection of their proposed new plant in the Blair Springs district, comprising a main 2- and 3-story mill, 80x160 ft., estimated to cost about $750,000, including machinery. Edward A. Wettengal, 578 Pierce Ave., Appleton, Wis., is architect and engineer. G. W. Burnside is secretary and general manager.

Canada

KINGSTON, ONT.—The Frontenac Floor & Wall Tile Co. has construction under way on an addition to its plant to double, approximately, the present capacity. Two new kilns will be built to be used primarily for wall tile production. The company has recently completed the installation of a new grinding mill for feldspar production. Everett Townsend is general manager.

MONTREAL, QUE.—The National Electric Products, Inc., recently consolidated with the Dominion Oxygen Co., Ltd., has plans under way for the erection of a number of commercial oxygen plants in different industrial centers in Canada. The enlarged company is closely allied to the National Carbon Co.

New Companies

THE FLANDILL PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of $25,000, to manufacture chemicals, paints, etc. The incorporators are H. M. Underhill and D. F. Young. The company is represented by C. A. Hand, 123 Liberty St., New York.

THE LASO LABORATORIES, INC., 3733 North Clark St., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are Ludwig Sayfarth, W. C. McGuire and E. H. Nealis.

THE PREMIER RUBBER CO., Newark, N. J., has been incorporated with a capital of 50,000 shares of stock, no par value, to manufacture rubber products of various kinds. The incorporators are James A. Whitman, John W. Stoddard and W. Howard Demarest, 790 Broad St., Newark.

THE TROPICAL ENGINEERING CO., Tampa, Fla., has been incorporated with a capital of $30,000, to manufacture fertilizer products. S. W. Allen is president; and W. H. Phillips, secretary, both of Tampa.

THE LINCOLN SOAP & CHEMICAL CO., Bellevue, Pa., has been incorporated under Delaware laws with a capital of $75,000, to manufacture soaps, chemicals and chemical byproducts. The incorporators are E. Zane and W. H. Butterworth, Bellevue; and L. W. Bewby, Crafton, Pa. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

MILLER, MILLER & CO., INC., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts; mineral specialties, etc. The incorporators are M., I., and B Miller, 950 Union Ave., New York.

THE ARGOL SULPHITE CO., INC., Curtis Bay, Baltimore, Md., has been incorporated with a capital of $100,000, to manufacture chemicals and chemical byproducts. The company will commence the immediate erection of a new plant at Curtis Ave. and Birch St. The incorporators are John H. Moran, F. Swift Gibson and George A Whiting.

THE WALKER PETROLEUM CO., Wilmington, Del., has been incorporated under state laws with a capital of $5,000,000, to manufacture petroleum products. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington.

G. O. BEEMAN & CO., Detroit, Mich., have been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are George O. Beeman, Jr., and Charles W. Beeman, 3328 Whitney Ave., Detroit.

THE CONSOLIDATED COPPER MINES CO., Richmond, Va., has been incorporated with a capital of $2,000,000, to operate copper properties and manufacture refined copper. T. G. Pool is president, and George P. Royster, secretary, both of Richmond.

THE PAN-AMERICAN FIBRE CORP., Wilmington, Del., has been incorporated under state laws with capital of $1,000,000, to manufacture fiber products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE OLEANDER PETROLEUM CO., Dallas, Tex., has been incorporated with a capital of $100,000,000 to manufacture petroleum products. The incorporators are J. H. Hill, F. M. Lege, Jr., and C. B. McKinney, all of Dallas.

M. DEMATTIA, INC., New York, N. Y., has been incorporated with a capital of $12,000, to manufacture chemicals and chemical byproducts. The incorporators are M. Lehman, F. Lowenfels and M. E. Schere. The company is represented by House, Grossman & Vorhaus, 115 Broadway, New York.

THE STANDARD GRAPHITE CO., Los Angeles, Cal., has been incorporated with a capital of $100,000, to manufacture graphite products. The incorporators are W. R. Morgan, Edward P. Jarvis, and K. R. Morgan, all of Los Angeles.

THE BROOKS CO., Utica, N. Y., has been incorporated with a capital of $25,000, to manufacture flavoring extracts and affiliated products. The incorporators are S. A., E. M. and V. E. Brooks. The company is represented by S. W. Brooks, Utica.

THE PETROLEUM OILS CORP., Kansas City, Mo., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are R. H. Erichsen, L. H. Schwald and H. J. Smith, all of Kansas City.

THE RESPESS PROCESS PAINT CORP., New York Division, New York, N. Y., has been incorporated with a capital of $1,000,000, to manufacture paints, varnishes, etc. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington, Del.

THE MICHIGAN FULLERS EARTH CORP., Hariette (Wexford County), Mich., has been incorporated with a capital of $400,000, to manufacture refined fullers earth and petroleum products. The incorporators are James E. Evans, Lakewood, O.; John Wall and Charles W. Hoffman, Cleveland, O.

THE STANDARD MAGNESIA MFG. CO., 613 Capitol Ave., Hartford, Conn., has filed notice of organization to manufacture magnesia specialties. C. H. Densmore heads the company.

THE WEST HAVEN RUBBER CO., West Haven, Conn., has been incorporated with a capital of $200,000, to manufacture automobile tires and other rubber products. The company has purchased the local plant of the Kelly Tire & Rubber Co. from the receiver for a consideration of $275,000, and will soon place the works in operation. The incorporators are A. F. Egner, J. A. Walsh and George F. Armstrong, president of the Armstrong Rubber Co., Garfield, N. J.

THE SOUTH RIVADAVIA OIL CO., Wilmington, Del., has been incorporated under state laws with a capital of $1,000,000, to manufacture petroleum products. The company is represented by the Corporation Service Co., Equitable Bldg., Wilmington.

THE UPPER LUBRICATION CO., INC., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture lubricating oils. The incorporators are M. Ross, F. Hart and W. J. McGirr. The company is represented by W. H. Brady, 280 Broadway, N. Y.

THE UNITED FLUORSPAR & MINERALS CO., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of $100,000, to operate fluorspar and kindred mineral properties and plants. The incorporators are Louis J. Adler, W. J. Strassburger and J. L. Hukill, Pittsburgh. The company is represented by the Delaware Registration Trust Co., 90 Market St., Wilmington.

THE SAINT ALBANS OIL CO., St. Albans, W. Va., has been incorporated with a capital of $30,000, to manufacture petroleum products. The incorporators are C. O. Nichols, A. G. Jacobson and Ward Harshbarger, all of St. Albans.

THE SUPERIOR PAINT & VARNISH CO., Wilmington, Del., has been incorporated under state laws with a capital of $50,000, to manufacture paints, varnishes, etc. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE PEP MFG. CO., New York, N. Y., has been incorporated under Delaware laws with a capital of $10,000, to manufacture abrasive compounds and kindred specialties. The incorporators are Eliot Norton, Alexander H. Jackson and Ralph Root, all of New York. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE NEW ENGLAND BRASS CO., 251 Fountain St., New Haven, Conn., has filed notice of organization to manufacture brass and bronze products. The company is headed by A. C. Stowe.

THE TWENTIETH CENTURY CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemicals and chemical byproducts. The company is headed by James Rea, 317 Adams St., Boston.

THE INDUSTRY OIL CORP., Houston, Tex., has been incorporated with a capital of $100,000, to manufacture petroleum products. The incorporators are W. B. Harris and J. H. De Metro, both of Houston.

THE HERCULES SILICA ASPHALT CORP., Nashville, Tenn., has been incorporated under Delaware laws with a capital of $1,000,000, to manufacture special asphalts and kindred products. The incorporators are M. Brumbaugh, Brown Davis and W. B. Evans, all of Nashville. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE MONUMENTAL CLAY PRODUCTS CO., 917 Munsey Bldg., Baltimore, Md., has been incorporated with a capital of $50,000, to manufacture brick, tile and kindred burned clay products. The incorporators are George H. Haines, Joseph J. Flynn and Edwin W. Herrmann.

THE MIDDLETOWN TIRE & RUBBER CO., Wilmington, Del., has been incorporated under state laws with a capital of $5,000,000, to manufacture automobile tires and other rubber products. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

THE SUFFOLK DRUG & CHEMICAL CO., Medford, Mass., has been incorporated with a capital of $10,000, to manufacture chemicals, chemical byproducts, drugs, etc. B. G. Payzant is president; and John P. McKown, 12 Madison Ave., Medford, treasurer.

THE MUDDLETY VALLEY CLAY PRODUCTS CO., Hookersville, W. Va., has been incorporated with a capital of $10,000, to manufacture brick, tile and other burned clay products. The incorporators are Porter Herold, K. B. McCue and D. H. Fletcher, all of Persinger, W. Va.

THE BORDERLAND REFINING CO., Mirando City, Tex., has been incorporated with a capital of $30,000, to manufacture refined petroleum products. The incorporators are P. N. McCullough, J. G. Taylor and L. O. Gleason, all of Mirando City.

THE CENTRAL SILICA CO., 312 Maloney Bldg., Ottawa, Ill., has been incorporated with a capital of $20,000, to manufacture silica products. The incorporators are E. B. Wilkinson, A. H. Hall and R. I. Thornton.

THE CLEARVIEW BRICK CO., Clearview, Okla., has been incorporated with a capital of $30,000, to manufacture brick, tile and other burned clay products. The incorporators are James E. Thompson and J. W. Swain, both of Clearview.

THE BEACON SOAP CO., Beacon, N. Y., has been incorporated with a capital of $25,000, to manufacture soaps and affiliated products. The incorporators are I. Weiss, W. Hamberger and F. W. Mann. The company is represented by V. D. Stearns, Beacon.

WHITE & KLEPPINGER, INC., 2309 Archer Ave., Chicago, Ill., has been incorporated under state laws to manufacture soda, baking powders and kindred products. The incorporators are George H. White, Vernon A. White and John M. Kleppinger.

THE UNITED CHEMICAL PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of $250,000, to manufacture chemicals and chemical byproducts. The incorporators are John P. Cann, M. N. Tyson and Henry McKeown, Wilmington. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington.

THE WILLMOTT OIL CORP., Okmulgee, Okla., has been incorporated with a capital of $400,000, to manufacture petroleum products. The incorporators are C. S. Willmott, John Caruthers and Joseph M. James, all of Okmulgee.

THE CLAY SERVICE CORP., Terra Cotta, Ill., has been incorporated under state laws with a capital of 1,000 shares of stock, no par value, to manufacture burned clay products of various kinds. The incorporators are Justus Chancellor, M. E. Gates and Justus Chancellor, Jr. The company is represented by Thornton & Chancellor, 1014 South Michigan Blvd., Chicago, Ill.

THE B. & R. LEATHER CO., New York, N. Y., has been incorporated with a capital of $30,000, to manufacture leather products. The incorporators are H. Rubin and E. Berkowitz. The company is represented by Herman Chaityn, 2 Cedar St., New York.

THE KNOX PORCELAIN CO., Wilmington, Del., has been incorporated under state laws with a capital of $370,000, to manufacture porcelain and affiliated ceramic products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE CRESCENT RUBBER MFG. & SUPPLY CO., Seattle, Wash., has been incorporated under state laws to manufacture rubber products of various kinds. The incorporators are William Rutherford and associates. The company is represented by Ryan & Desmond, 608 Pantages Bldg., Seattle.

Capital Increases, etc.

THE HAMERSLEY MFG. CO., 25 Park Place, New York, N. Y., manufacturer of waxed papers, with plant at Garfield, N. J., has disposed of a bond issue of $750,000, the proceeds to be used for general operations, extensions, etc.

THE MIDWEST & GULF OIL CORP., Tulsa, Okla., has filed notice of increase in capital from $5,000,000 to $10,000,000.

THE BORO CHEMICAL CO., Binghamton, N. Y., has arranged for an issue of 1,000 shares of common stock, no par value, for general operations, expansion, etc.

THE PLANTATION CONSOLIDATED OIL CO., Bowling Green, Ky., has filed notice of increase in capital from $350,000 to $850,000.

THE MIDWEST PAPER CO., 712 Federal St., Chicago. Ill., has filed notice of decrease in capital from $300,000 to $200,000.

THE SOUTH RIVADAVIA OIL CO., a Delaware corporation, has filed notice of organization to operate in New York, with a capital of 10,000 shares of stock, no par value. The company is represented by H. R. Stewart, 17 Battery Place, New York.

THE ATLANTIC FOUNDRY CO., Akron, O., has filed notice of decrease in capital to $985,300.

THE FARMERS' CO-OPERATIVE LIMESTONE CO., Branchville, N. J., has filed an involuntary petition in bankruptcy.

The plant of the FEDERAL OIL & REFINING CO., Oklahoma City, Okla., near Fort Worth, Tex., will be sold by J. C. Eagen, trustee in bankruptcy for the company.

THE THOMAS FURNACE CO., Kinnickinnic Ave., Milwaukee, Wis., manufacturer of pig iron, has arranged for a bond issue of $850,000, for general operations.

Plans are being perfected for a merger between the CUBAN-AMERICAN SUGAR CO., 129 Front St., New York, N. Y., and the NATIONAL SUGAR REFINING CO., same address.

Coming Meetings and Events

ALPHA CHI SIGMA fraternity will hold its seventh biennial conclave at the Marquette Hotel, St. Louis Mo., June 22, 23 and 24.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters will be at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet- at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NATIONAL FERTILIZER ASSOCIATION is holding its twenty-ninth annual convention at the Greenbrier, White Sulphur Springs, W. Va., this week.

NATIONAL LIME ASSOCIATION will hold its annual convention June 14-16 at the Hotel Statler, Cleveland, O.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

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CHEMICAL & METALLURGICAL ENGINEERING

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Markdown Sale In Technical Men

EVERY day now adds to the number of men trained in chemistry or chemical engineering who are embarking on their technical careers after finishing their college education. Therefore this is the time of year for retrospect and forecast. To one who has been in industrial work for a number of years and who has a pessimistic turn of mind, the entry of hundreds of young men into this particular profession is always a time for wailing and gnashing of teeth. "How many young men!" he cries. "What a large percentage of the total will remain mired in routine work and never rise to positions of authority or prominence or power!" To him let it be said that such is the case in any profession, in any walk of life. Few ever attain the top, and if many did attain the top, there would be yet another top to which only a few would attain. That need not be a ground for pessimism. It is a condition of our social and industrial order.

We ought, however, to remember this—that more of opportunity can be placed in the paths of men entering our profession and it lies in our power to do this. Some years ago a cry went up in the electrical industry that there were too many electrical engineers, and many sage comments were advanced at that time. Among them was the suggestion that the way out of the difficulty was to produce fewer electrical engineers. Fortunately for our industrial order, a wiser plan was evolved and more positions were made available for men trained in electrical engineering. Sales work, purchasing work, accounting work, non-technical work of many descriptions were opened to technically trained men in the electrical field. So it should be in chemistry, and now is the time to start! Even now, prophets are crying that we should diminish the number of chemical graduates. How foolish this would be, and yet how inevitable it is going to be if we do not find new outlets for them. Your company may need a salesman, or a purchasing agent, or a clerk in the purchasing office, or there may be openings in the cost-accounting department. Use your influence to get young technical men for this work. They will fall into it admirably and there is a big future for technical men in most of these fields. Perhaps you do not know of any opening. Search around and find out if there aren't openings in those departments. Young technical men will often be very glad to get the wages of a clerk in order to learn the ways of the department. They will be as well paid as they would be in a routine laboratory or as a beginner in a plant. Three months from now ask yourself this question (perhaps we shall ask it for you): How many chemists have I placed, how many of this year's crop, in either technical or non-technical work? To those who do not see a duty in this, we recommend a period of solitary meditation.

A Plot to Traffic In College Degrees

SOMETIMES the most innocent appearing advertisement leads to diverting circumstance and entertainment. Take for example the experience of a correspondent who answered an advertisement in one of the New York papers from someone who wanted to get in touch with people in South and Central America, either directly or through an agent having a wide circle of acquaintance in those countries.

In answer to the advertisement an appointment was made with the advertiser, who introduced himself as "Dr. SORGEN" and represented himself as president of a college in New Jersey, the name of which was unfamiliar and made no impression. Conversation opened in the approved manner, but the good doctor seemed loath to come directly to the business in hand and apparently preferred to spar for a round or two for the proper opening. The subject of education was brought up and naturally the conversation turned to college degrees. Did Dr. SORGEN'S auditor think that people in Central and South America were interested in higher education, and particularly in acquiring the coveted degrees granted to graduates and post-graduates of our higher institutions of learning? Sensing the possibility of adventure, our correspondent readily fell in with Dr. SORGEN'S line of investigation and assured him that the inhabitants of South and Central America deeply appreciated the advantages of higher education and had nothing short of a passion for the letters that can be tacked on to the names of those who rightly complete college courses.

With these preliminaries out of the way, progress was more rapid and Dr. SORGEN came to the point and proposed an alliance with our correspondent whereby he was to beat the bush in South and Central America for suckers for fake college degrees to be granted by Dr. SORGEN'S college. The proceeds were to be split on a 50-50 basis. The versatile doctor did not propose to confine himself to his own institution of learning, but he assured his prospective partner that engineering degrees, for example, could be obtained from a number of prominent institutions. Could he, for example, obtain the degree of Electrical Engineer from Massachusetts Institute of Technology? Yes indeed! But the doctor hastened to explain that a student could not pick the college from which to receive his degree, because they were given from different institutions in turn and one might catch Tech, while again he might get his degree from another college. Medicine, law, engineering, science and the arts were in the doctor's repertoire.

Efforts have since been made to entangle Dr. SORGEN in the meshes of the law, but he has developed a quality of wariness that has made it difficult to catch him. He declined to engage in correspondence

and apparently has dropped out of sight, preferring to forego the pleasure of bestowing degrees and granting diplomas for a stipulated sum—an avocation that ultimately might restrict his liberty. Our South American friends may well beware of "Dr. SORGEN" or any of his type who offers for sale the honorable evidences of an education earned in a reputable institution.

The War Is Over—
We Harbor No Malice

IN OUR ISSUE of March 8 we commented on "A German Chemist's View of Conditions in America." It had to do with an address he made in Germany after a visit to the United States, and now he writes to us in protest. We erred, he says, in translating some of his observations. We have mislaid the report, but are prepared to stand corrected, as he is a man of high character, wholly trustworthy and above dissembling.

The errors were not of leading importance. His protest is rather against the tone of our writing and the observations that we made of the curious workings of the German mind. His point of view is that the Germans want to be judged on their merits, in all fairness. and without the prejudice that he believes has been instigated here by "English and French lies."

The war is over, and we are resolved to be as generous as we can to Germans. We are all neighbors on the same earth, and we must get along together somehow. Like all the rest of the world they—and we too—are threatened with the "dictatorship of the proletariat," which means the rule of the incompetent, and this in turn means the breakdown of civilization which follows anarchy and disorder. We see it in Russia.

The difficulty in discussing Germany and Germans is due to a geographic difference in opinion. Outside that country the opinion prevails and always will prevail that Germany and the Germans stand guilty before the bar of the world's justice. To set down the indictment would only beget bad blood. We have no desire to do so. The German opinion appears to be the very opposite; that they, like others, participated in the great conflict, that they showed great bravery, and that they are no more guilty than any other participant. They do not ask for forgiveness, while we wonder that they are not ashamed. Some day when we know more than we do now we may be able to discuss the biology of opinion as a problem of calm, scientific research.

Once we were in a mixed company at lunch with the late THEODORE ROOSEVELT. A lady of the party who was an active social worker tried to steer the conversation over to some of the economic aspects of prostitution, and to get him to talk about it. The situation became rather tense. "Madam," said T. R. when her questioning had become categorical, "there was an old Frenchman who said that some subjects may only be discussed with safety in terms of statistics. I think he was right."

Our business has to do with pure and applied chemistry, and we do not discriminate whether it be of British, French, Italian, German or American origin. We take our hats off to the great work done by German chemists. They have added vastly to human knowledge and understanding. Let's stop right there and not upset the apple-cart by talking about what Germans did before and during the war.

A Significant
Chemical Merger

WE ARE in the midst of a season of mergers. Reports of combinations and consolidations are heard from all sides and in all industries. Just at present the public's attention is focused on the activities of the steel companies, but those of us in the chemical industry should not lose sight of a merger within our own ranks which would appear to carry with it more than usual significance. The purchase of the Condensite Co. of America by the Redmanol company, followed by the merging of both with the General Bakelite Co., is the climax of a remarkable story of industrial development. It is the outgrowth of the long-drawn-out litigation in which the courts broadly sustained the patents of Dr. L. H. BAEKELAND and recognized his pioneer work in the development of the commercial manufacture of synthetic resins and related products.

The chemical industry will be the first to welcome this amicable settlement of a historic controversy. We cannot help feeling that the merger opens the way to a wonderful opportunity for further progress and expansion. The constituent companies will continue on a competitive basis of manufacture; but there will be an exchange of information obtained in the several research laboratories. Thus the conditions will be most favorable for progress in the art of manufacture and for service to the industries consuming the product.

Mergers, for some reason or other, are always regarded with suspicion, and the present consolidation may arouse some criticism. However, if we have the right understanding of the Sherman law, it is not the actual consolidation of companies that is illegal, but rather the "combination in restraint of trade." From our own viewpoint, our respect for the technical men who are at the head of the new Bakelite Corporation and our confidence in their high-principled and able direction are such that we can look forward only to continued progress and increased service in this thoroughly American industry.

Dr. Jekyll
Boll Weevil

PROBABLY a very large percentage of the general public as well as the scientific and technical public believe that the boll weevil is the *sacre albion* of the South. In many ways this is true, but there is an interesting side of the boll weevil question which has received some publicity and deserves further emphasis as being a significant economic factor in the country. In many parts of the South the boll weevil cleaned out the cotton crop for several years and the planters in desperation began to plant other crops besides cotton. In this way they learned for the first time and of dire necessity the distinct advantage of being emancipated from the complete domination of old man cotton. As a one-crop district the South has always suffered. Planters had to bargain away their crops to brokers at a distinct disadvantage simply because they had no other weapons with which to bargain. Now in many communities with two or three or four other large crops cotton has still a major rôle, but it emancipates the planter from domination of the speculative buyer.

In one town in the South they have raised a statue to the boll weevil. This seems like a curious kind of grim humor, but the fact is that the town has for the first time in its career become a flourishing place, where

prosperity roosts occasionally. Previous to the invasion of the boll weevil the town was cotton poor. A good crop or a poor crop made very little difference. There seemed to be no large returns to the planter.

In this issue of CHEM. & MET. Mr. AMBRUSTER presents one phase of the fight which the government and the cotton planters are waging against the boll weevil. Calcium arsenate, the Nemesis of the boll weevil, developed by Dr. R. B. COAD of the Department of Agriculture and his energetic workers, is a peculiar commodity. Made from material which is a byproduct and whose value is not at all dependent on the demand, calcium arsenate has a price which is almost marginal as far as its use in cotton is concerned. Furthermore the cotton crop must compete for it with other crops which can afford to pay a much higher price for insecticides.

The fight against the boll weevil, however, is vital to the country's welfare and a knowledge of the conditions underlying that fight is most timely. The boll weevil has proved to be a Dr. Jekyll in waking some of the South to the folly of depending on one crop. He is essentially Mr. Hyde, however, and the war will stop only at extermination. At present calcium arsenate seems to be the way toward success.

The Demand for Steel Products in 1921

IN AN "off" year in the steel industry the demand for the different descriptions of steel does not decrease in equal proportions. Some steel products are relatively staple in character, while others exhibit wide fluctuations in demand from time to time. The full statistics of steel production in 1921, recently issued by the American Iron and Steel Institute, are of particular interest on this account.

It required no official statistics, of course, to inform us that the production of steel, as a whole, in 1921 was very light, but the exact measure is now furnished. The production of steel ingots was 19,184,084 gross tons, or less than half the production in 1916, 1917, 1918 or 1920. The backset was not only the greatest in tonnage but also the greatest in percentage ever experienced. In 1914 there was a 25 per cent backset from the best previous record, and in 1908 a 40 per cent backset.

The habit of thinking of steel production in terms of percentage of capacity is so common that this relation is given more importance than it deserves. Steel is so useful and its consumption is so interlocked with our various industrial and commercial activities that the amount of productive capacity is really only an incident. Considering the country as an industrial unit, we are engaged in consuming steel rather than in producing steel. It is the consumption that counts. It is a detail that the 1921 production was only about 35 per cent of the productive "capacity." It is very doubtful whether this "capacity" is really potential, whether it would today be possible to find enough transportation facilities and enough workmen to go with the production and consumption of steel at a rate equal to the physical capacity of the steel-making units. The existing "capacity" is more than double the actual production in 1910, which made a new record at the time, but the census reports only 9 per cent more persons "gainfully occupied" in 1920 than in 1910.

One of the most staple lines of steel production is the wire nail. As there were light exports in 1921, only 629,650 kegs, while five years in the past showed exports of more than 2,000,000 kegs, it is best to make comparisons by domestic consumption, which amounted to 11,259,762 kegs in 1921, or more than in any year prior to 1909, and only 22 per cent under the record, made in 1917.

Again, we may think of plates and sheets as not very different in character, but if we take sheets 13 gage and thinner and sheets and plates 12 gage and heavier (disregarding tin mill production entirely), we find that the 1921 production of 13 gage and lighter, 1,367,688 tons, was 54 per cent of the record output, made in 1920, and was greater than the output in any year prior to 1910, while the production of 12 gage and lighter, 1,804,453 tons, was only 33 per cent of the record, made in 1918, and was less than half the output in any one of the five years 1916 to 1920, while it was only 64 per cent of the output in 1910.

One may consider tin plate more of a staple than pipe, but pipe showed a very fair production in 1921, 1,987,442 tons, or 34 per cent under the record year, 1920, and 25 per cent under the second best year, 1916. Tin plate showed a production of only 793,198 tons, or only 52 per cent of the record output. The light production was largely because holders of goods packed in tin plate containers in 1920 at high cost were indisposed to liquidate by taking losses and named prices the buying public was unwilling to pay.

The Courage Of the Pioneer

IN THAT very charming comedy, "Little Old New York," there is a scene in which *John Jacob Astor*, the rugged Dutch leader of the community, upbraids a number of wealthy young men because of their unproductive and dissolute lives. "Habits such as yours," he scornfully remarks, "can never produce success such as mine." One of the young men protests to *Mr. Astor* that conditions are very different now from the time when he was a young man. There was more opportunity in those days. And yet young *Cornelius Vanderbilt* was just beginning his career at that moment. So it is with every generation. There appears to be no opportunity to most people until the pioneer has achieved success, and in achieving it reveals the opportunities that existed.

Besides vision it is necessary also to have courage. With vision only we have the dreamer who falls short of accomplishment. Courage is the energizer which picks up the dream and carries it to success.

Those who were fortunate enough to hear HERBERT DOW talk at the recent New York Section meeting of the A.C.S. on the early history of the company which now bears his name must be impressed with the high order of courage required to persist through the first five discouraging years of effort. When Mr. Dow described the fourth or fifth plant which he had built, and remarked, with a twinkle in his eye, "Well, that plant didn't work very well either," and then went on to describe some of the troubles which occurred, we all could laugh with him in his successful retrospect. But at the same time the fourth or fifth plant failed to produce, and when the embryonic company found itself again bankrupt, then was the time when, without courage, failure would have been inevitable.

The combination of vision and courage is rare. The reward of such a combination is inevitable. The inspiration, to the young chemist particularly, of the stories of such pioneers is beyond estimation. Let their stories be broadcasted.

Readers' Views and Comments

Spontaneous Formation of Martensite

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article on "X-ray Data on Martensite Formed Spontaneously From Austenite," by Edgar C. Bain, is of much interest, but it would seem that further information and consideration are necessary before accepting some of the statements and conclusions contained therein.

The analysis of the steel would not seem to me to be such as could be retained in the austenitic condition at room temperature, and the micrograph at 100 diameters would scarcely seem to be of high enough power to make sure that the structure is really austenitic.

Some of the grain boundaries look very much as if the metal had been burned, which, of course, would outline the gamma grain boundaries, while the alpha boundaries would be inside the gamma ones. It seems to me, as stated before, that further information is necesssary before it should be so strongly stated that the original structure was austenite and that in the course of time the room temperature has changed this to martensite.

S. W. MILLER.

Union Carbide & Carbon Research Labs., Inc.
Long Island City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reading over Mr. Bain's contribution to your issue of March 23 entitled "X-ray Data on Martensite Formed Spontaneously From Austenite" I am struck by the incompatability of his data, as presented, with previous experience. The chemical composition given would indicate that the steel used could not possibly have been austenitic, with so low a content of C, Ni and Mn. Since, however, the micrograph, Fig. 27, shows a characteristic austenite structure, it seems probable that there is a misprint in the analysis. Accordingly I asume that the nickel content is 28.1 per cent and not 2.81 per cent. On this basis the results become intelligible.

It is quite likely that a steel of that composition would be in the austenitic condition as cooled to ordinary temperatures and that it could be transformed more or less completely to martensite by appropriate treatment, but not by the action of time alone. Hanson and Hanson[1] give temperature vs. electrical resistance curves for iron-nickel alloys which show clearly this possibility. Their alloy of 25.5 per cent Ni content has its maximum of Ar_3 at 108 deg. C. and another of 29.4 per cent Ni content at —25 deg. C. An alloy corresponding to Mr. Bain's analysis but with 28.1 per cent Ni would probably behave like their 29.4 per cent Ni alloy because of its higher content of other lowering elements. It would then be austenitic as cooled to some ordinary temperature, but there is no existing data indicating that it would change appreciably to martensite with time if the temperature were kept constant.

However, there is a possibility that the specimen was subjected to the vagaries of weather. If severely chilled, it may very well have gone through the Ar_3 transformation. Mary Andrews[2] has shown very definitely the effect on the crystal structure of chilling by dipping a previously austenitic iron-nickel alloy in liquid air. Besides becoming magnetic, the specimen changed over to the body-centered cubic form.

Unfortunately Mr. Bain does not give a complete history of his specimen, so one cannot decide whether he has real evidence of a previously unknown "spontaneous" change of austenite to martensite or not. There are also several other inconsistencies which confuse the reader. Fig. 1 is evidently not of the same area as Fig. 2. Whether the illumination is vertical or oblique, the grain contrast should show in it and twins would be expected also.

The apparent difference in grain size also requires explanation. It is not stated whether Fig. 6 is the result of repolishing and etching or is the original etched and polished surface. If the latter is the case, no definite change in the surface appearance would be expected to be visible at the magnification used, even though the specimen changed completely from austenite to martensite. Figs. 8 and 9 are evidently reversed. In consequence of this situation it can scarcely be held that the data presented bear out the implication of the title.

Bureau of Standards,
Washington, D. C.

HOWARD SCOTT.

To the Editor of Chemical & Metallurgical Engineering

SIR:—The paper entitled "X-Ray Data on Martensite Formed Spontaneously From Austenite" in the issue of CHEM. & MET. for March 22, 1922, was written not so much to establish spontaneously transformation as to present observations corroborating the view that martensite is essentially a fine-grained material.

Jeffries and Archer have offered this theory and the data afforded by the author's X-ray crystallographs verify it in a way which probably could not have been accomplished by the microscope.

It is only incidental that martensite with apparent grain size many times the true grain size—a condition desirable for the proof—was found in an unusual specimen. A quench from the melting point made so quickly as to hold a steel largely austenitic with relatively low content of the agents carbon, manganese and nickel is rather unique and it was thought that this fact might lend interest to the account. The author has been able to produce very nearly pure austenite from ordinary high-carbon steel with insignificant content of manganese and nickel by quenching in iced brine and these specimens also lost the face-centered cubic crystallinity by transformation to body-centered iron at room temperature after the lapse of several months.

The microphotographs were made to show the twinned structure characteristic of austenite in one case and the absence of the "chevron" markings of martensite at the higher magnifications. These were of course made on the freshly quenched material. Doubtless the change began very soon after quench.

Unfortunately, the numbers designating figures 8 and 9 were interchanged, probably due to an oversight in reading the proof of the article.

EDGAR C. BAIN.
CHARLES Y. CLAYTON.

[1] *J. Iron & Steel Inst.*, vol. 102, p. 39 (1920).
[2] *Phys. Rev.*, vol. 18, p. 245 (1921).

Calcium Arsenate for Boll Weevil Control, and the Arsenic Situation

The Insect Infestation of the Cotton Fields of the South Has Developed a New Branch of the Chemical Industries, the Growth of Which Will Be Controlled by Many and Conflicting Factors, Including the Available Supply of the Principal Raw Material

By HOWARD W. AMBRUSTER

THE insect pests as a group are said to be the most powerful enemy of mankind today, the hazard to humanity being the starvation of the peoples of the earth through reduction of crops. And that part of the chemical industry which is devoted to the production of compounds for the destruction of insect pests is believed by those engaged in it to be the most hazardous of any industry based on applied chemistry from every standpoint. Of the insect pests which have been identified and combated by the combined ingenuity of agriculturists, entomologists and chemists, none has attained more prominence or greater disrepute than the Mexican, or cotton, boll weevil (*Anthonomus grandis*), which, though it does not attack a food crop, is equally as destructive from an economic standpoint as any insect now known. In the battle for the control of the boll weevil in the cotton states of the United States, after many methods have been tried by government officials and private investigators, the greatest encouragement that has resulted has been from the use of the compound known as calcium arsenate, $Ca_3(AsO_4)_2$. This product, made by the combination of arsenic acid and lime, is now manufactured in this country by about fifteen or twenty of the companies making agricultural insecticides.

Is a Shortage of White Arsenic Likely?

The probable increase in demand for calcium arsenate for boll weevil control has brought up the question as to whether the supply of commercial arsenic which is now available in this country and abroad is sufficient for any such quantity of calcium arsenate as some enthusiasts claim will be required annually within the next few years.

There are so many different factors, statistical and otherwise, which must be considered in reaching any conclusions on this subject that the latter are bound to be more or less controversial. But some phases of the situation are sufficiently defined to permit the contention that an acute shortage of arsenic probably will develop should the demand for calcium arsenate reach any sizable proportions. It must be acknowledged also that should the production of arsenic remain stationary, while the demand for calcium arsenate increases, the future program of the entomologists for the use of this spray for the cotton crop will be endangered.

That feature of the situation which is not appreciated by many of those directly interested in the industries affected is the fact that at present the world's available production of arsenic has no relation whatsoever to the market demand for the product. In this respect arsenic is somewhat unique among those products or commodities which may be described as basic raw materials. The white arsenic of commerce, or "arsenic oxide," is more correctly arsenic trioxide, As_2O_3 (also known as arsenious acid and arsenious anhydride). Practically all of this arsenic which is produced today is the byproduct of the smelters. It was first produced in the crude state at the smelters in what are known as bag houses attached to the furnace flues and in more recent years by the Cottrell process by electrical precipitation of the arsenical or black dust from the smelter fumes.

As the attorney said in advising his client, the latter's case had a "nuisance value" which made it worth while; just so is the arsenic production regarded by metallurgists and smelters. It is a nuisance and has a nuisance value only. It is usually regarded as the most objectionable content of the precious and semi-precious ores, and any ore is selected for its low arsenic content in preference to another ore equally available and valuable but containing a higher percentage of arsenic. It will be conceded generally that if it had not been for the legislation directed against the smelters on account of the damage done by their fumes, the use of arsenic as an agricultural spray material would have been seriously retarded from its inception for lack of sufficient supply of the raw material.

Method of Manufacture of White Arsenic

The crude arsenic as it is first collected varies in content all the way from 40 to 90 per cent As_2O_3, though the bulk of it approximates the higher level. To refine it to 99 per cent so that it is marketable as white arsenic, the crude must be treated one or more times in volatilizing furnaces, by which process the other ingredients in the original crude product are separated and driven off with the exception of a minimum ½ to 1 per cent of impurities which are found in all commercial white arsenic. The crude product varies greatly in percentage and character of impurities which are at times extremely difficult to reduce, and the smelters therefore sell a certain percentage of their output as off-grade arsenic testing between 90 and 99 per cent.

This off-grade arsenic can be used for a part of the market requirements, but is unsuitable for the most important use, which is the manufacture of arsenic acid, or H_3AsO_4, the first step in the production of the important arsenical insecticides, lead and calcium arsenate.

It should be obvious, therefore, that in case of sudden increase of the demand for arsenic we shall have to look elsewhere than to the smelters, which produce the crude because they cannot help themselves and refine it to make it marketable. The selling price has, therefore, no relation to the cost, but reflects in a way

an open bidding by the consumers for the given tonnage of arsenic which is available each season.

The real cost of production comprises, first, the transportation of the crude to the refining plant, the revolatilizing cost, which varies according to the number of treatments required, grinding if the product has solidified in the flues, and packaging for the market. If as an accounting policy a part of the actual cost of smelting is allocated to the arsenic byproduct as such, a considerable item may be added to the total cost of the refined white arsenic, and as the latter is now a standard market commodity of wide distribution, it is of course an entirely logical policy to divide total operating costs among all of the various products of the smelters. But this point should be taken into consideration when considering the actual cost of production in relation to selling price.

The direct production of arsenic from some of the many low-grade iron ores (mispickel or arseno-pyrites) containing a fairly high percentage of arsenic has been commercially attempted many times, but never with sufficient success to insure a stable enterprise. Should the demand increase to such a point as to put the market on a permanent level, about double its present selling price (6 to 7 cents per pound), many of these developments could undoubtedly be firmly established, but any such increase in the selling price of arsenic would seriously affect the cost of manufacture of calcium arsenate as well as all other arsenical spray materials. Calcium arsenate for boll weevil control must be sold at an even lower figure than it is at present to insure the utmost development of its use and value to the South.

On the other hand, spray materials for all other purposes and likewise all other uses for white arsenic, should necessity demand, can afford to pay increasing prices. This has been demonstrated in the recent past. So while it is a safe conclusion that the direct production of arsenic is a possible development at a higher price level for many other requirements, it does not follow that the increased supply thus made available will contribute to the protection of the cotton crop. Aside from the various known methods of direct production of commercial arsenic from mispickel, the only other alternative is the possible development of the production of arsenical compounds for spray requirements direct from an arsenical ore.

Use of Arsenate Ore as Short Cut

A short cut to the final product precludes the process of extracting the arsenic as As_2O_3 and its subsequent oxidation to As_2O_5, and requires an ore in which the arsenic is present in its natural state as an arsenate instead of an arsenite. Deposits of the latter classification are found in many parts of the United States and elsewhere, but there is only one known deposit of the former in any appreciable quantity, and its development, though contemplated for some years, is still in the future as a commercial enterprise. A very considerable saving in final cost would result should it prove to be practicable to produce the commercial arsenical sprays such as calcium and lead arsenate direct from an arsenical ore and without the successive steps of refining white arsenic and converting the arsenic to acid before combining with the lime or lead.

Extent of Market

Of the 16,000 tons of arsenic which it is estimated is now consumed annually in the United States, between 80 and 85 per cent is required by the insecticides and related industries such as the manufacture of weed killers and cattle dip. The bulk of the remainder of the total goes to the glass maker and for the manufacture of pharmaceuticals. Of the requirements for insecticides the largest part is converted into arsenic acid in about twenty-five different plants mostly located in the East and Middle West. The majority of these are small and operate only a few months in the year. The same intermittent schedule of operation applies to the other plants, about twenty in number, including those which compound spray materials like paris green direct from the white arsenic and those making weed killer and cattle dip. This irregularity of consumption has always brought the maximum demand within a few months for a basic raw material which is produced normally over the entire twelve months. The effect on the market price is obvious.

The other principal demand for arsenic, for the glass industry, is an all the year round requirement, as is also the limited use of arsenic acid for the production of arsepheminine, or salvarsan, and small requirements such as for rat poisons, preserving hides and the reduction of metallic arsenic. In times past arsenic was an important raw material for the dye industry, it being used in the production of fuchsine colors, but this method has been abandoned, and the industries enumerated above cover practically all the uses to which arsenic is now put.

Official figures indicate that the present production of byproduct arsenic in the United States is at the rate of approximately 12,000 tons annually, and the remainder consumed here comes mainly from Canada and Mexico and from Germany, Japan and Belgium.

The figures for the world's production of arsenic are exceedingly difficult to compile intelligently, as official statistics are irregular in classifying white arsenic with the crude, with ore content and with red arsenic and with the metal itself.

From such figures as are available, however, it is evident that the annual production of commercial white arsenic from all world sources is not much in excess of 30,000 tons when the smelters are at normal production, and the total is probably less than that figure during the last two years of restricted metal output.

A large quantity of arsenic was imported into this country in years past from Spain and England, as well as from Germany, but more recently the English supply has been consumed at home or gone elsewhere, and unsettled conditions in Europe since the war have permitted the Japanese producers to make considerable inroads on the importations to America. In addition to the countries named, arsenic is also produced in South Africa, Australia, Greece, Portugal and France, but in none of these countries is there any surplus for export to the United States.

The demand abroad is fairly stable and the uses are similar to those in the United States, though a much larger proportion of the total is consumed by the industries other than the agricultural sprays. Of the latter broad classification the use of arsenic for cattle dips is in much greater proportion abroad than in the United States. In South Africa, South America and Australia, where cattle raising is highly developed, the use of arsenic for dips preceded this use in the United States. All agricultural countries are using insect sprays in a greater degree than ever before, though nowhere to the same extent as the American farmer

and fruit grower. The cotton planter abroad has his own weevil problems to help along the consumption of arsenic. There is no reason to believe, therefore, that a normal or steady increase in the world's consumption of arsenic will not keep pace with any possible normal increase in the byproduct production of the smelters, and this leaves a margin of only a few thousand tons available at present prices for any abnormal increase in demand which the situation in the South may develop.

Loss Caused by Weevil

Anything like an exact estimate of the actual loss caused by the boll weevil must be an exceedingly argumentative conclusion, based on unreliable premises. The shiftless planter blames on the weevil everything which he cannot unload on the weather and the cotton traders; the intelligent cotton raiser in boll weevil districts tries every precaution or remedy recommended by government and state officials and admits that the weevil is at least largely responsible for the difference between a minimum and a maximum yield per acre. However, there can be no valid objection raised to the statement that the loss to the cotton grower due solely to the destruction by this one pest has already reached a total of hundreds of millions of dollars.

Poor Quality of Early Product

When the use of calcium arsenate was first advocated a few years ago, a number of manufacturers began to produce it. The quality of this first material was so irregular, however, that a great deal of distrust was developed, and this retarded greatly the use of calcium arsenate. In some sections the cotton crop was seriously injured by the high percentage of soluble arsenic. The resulting prejudice is so strong that it is very doubtful if the government can ever altogether overcome it. In addition to the poor quality of the product, the lack of knowledge of how to apply it also caused considerable damage to the cotton crops. It is perhaps not unnatural that the ignorant negro planters cultivating a few acres of cotton should be slow to learn the proper way to use the insecticide. Chemical manufacturers, however, have not the excuse of ignorance which the poor negro planter has and it is therefore not unreasonable to expect that they should have known better. The manufacture of calcium arsenate according to the chemical and physical specifications recommended by Dr. Coad, the government entomologist, is not a difficult problem, but many producers have found its manufacture tricky and many tons of material have been condemned by government agents.

Present Production and Future Estimate

The production of calcium arsenate thus far reached its high point in 1920, when upward of 5,000 tons was manufactured in the United States. Much of this was made too late for the 1920 season, and was carried over for 1921. On account of the condition of the South last year, the use of this spray did not develop as expected, and part of the 1920 production was carried in stock for the second year. In some quarters it is felt that the prospects this season are for an extremely heavy demand. The manufacturers, with last year's disastrous losses in view, have declined to pile up any new accumulation of stock ahead of the selling season, and it is entirely possible that the demand this season will exceed the available supply, though this is not likely, as there are large stocks in the Southern warehouses of many companies.

Such manufacturing capacity as the plants now have, if operated continually through the year, would be more than ample for any possible demand at present. In the recent past, however, the erratic market records for the product itself and for white arsenic, the principal raw material, have made it unwise to anticipate the demand before it actually comes about.

It is improbable that this marketing condition will continue to prevail should the demand for calcium increase as expected. But the estimating of just what the possible or probable increase shall be has led some of the producers far astray in the past and will probably continue to do so for years to come. One enthusiast in the early years of the use of calcium arsenate based his calculations on the number of acres planted in cotton in the South and the maximum amount of calcium arsenate which could be used per acre. The result was startling, and disastrous to those who were influenced by the figures. There was not enough manufacturing capacity available, or enough white arsenic in sight, to produce in a long period of years the amount of calcium arsenate which would be consumed in a single season on the basis of this simple calculation. Far below the figures of that brilliant statistician is a conservative estimate for the ultimate consumption of calcium arsenate. When that time will be reached and whether more effective means will be devised in the meantime only a reckless prophet would predict.

Problem of Price

It would be somewhat desirable to get a rough estimate of just how the price of calcium arsenate affects the extent of its use. Official recommendations from the Department of Agriculture advise the use of about 5 lb. of arsenate of lime per acre and at least four applications during the season, if the weevils are actually damaging the crop. Calcium arsenate now sells at from 9 to 12 cents a pound, which represents more than half of the total cost of dusting the cotton. Assuming that we dust four times in a season and use 5 lb. per acre at 10 cents a pound, the poison alone would cost $2. Adding $1.50 for application, the total expense per acre would be between $3 and $3.50. When it is realized that the average yield per acre is a third of a bale and that cotton has been selling for as low as $50 per bale, it is seen that the cost of applying the spray may represent a very considerable percentage of the selling price of the cotton. Dusting with arsenate of lime pays the farmer well if the control is successful and if the yield is a bale per acre or over, as it is in the heart of the Delta cotton belt. In the poorer sections, however, the situation is very different, and a planter who cannot hope for over a quarter of a bale per acre would really just about as soon have the boll weevil eat his cotton as have his profits go to the manufacturer of calcium arsenate. If the price of arsenate of lime could be cut in half, this would very naturally extend its application to the poorer fields. Likewise, when cotton is selling at a high price, the cotton planter can afford to buy calcium arsenate, when otherwise he could not. It is not a simple problem, but one which involves considerable guesswork as well as experience in the yield of the particular land which the planter is cultivating.

Another handicap to the development of the use of

calcium arsenate is the method of marketing the product, which has been both erratic and expensive. The product, being an agricultural spray material, has been handled along similar lines as other insecticides, the sale of which is largely a package proposition. Calcium arsenate is a spray material, but as a marketing proposition for boll weevil control it must ultimately be sold on a tonnage basis and the margin for sales expense and middleman profit must be reduced to the minimum permitted for fertilizers and similar products. Time will bring about this change in the natural course of events, and the State of Georgia in a way has forced the issue this season by purchasing direct from a manufacturer and distributing to the planter at cost.

The production of calcium arsenate must be classified at present as an "infant industry," but it is evident to any careful investigator of all phases of the situation that a demand for a great many thousand tons will develop in the next few years if the price is low enough.

Summary

For every hundred pounds of calcium arsenate which is made, approximately 40 lb. of white arsenic is necessary. The supply of white arsenic annually consumed by this product thus far is not large, but it is an appreciable percentage of the total supply, which, it must be remembered, is a relatively stationary quantity. The use of calcium arsenate for the boll weevil will increase, but at a rate which cannot be anticipated. It will depend upon the supply of arsenic which is available, upon the price of cotton, upon the yield of cotton per acre and upon the price of calcium arsenate itself. In addition, other uses of calcium arsenate are increasing from year to year, notably those which have to do with truck garden produce. Finally, calcium arsenate has been recently recommended as an effective means of preventing the alfalfa weevil from spreading. It is barely possible that this use may eclipse the use of calcium arsenate as a cotton insecticide. Other uses of white arsenic in various insecticides are also increasing, and these uses can easily outbid the cotton market for the available white arsenic. It will be seen, therefore, that many factors enter into the use of calcium arsenate as a cotton insecticide. Besides those already mentioned in this summary, we must refer to such things as the fashions for cotton fabric, the smelting of semi-precious metals, the education of the Southern darky and many others far afield from chemical engineering.

Lead Pigments Marketed in the United States in 1920 and 1921

The following table shows the quantity and value of lead pigments marketed in the United States in 1920 and 1921 as reported by producers to the United States Geological Survey.

LEAD PIGMENTS MARKETED IN THE UNITED STATES

	1920			1921		
	Short Tons	Value — Total	Value — Per Ton	Short Tons	Value — Total	Value — Per Ton
Sublimed lead:*						
White	12,412	$2,033,647	$167.87	11,568	$1,418,403	$122.61
Blue	928	153,657	165.58	463	58,593	126.55
Red lead				21,814	3,410,904	156.36
Orange mineral	34,431	7,523,089	218.50			
				379	91,184	240.59
Litharge	62,329	12,386,185	198.72	41,953	5,740,690	136.84
White lead:						
Dry	33,678	6,351,798	188.60	26,695	3,749,851	140.47
In oil	112,017	25,986,100	231.98	143,634	27,713,257	192.94

* Includes basic sulphate lead.

Petroleum Refineries in the United States

Of the total of 479 refineries, with a capacity of 2,109,700 bbl., reported by the U. S. Bureau of Mines as existing in the United States Jan. 1, 1922, 31 plants with a capacity of 759,000 bbl. were complete refineries representing 36 per cent of the total capacity, according to a compilation made by the American Petroleum Institute based on the data of the Bureau of Mines.

There were 251 skimming plants, with a capacity of 636,890 bbl., representing 30.2 per cent of the total capacity.

Skimming and lubricating plants numbered 56, with a capacity of 186,950 bbl., representing 8.9 per cent of the total capacity.

Wax plants numbered 51, with a capacity of 187,260 bbl., or 8.9 per cent of the total capacity.

There were 7 skimming and asphalt plants, with a capacity of 89,700 bbl., or 4.3 per cent of the total capacity.

There were 9 topping plants with a capacity of 68,800 bbl., representing 3.2 per cent of the total capacity.

Skimming, lubricating and asphalt plants numbered 3, with a capacity of 45,000 bbl., or 2.1 per cent of the total capacity.

There were 7 asphalt plants with a capacity of 33,850 bbl., or 1.6 per cent of the total capacity.

Lubricating plants totaled 12, with a capacity of 18,000 bbl., or 0.8 per cent of the total capacity.

Forty-seven plants with a capacity of 50,050 bbl., or 2.4 per cent of the total capacity, were unclassified.

The following table shows the capacity percentage rank of the various types of refineries as classified by the Bureau of Mines:

PETROLEUM REFINERIES IN THE UNITED STATES

Kind of Plant	Total — No.	Total — Capacity Bbl.	Total — Per Cent of Combined Capacity
Complete	31	759,000	36.0
Skimming	251	636,890	30.2
Skimming and lubricating	56	186,950	8.9
Skimming and asphalt	7	89,700	4.3
Skimming and coke	4	22,200	1.0
Skimming, lubricating and asphalt	3	45,000	2.1
Skimming, lubricating and coke	1	12,000	0.6
Wax	51	187,260	8.9
Lubricating	12	18,000	0.8
Asphalt	7	33,850	1.6
Topping	9	68,800	3.2
Unclassified	47	50,050	2.4
Total	479	2,109,700	100.0

An Exceptional Industrial Safety Record

Total elimination of accidents during 1921 without a minute lost time by workmen is the record established by the 124 employees of the H. H. Robertson Co. plant at Ambridge, Pa. Recognition of this unusual accomplishment was made at the fourth annual banquet of the Western Pennsylvania division, National Safety Council, through the presentation of the Rice Safety Award bronze tablet to the employees of the company. The award was accepted on behalf of the employees by W. E. Megraw, safety director.

This record is particularly interesting because in addition to the usual industrial hazards, employees are constantly unloading and handling steel sheets, coating them with asphaltic compounds heated to from 300 to 400 deg. often under severe fume conditions, moving the sheets and finished product from place to place and at times working on lines through which hot oils are piped.

Modern Methods of Concentrating Sulphuric Acid*

Methods in General Use and a Newly Developed Apparatus of the Submerged Hot Air Type With Particular Reference to Its Application in the Concentration of Separated Sludge Acid From Oil Refining

BY PETER S. GILCHRIST
Chemical Construction Company

CONSIDERABLE study of sulphuric acid concentration has been made by different chemical engineers during the last few years, stimulated, to some extent, by the heavy demand occasioned by the war. Instead of small units of 5 to 10 tons capacity per day, we now think of units of 80 to 125 tons capacity per day, the large units requiring no more labor than was required for the smaller units and, at the same time, operating with greater economy of fuel.

The advent of the Glover tower gave chemical engineers the idea of using the principle of the Glover tower for the higher concentration of acid. Today the tower system and the combined tower and surface evaporation systems of concentration are the methods in most general use, especially for concentrating chamber acid.

Owners of plants for the concentration of chamber acid, or the reclaiming of contaminated sulphuric acid, are today looking for equipment that will operate without too many unnecessary shutdowns for repairs, and that can be operated with the least possible labor.

The principal features to be considered when planning the installation of a concentrator are the following: A reasonable investment for the owner, durability of the equipment, minimum labor, low consumption of fuel and power, high recoveries and elimination of waste fumes.

The use of fuel oil as a heating medium for evaporation and the perfection of the oil burner so as to get absolute combustion have made it practical to apply the direct heating principle for evaporating, without discoloring or contaminating the acid.

The use of more permanent construction materials has reduced to a minimum the maintenance and labor costs. For instance, a vast amount of concentrating is now being done in baths by the direct-heating principle and in towers where the principal item of construction is acidproof masonry. The adoption of acidproof iron for overflows and transfer lines for hot strong acids has been very advantageous.

In this paper the antiquated pan, still and bottle systems are eliminated, confining the description to the following systems: (1) Cascade. (2) Tower system. (3) Combination surface evaporation and tower concentration. (4) Hot air submergence type. These four methods, especially the last three, are the ones used principally in modern plants.

DESCRIPTION OF CONTINUOUS CASCADE SYSTEM

In this type of concentrator we have the application of indirect heat for evaporation. The heat can be supplied with oil, gas, coal or coke. The combustion gases do not contaminate the acid, as the pans are heated from the under side, the hot gases not coming in direct contact with the acid. This type consists of a series of pans, or dishes, in several rows, each row a step higher than the preceding one in order that the acid may enter at the top pan and overflow by gravity from one pan or dish to the other until it is sufficiently concentrated. The heat is applied at the acid outlet end, at which place is located the lowest row of pans. The pans or dishes are supported on open seats which are directly exposed to the heat.

The three or four lowest dishes in each series are protected by bowls from the direct heat, so as to prevent violent ebullition and spurting of the acid. The acid vapors are drawn off by an exhauster and condensed. The loss by fumes is apt to be greater with this system than with the tower system. The cascade apparatus is designed so as to get at each dish or pan readily in case of breakage. A cracked or broken pan necessitates an interruption in the flow of acid, in addition to the loss of acid sustained. The advent of the vitreosil dish, which has a very low coefficient of expansion, has very materially reduced the losses by breakage. It is claimed that the breakage of vitreosil dishes is about 5 per cent and the pans 1 per cent. A. E. Wells and D. E. Fogg[1] described a 10-ton plant with one hundred dishes 12 in. in diameter and 60 preheating pans 24 x 12 in. for concentrating acid from 60 to 66 deg. Bé. They give the cost of concentration as follows:

Coal, 17 per cent at $5.00 per ton	$0.85
Labor	1.25
General expense and repairs	1.00
Losses, 4 per cent of acid, assuming 60 deg. Bé. acid at $8.00 per ton	.30
Operating cost per ton of 66 deg. Bé. from 60 deg. Bé.	$3.40

For comparison with other estimates following in this paper, it is to be noted that 17 per cent of a ton of coal, or 340 lb., is equivalent to 245½ lb. oil, or 32.3 gal. Then 32.3 gal. oil at 4c. per gal. equals $1.29, or an increase of 44c. in fuel cost per ton of acid, making the total cost on the basis of Wells' and Fogg's figures $3.84 per ton.

DESCRIPTION OF COMBINATION CASCADE AND TOWER SYSTEM

Combinations of cascade and tower systems have been used. An installation at Baltimore in 1916, with twelve iron pans 36 in. in diameter, in two rows, produced 23 tons of 66 deg. acid per 24 hours from 54 deg.

*A paper presented before the Acid Symposium at the fourteenth semi-annual meeting of the American Institute of Chemical Engineers, Niagara Falls, Canada, June 19 to 22, 1922.

[1] "The Manufacture of Sulphuric Acid In the United States," Bulletin 184, Department of the Interior, p. 137.

Bé., the acid entering the top pans being 57 deg. Bé. at 290 deg. F. Actual operating cost per ton of acid is as follows:

Fuel oil, 19.5 gal. at 4c.	$0.78
Labor	.71
General expenses and repairs	.85
Losses, 10 per cent of acid, assuming 60 deg. Bé. acid at $8.00 per ton	.80
Operating cost per ton of 66 deg. from 54 deg. Bé.	$3.14

Description of Tower System

In this type of concentrator the entire concentration is done in a tower. The tower is partly filled with suitable tower packing. The combustion gases enter at the bottom of the tower, and as they ascend they meet the downcoming acid in the tower, the exit of steam and gases being made at the top of the tower.

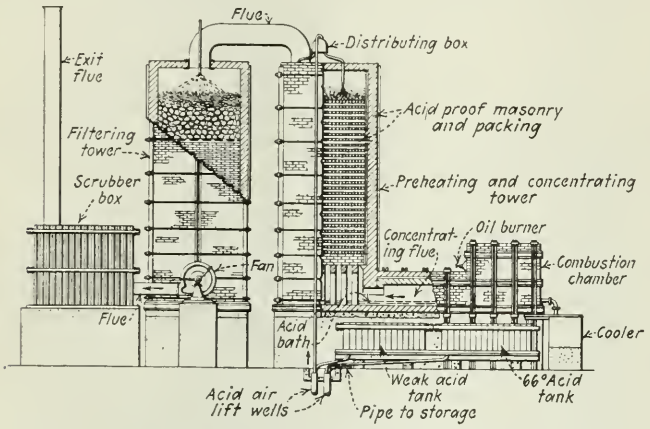


FIG. 1—COMBINATION SURFACE EVAPORATION AND TOWER TYPE FOR CONCENTRATING CHAMBER ACID

The weak acid is sprayed in at the top, and the strong acid settles in a basin at the foot of the tower. It is interesting to note that in this type of concentrator the entire volume of hot air comes in direct contact with the acid, thus keeping the strong acid at its actual boiling point. This has the disadvantage that the hot gases of combustion play directly on the arches and tower packing before the gases have much chance to cool.

The depreciation on the apparatus for this method of concentration is very reasonable, due to the tower being made of acidproof masonry work, but it is understood that the lower part of the packing has to be renewed occasionally, as it will burn out due to the high heat. Results from this method are claimed to be 1 ton of 66 deg. acid from 60 deg. with 11 to 12 gal. of oil.

Description of Combination Surface Evaporation and Tower System

It was found years ago that the method of surface evaporation, or direct heat application, was much more efficient than the indirect application of heat, such as with pan or still systems. Surface evaporation was not very practical before the advent of the oil burner, as absolute combustion is essential to success. The principle of tower concentration is well known. In this combination type concentration is accomplished (1) by surface evaporation, (2) by tower evaporation and preheating. The weak acid is sprayed in at the top of the tower. The upper portion of the tower does the preheating and the lower portion the preliminary concentration. The tower is packed with suitable packing materials. The acid falls from the tower into a long horizontal flue containing a bath of acid, over which the hot gases pass. The combustion gases enter the flue at the acid outlet end and pass along the surface of the acid to the foot of the tower, where they pass up through the interstices of the tower packing, meeting the downcoming weak acid. The tower is of sufficient height and size to utilize the remaining sensible heat of the combustion gases. The greater part of the concentration is done in the pan flue, where the acid is brought to maximum strength. The bath of acid is about 9 in. deep, and as the hot gases are brought into immediate contact with the surface acid, the acid takes up the heat much better than when the acid and heat are separated by metal plates, as is the case with cascade or pan systems. Evaporation is very greatly assisted by the direct heat over the acid, as the draft quickly removes the vapors formed. The finished acid leaves the concentrator at the furnace end, temperature about 50 deg. F. below the actual boiling of the acid, which is strong evidence of the efficiency of this system. Because of low heat reaching the tower, the apparatus itself has a very long life and the tower packing proper will last as long as any of the apparatus.

The principal apparatus of this concentrator consists of a combustion chamber, a concentrating pan flue, concentrating tower, filter and scrubbing tower, all of which are constructed of acidproof masonry, well braced with steel framing and supported on concrete or brick foundations at a suitable height above the ground level. On top of the concrete foundations, masonry-lined lead pans are used, on which are built the masonry walls. The concentrating tower is packed with checkered brick, quartz or other suitable packing, and the

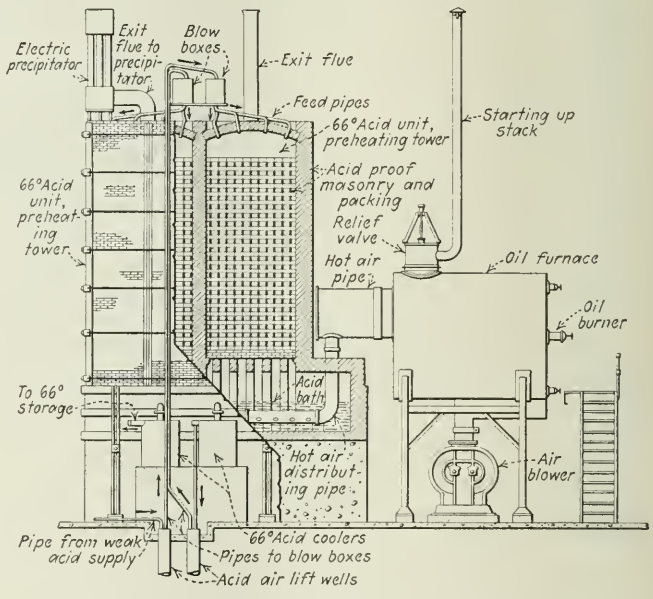


FIG. 2—HOT AIR-SUBMERGENCE TYPE UNIT FOR CONCENTRATING SLUDGE ACID FROM OIL REFINING

filter tower is packed with 3 in. special rings, or quartz. If the packing materials are carefully selected, the distillate from the tower can be sold for battery acid and other similar uses.

Two 50-ton units of this type concentrator were installed nearly 5 years ago at Bayonne, N. J., for the

Standard Oil Co. Recent figures have shown that over this protracted period of operation the consumption of oil was from 10 to 11 gal. per ton of 66 deg. acid starting from 55 deg. Bé. During a period of a little more than 4 years, over 140,000 tons of 66 deg. acid was turned out with a repair and upkeep cost of less than $10,000. This gives the cost of repairs and upkeep at 7c. to 8c. per ton of 66 deg. acid. One man per shift operates the entire plant. Cost of operation is as follows:

Fuel, 11 gal. at 4c.	$0.44
Labor	.12
General expenses and repairs	.30
Losses, 3½ per cent based on $8 per ton of 60 deg. acid	.28
Operating cost per ton of 66 deg. acid from 54 deg. Bé.	$1.14

The labor per ton for large plants is naturally less than for small plants.

This system of concentration is especially adaptable for making 98 per cent acid, on account of construction. The apparatus can easily withstand the higher temperatures encountered in the final stage of concentration. In bringing acid to 98 per cent strength, provision has to be made for taking care of the additional distillate, and naturally the output of acid decreases and the oil consumption increases.

Description of Hot Air Submergence System

Especially in the concentration of sludge acid it is necessary to accomplish concentration at the lowest possible temperature, because the acid to be concentrated is contaminated with carbonaceous matters which, in company with strong hot acid, quickly causes the breaking up of the acid into SO_2, it being well known that 1 lb. of carbon will break up 16 lb. of acid. Heretofore the pans have been used mostly for the concentration of sludge acid, but the cost is almost prohibitive, and in some cases when using the pan system the cost of concentration exceeded the cost of new acid. The cost of concentration by this new method of hot air submergence in some instances has reduced the cost of the 66 deg. recovered acid to one-third or one-fourth the cost of new acid.

This hot air submergence type of apparatus is designed to concentrate any kind of sulphuric acid, and especially separated sludge acid of any quality. The underlying principle of the process is concentration by blowing hot air, at a temperature of about 1,200 deg. F., through the acid. The process is continuous except that when handling sludge acid the concentration must be carried out in two stages for reasons stated later.

Operation of Submergence System on Sludge Acid

In concentrating sludge acid from oil refineries, the operation is carried out in two stages in order to avoid frothing and foaming due to the decomposition of the hydrocarbons. In the first stage operation the weak acid is fed in at the top of the tower direct from the pumping lines. The pumping and regulation of the acid are done entirely with the well-known acid air lifts. The rate of supply is carefully regulated to control the speed of operation, also the strength and temperature of the acid bath in the concentrator. By controlling the temperature and the quantity of air blown through the acid and the amount of acid fed to the concentrator, the acid in the pan is maintained constantly at from 50 to 55 deg. Bé., or just below the point at which foaming commences. At this strength the acid hydrocarbons are broken down and volatilized by the rapid stream of air passing through the acid. The acid remains constantly at a strength sufficiently low so that carbonaceous matters (tar, oil, etc.,) are not attacked, and consequently the losses in the first unit are practically negligible. The acid is drained off continuously, passing through a cooler into intermediate storage tanks, from which it is pumped to the top of the high stage unit for the second stage operation. The operation of the high stage unit is very similar to that of the low stage unit. The acid bath is maintained at 66 deg. Bé. and is drawn off continuously at that strength. The finished acid comes out of the concentrator at about 110 deg. F. below its actual boiling point.

Each unit is provided with a tower packed with checkered brick which serves principally as a preheater.

The hot air is produced by the combustion of oil in a specially designed combustion furnace which operates under pressure. A blower provides air sufficient for combustion and an excess necessary for the proper regulation of the temperature. The hot air from the combustion chamber passes through a main header to both units and is distributed through manifolds to a point below the acid level in the concentrator bath.

When the air at 1,200 deg. F. is released under the surface of the acid, it quickly gives up its heat and passes out of the bath at a temperature slightly higher than the temperature of the acid. It gives up most of its remaining heat in passing through the preheating tower.

The two units in which the first and second stages of concentration are carried out are of similar construction. The acid bath is contained in a rectangular

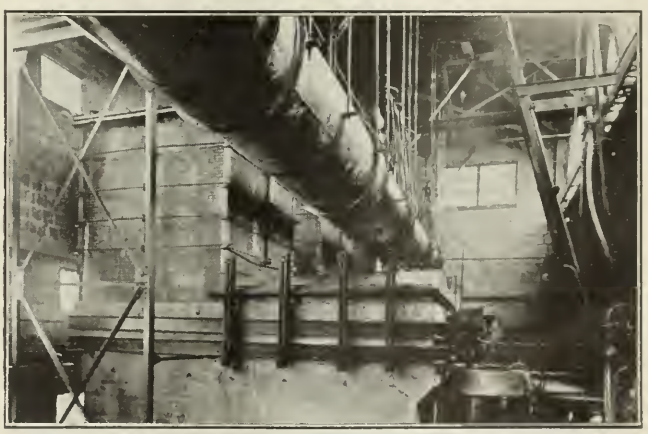


FIG. 3—SEPARATED SLUDGE ACID CONCENTRATING PLANT IN OPERATION

lead pan on a raised concrete foundation, the pan being lined with acidproof brick. About two-thirds of the pan is covered with a chemical brick arch, through which project the acidproof iron pipes that carry the hot air under the surface of the acid. A tower of acidproof masonry rises from the rear end of the pan to a height of about 30 ft. This tower is packed with staggered brick and provides sufficient surface for the transfer of the heat from the escaping gases to the incoming acid.

The results over a protracted period of operation

have shown the oil consumption to be around 35 gal. per ton of 66 deg. Bé. acid when starting from acid of 35 deg. Bé. at room temperature. This oil consumption figure includes raising the heat of the acid in the second stage operation. This gives an equivalent of about 9½ to 10 gal. of oil per ton of 66 deg. Bé. acid when starting from 60 deg. Bé. In the lead pan system, besides the expense incurred by frequent repairs to the pans, it has been recorded that it requires 90 to 110 gal. of fuel to concentrate 1 ton of 66 deg. acid when starting from 35 deg. Bé.

One man per shift can operate the largest plant in existence, and the maintenance cost has proved to be around 30c. per ton of 66 deg. acid.

Comparative cost of concentrating sludge acid by the old and new method is as follows:

Cost of Producing 66 Deg. Acid From 35 Deg. Bé. Sludge Acid Using Lead Pans and C. I. Stills

100 gal. oil at 4c.	$4.00
Labor	.60
General expenses and repairs	2.50
Losses, 20 per cent based on $8 per ton of 60 deg. acid	1.60
Operating cost per ton 66 deg. acid from 35 deg. Bé.	$8.70

Cost of Producing 66 Deg. Acid From 35 Deg. Bé. Sludge Acid Using Hot Air Submergence Type

35 gal. oil at 4c.	$1.40
Labor	.20
General expenses and repairs	1.10
Losses, 6 per cent based on $8.00 per ton 60 deg. acid	.48
Royalty	1.00
Operating cost per ton 66 deg. acid from 35 deg. Bé.	$4.18

Sulphuric Acid Gas Recovery

The method of recovering gases has not been touched upon. This is interesting, because the fume trouble has always been an important subject for lawsuits.

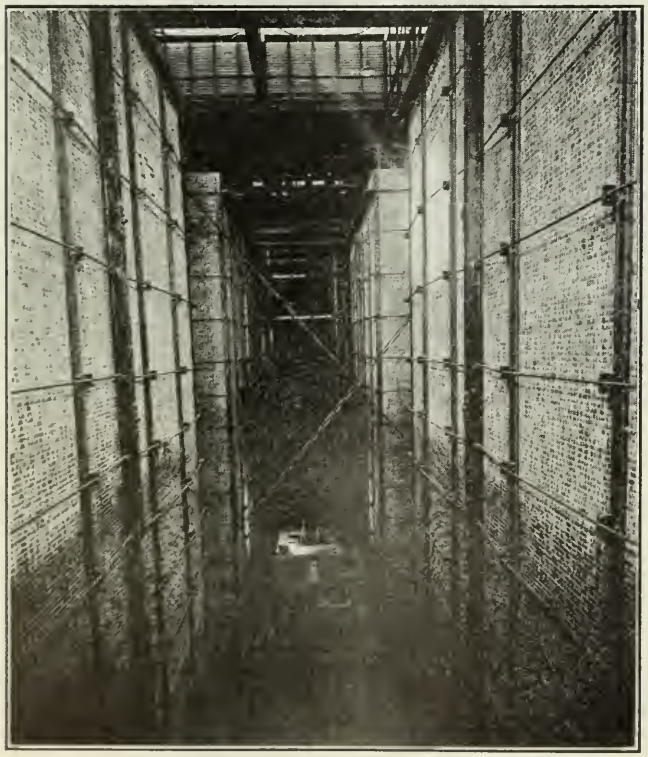


FIG. 4—NITRIC ACID ABSORPTION TOWERS AT U. S. NITRATE PLANT NO. 2

In the indirect method of concentration, the escaping gases may be efficiently condensed in water-cooled condensers, but when concentrating by the direct heat method, the escaping gases are of greater volume, for which reason such condensers are impracticable. In general practice a filtering or scrubbing tower is used. These generally consist of towers or large boxes constructed of lead or acidproof masonry, packed with suitable tower filling, such as coke, hard coal, quartz or rings. If the filtering area, or the tower filling, is of large enough volume, and if the filling material itself is efficient, water is not required. In cases where the filtering area is small, the gases will be absorbed more efficiently by spraying a little water in at the top of the tower. When using water for filtering, in some cases the strength of the distillate acid varies from 30 to 40 deg. Bé. In efficient towers the condensed acid varies in strength from 40 to 55 deg. Bé. when no water is used.

The electric precipitator is being used exclusively for the precipitation of the acid gases in conjunction with hot air submergence type concentrators, whether used for concentrating chamber acid, sludge acid or other contaminated acids. It has also been found very effective on other installations. It looks as if this precipitator will eventually replace all other gas-filtering methods, as the construction is very simple, the recovery the most perfect and the cost of operation very little. The acid comes out of the precipitator at from 50 to 60 deg. strength and the recovery in several instances has been recorded at 99 per cent, while the recovery in filtering towers varies from 60 per cent to 95 per cent.

Acidproof Masonry

The use of acidproof masonry as a permanent construction material for concentrators has been mentioned several times. The success of this construction for concentrators and for all other kinds of acid absorption and treating towers is assured. The construction requires careful design, the use of superior and proper grades of material, the best workmanship and the proper curing and treating of the cement, especially in the hot towers for sulphuric acid. The outer walls are constructed of acidproof shale brick and acidproof cement, and the inside of tower is lined with several layers of 1-in. chemical tile. Towers thus constructed are very durable and if the work is properly done and the towers properly treated, very little seepage will take place. All masonry towers should be operated under slight vacuum.

Several makes of cement have been used—for example, "Acipruf" as manufactured by the Chemical Construction Co., and "Duro" as used by the Process Engineering Co. In these cements, sodium silicate is used as a binder.

The largest example of acidproof masonry work in this country is the installation of the nitric-acid absorption towers and acid concentrators at government nitrate plants at Sheffield and Muscle Shoals. In both places combined there were fourteen large towers, each measuring 32 ft. square on the outside and 60 ft. high, each tower being divided into four parts and each part packed in its entirety with "Chemico" spiral packing rings. In these installations it required millions of brick and several thousand tons of "Acipruf" cement. During the operating test period of these towers, no leakage whatever developed.

Preparation of Metal for Microscopic Examination

From Laboratory Notes by
William Campbell
Professor of Metallurgy, Columbia University

Preparation of Specimens

FOR microscopic examination it is necessary to have a flat surface free from all scratches and possessing a high degree of polish. To attain this, various methods may be followed, depending on the nature of the specimen and the polishing equipment available.

For ordinary material, the most convenient size of specimen is from ½ to 1 in. square and ¼ to ⅜ in. thick. Larger specimens are increasingly difficult to handle.

Brittle and hard material may be broken with a hammer or cut with an emery disk well flooded with water to prevent heating. It is then ground down flat on an emery wheel of No. 60 grade or slightly coarser. Extremely brittle material will not stand the emery wheel and has to be taken down on a lap or a flat glass plate using carborundum powder of about FFF grade.

Normally tough material is cut to size with a power hacksaw. A flat surface is then obtained by using "smooth" and "dead smooth" files, rubbing the specimen on the file, which is held on the jaws of a vise. Steel and cast iron may be ground free from hacksaw marks on the emery wheels.

Material of small size has to be mounted. For wire or sheet a convenient method is to hold the specimen in a clamp built up of two brass plates, 1 in. x ½ in. and ⅜ in. thick, held together by two screws. A layer of red fiberboard or Bakelite is placed between the brass plates and the specimen. For thin wires, a mount can be made of fusible metal or "gum-lac," set in a brass container.

Having obtained a smooth surface of workable size, the next step is to get as fine a surface as possible preliminary to the final polishing with rouge or alumina. With mechanical polishing this can be done on finer grades of emery wheels (No. 100 and 200), or disks covered with strong, fine canvas and armed with carborundum or alundum powders of progressively finer grades. The number of grades necessary depend on the nature of the specimen. Disks should run horizontally.

With hand polishing the specimen is rubbed on the following grades of emery paper:

1. Rough—Commercial No. 0
2. Smooth—Commercial No. 00
3. French—Hubert No. 0
4. French—Hubert No. 00
5. French—Hubert No. 000

The specimen is first rubbed on the rough paper perpendicular to the direction of the file marks or emery wheel scratches until all of these have disappeared. The specimen is then dusted and wiped free from all grit and rubbed on the smooth paper, the new scratches being 90 deg. to those of the last paper, and so on through the series. All scratches from the previous paper must be taken out before passing to the next. Grits from one paper must never get onto the next, or the specimen will be spoiled.

Final polish is given with well-washed rouge or alumina. With hand polishing a block of wood, 12 x 6 in., is covered with broadcloth stretched tight. It is covered with well-moistened rouge or alumina, conveniently kept in a wash bottle containing 1 part rouge to about 5 parts of water. The specimen is given a circular motion to avoid pitting. When mechanical polishing is used, the disk is covered with broadcloth and armed with rouge or alumina as above, and runs horizontally at not over 500 r.p.m. If a higher speed is used, the polishing material is thrown off the wheel unnecessarily. If the disk revolves vertically, much polishing material is thrown off even at lower speed. In all this kind of polishing the specimens must be revolved round and round the wheel or pitting results, due to a scouring action in the softer spots.

The above methods hold good for iron, steel, cast iron, brass, bronze, or bearing metals. However, very soft alloys, such as the solders or any alloy with a large porportion of lead, must be polished with great care, or the surface of the metal actually flows like molasses, and the true structure is masked. The later etching does not serve to get rid of this difficulty.

When the final polish is finished, wash well under the tap, dry with alcohol and mop or pat the surface with a soft rag. This must be done immediately, or the specimen will oxidize. Do not rub the specimen in any way, or the surface is likely to be spoiled.

Now examine the specimen under the microscope and note any colored constituents, such as slag in wrought iron, oxide, manganese sulphide and silicate in steel, graphite in cast iron, temper carbon in malleable cast iron; oxides or sulphides in copper and its alloys, and so forth. Flaws and cracks in faulty material are to be noted. Shrinkage cavities show up.

In the preparation of specimens the object is to learn the true structure of the material. In many cases this varies with the location of the specimen. In cast material, sections should be cut perpendicular to the cooling surface, from the outside to the center of the ingot or casting. In rolled or forged material the sections should be parallel to the direction of rolling or forging, for a cross-section alone is often misleading.

Development of Structure

The usual method is by etching. Care must be taken to avoid overetching or the specimen must be repolished. The etching material varies with the specimen, as follows:

Wrought Iron. Etch with 5 per cent picric acid in alcohol. The surface of the specimen is covered with the solution on a container, which is rocked slightly to get uniform action. When the picric acid has become very dark, say after 1 minute, the specimen is washed under the tap, and dried with alcohol. This will show up any pearlite present. In order to develop the grains of the ferrite, the specimen is re-etched by immersing in picric acid for 5 minutes. This can also be done by etching in 2 per cent solution of nitric acid in water for 5 seconds, but the picric acid is safer, since there is not the same liability to overetch. Furthermore, nitric acid eats into the iron very deeply around the slag areas and also pits very deeply.

Steel. Etch with picric acid, as above. Pearlite is attacked and turns brown to blue-black. Ferrite and cementite are not attacked. Steels with carbon content in the neighborhood of the eutectoid (0.9 per cent C), possess a structure in which it is often difficult to distinguish between ferrite and cementite when the excess constituent occurs in very thin envelopes. They may easily be distinguished by boiling in a solution of picrate of soda which turns Fe_3C black, but leaves ferrite bright white. The carbon content of pearlite varies

with the rate of cooling and the percentage of manganese present. In ordinary rolled material (bessemer or open hearth) we can assume:

0 to 10 per cent	pearlite.	C in pearlite	= 0.9 per cent
10 to 25 per cent	"	" " "	= 0.85 per cent
33 per cent	"	" " "	= 0.80 per cent
50 per cent	"	" " "	= 0.75 per cent
66 per cent	"	" " "	= 0.70 per cent
75 per cent	"	" " "	= 0.65 per cent
90 to 100 per cent	"	" " "	= 0.60 per cent

With very thin sections, containing from 90 to 100 per cent pearlite and analyzing 1 per cent manganese, the carbon content of pearlite is nearer 0.55 per cent than 0.60 per cent.

Cast Irons. Etch with picric acid. Cementite is likely to be stained before all of the pearlite is developed in certain high-silicon irons showing the "cementite" eutectic as a network more or less discontinuous, surrounding grains containing ferrite, etc. A light etch with 2 per cent nitric acid will often differentiate between the ferrite high in silicon (silico-ferrite) and the pearlite, and still leave the cementite eutectic bright.

Copper Alloys. Pure copper, sheet bronze, cast brass, german silver, etc.: Etch with ammonia and peroxide as described for gunmetal. Ferric chloride, ammonium persulphate and 50 per cent nitric acid have been advocated. Nitric acid etches rather deeply for photographic work, but is better for general work than the other two, but less desirable than ammonia and peroxide.

Gunmetal, Bell Metal, Cast Bronze. When these are etched with 50 per cent nitric acid (1 part concentrated acid to 1 part water) the dendritic structure shows up well, but the eutectoid is darkened and its structure obliterated. A much better method is to use 5 c.c. ammonia with a few drops of hydrogen peroxide and apply it by rubbing with a small wad of absorbent cotton until the structure appears quite clear to the eye. Fresh solutions should be made up in a watch glass for each specimen. By this means the copper-rich cores of the dendrites are deeply attacked while the eutectoid remains quite bright. The eutectoid can be made to show up in strong contrast by flooding the etched specimen with Grard's solution[1] until the color begins to change, and then quickly washing off the liquid reagent under the tap.

Sheet Brass. The structure is best developed by using ammonia with a few drops of hydrogen peroxide, as demonstrated by the wonderful photographs of Mathewson, Bassett and their associates.

Monel Metal. As cast, the structure is best developed by a mixture of dilute acetic and nitric acids. The wrought metal when in the annealed condition can also be etched with Grard's solution, which shows up the grains alternately light and dark. When Monel metal is etched with 50 per cent nitric acid it tends to pit badly, these pits starting with tiny dots of oxide as nuclei. The resulting structure is therefore very badly pitted.

Bearing Metals. For white metals in general use 2 per cent HNO_3 in water or alcohol. Great care must be taken not to overetch the specimen, especially those with a zinc base. Those with a lead or tin base are not so easily overetched and, with care, a 10 per cent HNO_3 in water can be used.

[1] Made of 5 g. ferric chloride, 50 c.c. hydrochloric acid and 100 c.c. water.

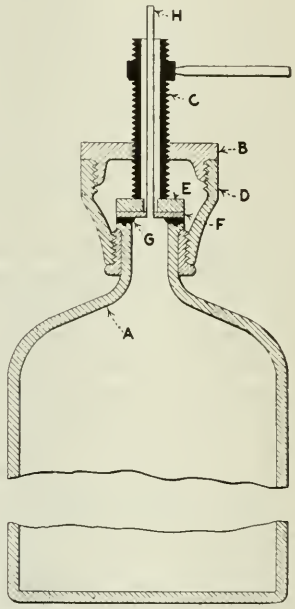
A Simple Type of Glass Pressure Bottle*

By R. R. Reed

Editor's Note—It is not our custom to publish articles dealing with laboratory apparatus, but the possible use of this ingenious device in development work and in tests on manufacturing processes makes it of considerable interest to technical men.

A requisite for every chemical laboratory is a glass pressure bottle, in which reactions between corrosive reagents requiring moderate temperatures and pressures may be carried out. Such a bottle with a capacity of 800 c.c. can be constructed from readily available materials at moderate cost.

The top of a soda-water siphon *A* (the ordinary seltzer bottle) is ground flat on a wet stone and a narrow, shallow groove cut concentrically by means of emery and a metal tube rotated in a lathe, the groove assisting materially in preventing any leakage.



GLASS PRESSURE BOTTLE

The top is constructed of pipe fittings: a reducing coupling *D*; a reducing plug *B*; a short length of ½-in. pipe threaded from the ends so that a T may be screwed down one-third the length of the pipe; an iron disk *E* with a ⅜-in. hole; a lead disk *F*, and an asbestos disk *G*. A very thin platinum foil gasket may be placed between the asbestos and the bottle if necessary.

The top is attached by means of the split, threaded fitting which serves the same purpose in the original bottle. Closing of the bottle is effected by careful application of pressure by means of *C*.

When it is desirable to ascertain the pressure in the bottle, a manometer, made of capillary tubing closed at one end, is attached by means of a ¼-in. copper tube *H*, which extends down through *C*, *E* and *F*, to which latter it is soldered. By this means pressures up to 150 lb. per sq.in. (the limit of safety) may be measured.

Due to the thickness of the glass, heating must be carried out very slowly in a water, salt or oil bath, otherwise breakage is sure to result. In general a rise in temperature to 100 deg. should take about 1 hour. These bottles will stand 150 lb. per sq.in. pressure, but precautions against explosion should always be taken.

*Contribution from the department of chemistry, Yale University.

Corrosion of Iron and Steel—Influence of Molecular Concentration on Immersion-Test Investigations

Initial Rate of Corrosion the Most Important, Since Solution Rates Change as Equilibrium Approaches —Spent Solutions Often Harmless, but Sometimes Accelerate Corrosion—Short Tests in Circulating Pure Chemicals the Logical Method for Comparative Tests

By D. M. STRICKLAND
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SCIENTIFIC experiments which yield constructive information relative to the various phases of iron and steel corrosion command the attention, not only of investigators, but also of architects, contractors, engineers of tests, civil and highway engineers and all other extensive users of ferrous metals.

Tests in which uncoated sheet metals are exposed to atmospheric conditions yield results which may be of little commercial value, because the conditions of such tests simulate but a limited class of daily service requirements. It is very seldom that uncoated material is chosen for sheet metal installations, the general practice being to protect the sheets with paint, spelter, tin or lead coatings. When uncoated sheets are used for testing purposes the formation of oxide coating introduces into the test a condition not found in actual service. In everyday usage, iron and steels are usually subjected to service requirements far different than the conditions which influence an atmospheric test. This is true for all underground constructions, boilers, tanks, railroad equipment, flumes, culverts and drainage constructions in general. In fact, there are few ferrous metal installations which are not subjected to partial, intermittent or total immersion conditions.

Endeavoring to devise test methods which more nearly approach such conditions of commercial requirements, chemists and metallurgists both at home and abroad have rightly turned to immersion-test investigations in order to obtain reliable data concerning the service life of iron and steel. The supervision of fresh water, salt water and mine water immersion investigations by the American Society for Testing Materials shows that the members of this society recognize the importance of immersion tests.

Laboratory immersion tests when properly conducted are valuable indicators of the performance of ferrous metals, but valuable as such investigations may be, if they are not conducted under conditions of recognized and standardized uniformity, the results are of no value. The importance of uniformity of testing conditions cannot be overestimated, as the non-conclusive and even misleading interpretations which follow an unscientific investigation obscure the solution of any corrosion problem.

The purpose of this paper is to show the reliability of immersion tests when carefully conducted, not only by pointing out the necessity of properly interpreting the influence of solution molecular concentration but also by describing an immersion-test method where the variations in solution strength are reduced to a minimum and one which will be extremely valuable in establishing the immersion test as the most reliable of present day testing procedures.

Immersion tests require close attention and study. Before starting, the investigator must consider carefully the nature of the chemical actions which occur. One must understand not only the influence of temperature changes but also the influence of such variable molecular concentrations as result from unequal evaporation or exhaustion of solution.

Chemical Changes During Corrosion

Corrosion is a chemical change and the reaction conforms to the chemical reaction laws. As the metal reacts with the corroding liquid it is possible that

First, the reaction is irreversible, and an insoluble precipitate forms or a gas is evolved.

Second, a chemical equilibrium is established, characterized by the usual phenomena of the reversible reaction.

Third, byproducts of the reaction in turn attack the metal, inducing a secondary reaction, which in some instances accelerates the corrosion and in other cases retards the primary action.

Usually corrosion reactions are of the first class and irreversible. However, regardless of the type of reaction, at any given moment of time the speed of the chemical action depends directly upon the molecular concentration of the solution surrounding the metal samples. Generally the speed of the reaction approaches zero as the chemical approaches exhaustion or as the pending chemical equilibrium approaches a balance.

It must be remembered that chemical action begins the moment the specimens are brought in contact with the corroding solution. Since the rates of corrosion of the various grades of metals differ, the test conditions quickly lose their uniformity, since the relative resistivity of the metals to the chemical change involved determines the molecular concentration of the solution and this condition governs the reaction speeds.

It is obvious that when this complex variable is considered, true conclusions will be derived from the test data. The various theoretical factors which contribute to variations of molecular concentration may be of little interest to many investigators, but when they realize that such a variable exists and continuously changes the speeds of corrosion even in tests where all other conditions are uniform, their experiments will yield results of great value.

Consider an immersion test where specimens are immersed in equal volumes of a 10 per cent solution of S. An iron or steel reacting rapidly will be surrounded at

the end of T hours by a solution of molecular concentration differing in marked degree from the liquid surrounding test-pieces which reacted at a slower rate. Such a condition usually favors the less resistant metal, as the speed of its corrosion is perceptibly lessened. As the test progresses, some particular grade of material will finally exhaust its solution strength. The action ceases. Unless the solution is then fortified with additional corroding medium or the entire test is discontinued, the iron or steel specimens which have been slightly attacked will continue corroding until in time they catch up with the worst sample. When cleaned and weighed, it will be found that the weight losses are practically equalized and the metal which in reality exhausted its solution first is erroneously deemed to have an equal corrosion-resistance value as metals actually far superior. The following résumé of tests conducted to determine the influence of variable solution strengths are interesting, as they bear out in practice the foregoing statements.

Description of Test Methods

A brief description of test methods will be of interest: Black sheets of 16-gage commercially pure iron made in open-hearth furnaces, coppered iron, common steel and coppered steel[1] were cut into 2x2-in. squares and carefully pickled. They were free from scale, rust, dirt, mechanical injuries, surface irregularities, excessively deep stencil marks, etc. All tests were conducted at room temperature, and any tendency toward unequal evaporation was eliminated. All experiments were run in duplicate and the figures reported are the averages of closely agreeing weight losses. All weighings were checked and the chosen time intervals were accurately followed. The samples were placed vertically in separate tumblers and completely immersed in equal solution volumes.

With such uniform initial conditions, the results obtained in the various corroding media will be influenced by two factors only:

First, the differences existing between the metals under test—that is, their various corrosion resistivities; due in turn to differences in homogeneity, uniformity, chemical purity, surface condition and other factors.

Second, the molecular concentration of the corroding solution.

Loss in Hydrochloric Acid

Test-pieces were immersed in 250 c.c. of 3 per cent hydrochloric acid. One set of samples was weighed at the end of 48 hours; the others remained in the solution for 30 days. Following is a comparison of weight losses expressed in ounces per square foot of actual surface:[2]

Material	End of 48 Hours	End of 30 Days
Commercially pure iron	0.08	4.31
Coppered iron	0.26	4.08
Common steel	0.29	4.20
Coppered steel	0.52	4.13

It would be erroneous to assume from the 30-day data that all metals were equally resistant to the corrosion reaction. The short-time test shows that the commercially pure iron is most resistant to the action of the hydrochloric acid. It is obvious that the various reaction speeds varied as the solution strength weakened. The rapidly corroding coppered steel soon so weakened the acid strength that the action slowed down. Between 48 hours and 30 days the action was so slow that the more resistant metals caught up and yielded equalized weight losses.

In actual service conditions, the corroding medium is generally in excess to the ferrous metals. It is the metal which fails and not the corroding medium which is exhausted. If, in everyday service, metal is in contact with hydrochloric acid, the acid strength would not weaken perceptibly, since it doubtless would circulate. The more rapidly dissolving metal has no opportunity to weaken the corroding medium or slow down in action. Instead, it will continue its rapid corrosion and fail quickly. Thus it is that a short-time immersion test closely approximates the working conditions.

Other samples were immersed in 300 c.c. of concentrated hydrochloric acid (38 per cent). At intervals of 30 minutes the samples were removed, dried, weighed and again immersed in *fresh* acid. Weight losses were determined from time to time with results as shown in Table I.

TABLE I—REPEATED IMMERSIONS IN FRESH CONCENTRATED HCl

Material	End of 5 ½-Hr. Periods	End of 15 ½-Hr. Periods	End of 20 ½-Hr. Periods	End of 30 ½-Hr. Periods
Commercially pure iron	0.14	0.50	0.66	0.75
Coppered iron	0.74	2.62	3.56	5.63
Common steel	1.65	5.25	6.93	10.29
Coppered steel	1.08	3.68	4.28	7.21

These figures verify results obtained by Dr. A. S. Cushman[3] as embodied in his paper wherein he describes the action of 38 per cent hydrochloric acid on pickled galvanized 2x3-in., 26-gage specimens.

TABLE II—REPEATED IMMERSIONS IN FRESH 20 PER CENT HC

Material	End of 5 1-Hr. Periods	End of 10 1-Hr. Periods	End of 20 1-Hr. Periods
Commercially pure iron	0.02	0.05	0.08
Coppered iron	0.03	0.08	0.12
Common steel	0.15	0.31	0.44
Coppered steel	0.04	0.10	0.17

Again, using 20 per cent hydrochloric acid solution and immersing samples in fresh solution every hour, the losses in weight obtained, expressed in ounces per square foot actual surface, are given in Table II.

Loss in Sulphuric Acid

Similar test-pieces were subjected to the action of 200 c.c. of 5 per cent sulphuric acid. The samples were removed from time to time, weighed and re-immersed in the same acid. The results are given in Table III.

TABLE III—REPEATED IMMERSIONS IN THE SAME 5 PER CENT H_2SO_4

Material	24 Hr.	48 Hr.	192 Hr.	40 Days
Commercially pure iron	0.09	0.16	0.93	4.25
Coppered iron	0.02	0.08	0.17	4.18
Common steel	0.28	0.38	1.77	4.20
Coppered steel	0.07	0.15	0.42	4.15

These results again show that if the test is undisturbed for a sufficient length of time the weight loss will

[1] Average analyses of the various materials:

Material	S	P	C	Mn	Cu
Commercially pure iron	0.020	0.005	0.010	0.009	0.020
Coppered iron	0.028	0.006	0.010	0.015	0.204
Common steel	0.020	0.012	0.090	0.273	0.034
Coppered steel	0.025	0.011	0.110	0.420	0.235

[2] All weight losses are reported as ounces per square foot actual surface. To convert to grams per square meter actual surface, multiply the reported figures by 305. A piece of 16-gage, having one square meter actual surface, weights 6,100 grams; one square foot weighs 20 ounces.

[3] "Notes on Some Anomalies Encountered in a Study of Immersion Tests of Iron and Steel," by A. S. Cushman and G. W. Coggeshall, American Electrochemical Society, 1921.

approach equality. The weight loss of each grade increases with time until the strength of the solution is weakened to such an extent that the speed of corrosion diminishes. For example, at the end of 192 hours the common steel lost 1.77 oz. per sq. ft., whereas at the end of 40 days this metal (instead of corroding at the same rate for a total loss of 8.85 oz. per square foot) had lost only 4.20 due to the fact that a weakening solution had retarded the corrosion reaction.

Loss in Nitric Acid

Using a 5-hour time interval between solution changes, similar test-pieces were immersed in 300 c.c. of concentrated nitric acid (70 per cent), with results as shown in Table IV.

TABLE IV—REIMMERSED IN FRESH 70 PER CENT HNO_3 EVERY 5 HOURS

Material	End of Total Immersion of 120 Hr.	End of Total Immersion of 240 Hr.
Commercially pure iron	0.09	0.17
Coppered iron	0.70	1.42
Common steel	0.23	0.48
Coppered steel	0.21	0.46

Had this test continued to the exhaustion of the reacting metals or corroding medium, figures would have been obtained which would be without value. This test is all the more interesting in that iron and steel is generally understood to be passive when in contact with cold concentrated nitric acid, whereas in this instance sufficient weight losses were obtained in 10 days to indicate accurately the greater resistivity of the commercially pure iron.

Loss in Aluminum Sulphate

Two separate tests were conducted in beakers containing 250 c.c. of 20 per cent anhydrous aluminum sulphate. One was permitted to continue until all specimens had exhausted their solutions. It required 1,500 hours for the commercially pure iron to reach this point, at which time the test was discontinued. Test-pieces used in the second test were all removed from the liquid after 296 hours when the most corodible metal had exhausted its solution. Table V shows the results.

TABLE V—CORROSION IN ALUMINUM SULPHATE

Material	End of 1,500 Hr.	End of 296 Hr.
Commercially pure iron	6.73	0.066
Coppered iron	6.80	0.138
Common steel	7.00	1.106
Coppered steel	7.00	5.113

It would be unjust to assume anything from the results obtained in 1,500 hours. The short-time tests shows that the coppered steel lost eighty times as much metal as did the commercially pure iron. This test is interesting in that it gives a striking example of relative initial resistivity.

Although it requires increased attention, investigators who remove all the samples at regular time intervals and again immerse them in full-strength solutions are conducting their tests in a manner closely approximating usual commercial requirements. As a rule, the shorter the time interval between solution changes the nearer will test conditions approach actual service conditions where the corroding medium is changing continuously. It would be poor practice to fortify from time to time all the solutions by adding equal volumes of the corroding medium. This would increase the complexity rather than simplify the problem of solution changes, as such practice would certainly concentrate solutions to variable extents, depending upon the relative amount of depletion occurring up to that time.

Loss in Ferric Chloride

In this experiment several groups of samples were immersed in 200 c.c. of 3 per cent ferric chloride and permitted to remain for various periods of time. At the end of each time interval the corroding medium was discarded and, after cleaning and weighing, the test-pieces were immersed in freshly prepared 3 per cent ferric chloride. The results, expressed in loss of weight in ounces per square foot of actual surface are summarized in Table VI.

TABLE VI—CORROSION BY PERIODICALLY RENEWED FERRIC CHLORIDE (3 PER CENT)

24-Hour Periods

Material	First 24 Hr.	Second 24 Hr.	Total 48 Hr.	Third 24 Hr.	Total 72 Hr.	Fourth 24 Hr.	Total 96 Hr.
Commercially pure iron	0.22	0.29	0.51	0.31	0.82	0.29	1.11
Coppered iron	0.24	0.30	0.54	0.33	0.87	0.31	1.18
Common steel	0.27	0.30	0.57	0.32	0.89	0.30	1.19
Coppered steel	0.27	0.32	0.59	0.33	0.92	0.31	1.23

48-Hour Periods

Material	First 48 Hr.	Second 48 Hr.	Total 96 Hr.
Commercially pure iron	0.36	0.35	0.71
Coppered iron	0.37	0.35	0.72
Common steel	0.37	0.35	0.72
Coppered steel	0.39	0.37	0.78

96-Hour Periods

Material	First 96 Hr.	Second 96 Hr.	Total 192 Hr.
Commercially pure iron	0.39	0.43	0.82
Coppered iron	0.41	0.43	0.84
Common steel	0.41	0.45	0.86
Coppered steel	0.40	0.55	0.95

192 Hour-Periods

Material	First 192 Hr.
Commercially pure iron	0.38
Coppered iron	0.42
Common steel	0.43
Coppered steel	0.57

240-Hour Periods

Material	First 240-Hr.	Second 240 Hr.	Total 480 Hr.
Commercially pure iron	0.47	0.38	0.85
Coppered iron	0.51	0.45	0.96
Common steel	0.49	0.36	0.85
Coppered steel	0.48	0.48	0.96

Table VI shows clearly how weight losses are absolutely dependent on the solution strength. The weight losses for each 24-hour interval agree closely. Even though the weight loss for a single 48-hour period is approximately 20 per cent greater than for a 24-hour period, yet the significant fact remains that the losses at the end of two 48-hour periods are much less than the weight losses recorded for three 24-hour periods. In fact, at the completion of four 24-hour periods figures were obtained which were greater than those recorded for any other time interval or combination of time intervals, including the two 10-day periods.

Investigators should determine before starting their immersion tests what time intervals should elapse between solution changes. Differences in losses between samples immersed for variable time periods will be noticeable regardless of the time intervals chosen, providing the shortest interval is not longer than the time required for equalization. Notice the ferric chloride weight losses for the 192-hour and 240-hour periods. Here we have average losses of 0.45 and 0.49 oz. per square foot, showing that these time periods are both too long to be used if reliable data are desired. It is probable that at the end of 96 hours an even greater variation in total corrosion would have resulted had 12-hour instead of 24-hour periods been used.

It will be noted that the various experiments described in this paper have corrosion reactions which are so rapid that it is only necessary for a few hours to elapse before confirming evidence is obtained showing that molecular concentration is an important variable in immersion tests. Although it would require many months to duplicate the evidence for slow reactions, nevertheless similar data would be the result of the longer investigation. This is because corrosion is a chemical change and the reactions involved conform to reaction laws. Consequently, if the corroding medium plays a direct part (no matter how slight or slow reacting), it must follow that the molecular concentration changes and reaction speeds vary, even though long periods of time may elapse before the influence is detectible.

It is possible that the corroding medium exerts only an indirect influence. The character of the reaction may be such that as the chemical in solution reacts with the ferrous metals the byproducts interact to the replenishment of this chemical. The solution may act as a catalytic agent, a carrier of necessary oxygen, an intensifier of electrolytic action, or in some other capacity where the corroding medium is seemingly unchanged. An investigator will study such complex reactions and use all the greater care to insure uniform test conditions. Unequal evaporation or water additions give a conductivity variable to electrolytes; variable air supply changes uniformity in tests requiring oxygen. There are a multitude of factors which influence tests where the functions of the corroding media are indirect; conclusions drawn from such investigations will indeed be valuable when due care is given to these variables.

Loss in Ammonium Persulphate

The solution used in this experiment was 10 per cent crystalline ammonium persulphate and it was conducted in the same manner as described immediately above for ferric chloride. See Table VII.

It is apparent that the figures in Table VII are comparable with results reported for the ferric chloride tests. After the samples had been immersed for four 24-hour periods, the resulting losses are again far greater than any other figures obtained. The losses after a 50-day immersion period were less than for two 24-hour intervals. It is conservative to say that during the 50-day period all samples lay idle in an exhausted solution for about 45 days.

TABLE VII—CORROSION BY PERIODICALLY RENEWED AMMONIUM PERSULPHATE (10 PER CENT)

24-Hour Periods

Material	First 24 Hr.	Sec. 24 Hr.	Total 48 Hr.	Third 24 Hr.	Total 72 Hr.	Fourth 24 Hr.	Total 96 Hr.
Commercially pure iron	1.97	2.37	4.34	1.95	6.29	2.09	8.38
Coppered iron	2.15	2.47	4.62	2.06	6.68	2.25	8.95
Common steel	2.23	2.62	4.85	2.11	6.96	2.04	9.00
Coppered steel	2.72	3.24	5.96	2.58	8.54	3.11	11.65

48-Hour Periods

Material	First 48 Hr.	Second 48 Hr.	Total 96 Hr.
Commercially pure iron	2.42	2.22	4.64
Coppered iron	2.96	2.88	5.84
Common steel	2.81	2.66	5.47
Coppered steel	3.72	3.43	7.15

96-Hour Periods

Material	First 96 Hr.	Second 96 Hr.	Total 192 Hr.
Commercially pure iron	2.98	2.67	5.65
Coppered iron	2.99	3.34	6.33
Common steel	3.05	2.96	6.01
Coppered steel	3.50	3.51	7.01

50-Day Period

Material	End of 50 Days
Commercially pure iron	3.52
Coppered iron	3.82
Common steel	3.62
Coppered steel	3.96

Considering the 50-day test alone, it would appear that the coppered steel lost approximately 12 per cent more than the commercially pure iron samples, whereas the decisive short-time tests indicated that this percentage should be 39. Had 12-hour or 6-hour periods been used for the shortest time interval this percentage would no doubt be greater. In fact, as the interval between solution changes shorten, the weight losses obtained approach the true figures to be expected from actual service.

This series of experiments shows very clearly that valuable conclusions may be drawn from rapid tests conducted under proper conditions. Conclusions which have been derived from tests conducted in the past are open to question unless such tests were scientifically controlled, with due attention given to the variable molecular concentration of the various corroding media.

Recommended Procedure

The most successful means of conducting immersion tests, yet a procedure which will closely approach actual service conditions, is to immerse all test-pieces in one tank. The specimens should be suspended on glass rods

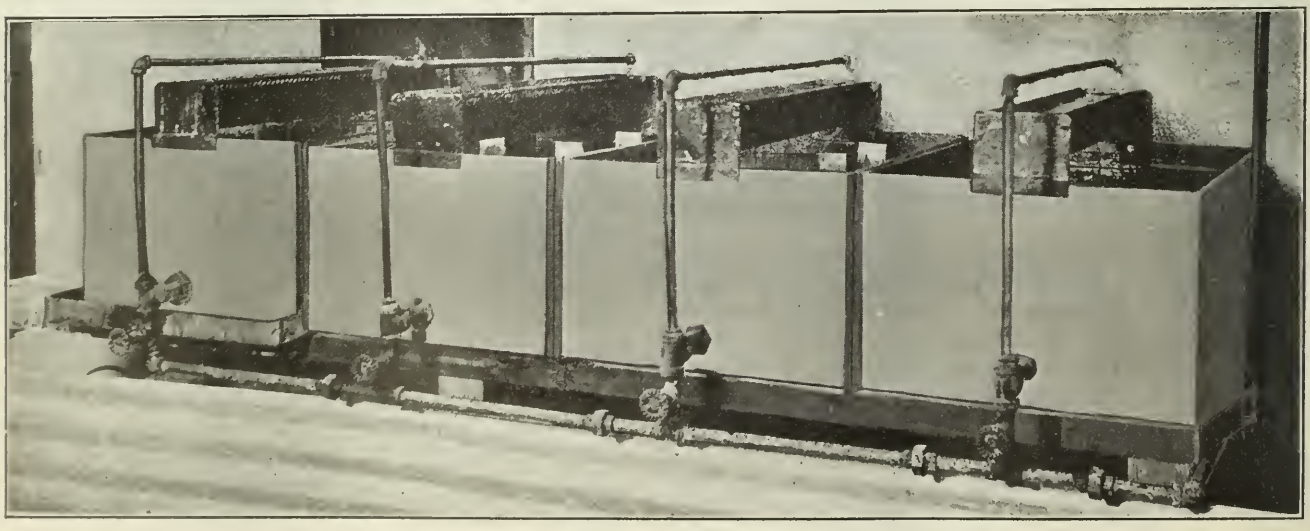

FIG. 1—ROW OF TANKS FOR CORROSION EXPERIMENTS

at distances apart sufficient to prevent any tendency toward electrolytic action. The tank should be ample in size to hold a large volume of the corroding liquid, so that when possible, the reacting chemical will be present in amounts in excess to the ferrous metals. Fig. 1 shows equipment adaptable for these suggestion.[4]

Although this illustration shows a metal tank, stoneware or enameled ware can be used equally as well. A convenient size is 12x18x30 in. An air lift is employed for circulating the solution. Air regulated by the globe valve and blowing up the vertical pipe from the bottom of the tank requires but a small amount of air to lift the solution from the bottom of the tank to a pipe parallel to and above the V-shaped trough which is placed between the pipe and the surface of the liquid. The solution will not only mix with air while passing through the pipes but will also have the opportunity to absorb additional air when dripping from the holes in the pipe into the trough and from the trough into the liquid in the main tank. Evaporation losses are equalized and temperature conditions are uniform when tests are conducted under the conditions described. Although the molecular concentration of the solution may vary continuously, yet at any moment of time the same strength of solution is attacking all grades of material under test. In investigations where the solution strength changes rapidly, it is possible to determine accurately this variable by daily tests and to fortify the liquid by calculated additions. If the reaction by-products form in appreciable amounts and exert either an accelerating or retarding influence, the entire solution can be easily changed.

Mercury Poisoning

There is probably no industry, trade or art in which mercury is used which has not produced some cases of mercury poisoning. In the mining and smelting of mercury the hazard has long been recognized.

The cases of industrial mercury poisoning occurring about mines and reduction works are usually chronic in form, with occasional development of acute symptoms when the workmen are exposed to undue amounts of mercury vapors, dust, or soot. The cardinal symptoms of the disease are stomatitis (inflammation of the mouth), often with some salivation, tremors and a peculiar timidity (erethism). These symptoms are accompanied by organic degenerative changes in various organs of the digestive system, circulatory system and the kidneys. Insufficient or improper ventilation of the working places, together with failure to maintain sufficient back pressure to prevent the escape of mercury vapor from furnaces, condensers and retorts, is a very important predisposing cause of the poisoning. Uncleanliness of the workmen appears to be no small factor in the production of the condition. Men who do not wash their hands well before eating or putting anything into the mouth, who do not care for their teeth and who fail to rinse the mouth well before eating and drinking, those who do not take a hot cleansing bath at the end of each day's work and who do not change their work clothing for street clothing after work develop poisoning more often than those taking these precautions.

Further details are given in Serial 2,354, just issued by the Bureau of Mines.

[4]This equipment was first described in "Observations on the Corrosion of Iron and Steel," by J. A. Aupperle and D. M. Strickland, American Electrochemical Society, 1921.

Plant Transportation, Plant Roadways and Concrete

By Graham L. Montgomery

OTHER things besides the selection of the correct machinery and appliances must be considered when purchasing the equipment for a plant transportation system. It is important to be able to form some opinion in advance as to just what effect the equipment will have on plant conditions other than material handling. It is important to determine the proper relations between the new equipment and the existing plant so that any changes that are necessary to enable the new equipment to function at its best may be made. It is often found necessary to make such changes, even when by so doing some interference occurs with other phases of the operation so as to reduce their efficiency. On the other hand, these changes often give benefits to some phase of operation other than transportation which had not been foreseen and which may actually be of as great or greater value than the benefit which the transportation derives. It will be seen, then, that any changes of this nature must be carefully weighed, and such disadvantages as may be foreseen balanced against the advantages that are to be derived, before a sound decision can be reached as to the course to be followed.

Plant Transportation

Chemical plants and many other plants of a similar nature often consist of a multiplicity of buildings, distributed over a wide area. Generally each building houses but one or two steps of the process at most, and often, as a result, the different steps are separated by considerable distances. This means that it is necessary to handle a large amount of material between the various buildings, from step to step of the processes. In addition the raw materials must be unloaded and then taken to the storehouse or to the primary step of a manufacturing process and the finished goods must be moved from the last step of manufacturing to the warehouse or shipping department.

This means that some form of mechanical transportation equipment is a necessity in such a plant. Of course, it is always wise for a manufacturer so to equip and organize his plant that costs of production are kept at a minimum. And this is particularly so under present conditions of manufacture, when the labor cost of manufactured goods is disproportionately high and the market conditions make it imperative to produce with the minimum of cost so that the goods may be held at a low enough price to find a ready sale.

Transportation Equipment

The equipment employed to accomplish this transportation will vary with the nature of the goods produced in the plant. In a plant where the goods are all of one class, the solution will rest in choosing the one type of equipment which is best suited to handling goods of this class. Many plants require several different types of equipment, as the handling includes several different classes of material. Thus we find handling equipment comprising traveling cranes, monorail hoists and some form of storage battery trucks in common use by large foundries for the solution of their transportation problems.

The largest category of these plants, however, is that in which the goods to be handled cover a wide variety of

sizes, shapes and weights and the physical constitution of the plant precludes any possibility of an economic utilization of such fixed-path equipment as a crane, monorail or industrial railway. Here the solution most commonly arrived at is to use a fleet of storage battery trucks, or a storage battery tractor or two with a fleet of trailers. The choice between truck and tractor and trailers rests on such factors as length of haul, speed at which it is desired to handle, character of handling and size of plant. In general, the choice falls on the truck when the haul is short, when the goods are light, when speed is desired, or the total to be moved is small, while under reverse circumstances the tractor and trailers get first call.

Plant Roadways

In all plants of the type here under discussion, when the transportation system utilizes trucks or tractors, there must be some sort of roads between the various buildings. It is obvious that the better these roadways are the more successfully the trucks and tractors can be used. The necessity for such roadways has long been a commonplace in a number of industries. In the metal-working industry we have many examples from the small unit made up of perhaps but two buildings with a paved runway between up to such huge units as the plants of the Ford Motor Co. or the General Electric Co., where the plant roadways become veritable speedways.

Unfortunately for the chemical and allied industries, they have not come to as keen a realization of the possibilities pointed out above as have plants in some other lines of industry. In the first place, despite the adverse conditions of labor market and sales market, by far the larger number of such plants have made no endeavor whatever to utilize mechanical handling devices of any kind. Then again, it is quite usual to find the roadways of these plants in a truly deplorable condition—rough, muddy, and, in wet weather, almost impassable.

The Concrete Solution

Apropos of these facts, it is worth while noting what has been done at the Rensselaer plant of the Grasselli Chemical Co. This plant is an ideal example of a plant consisting of numerous buildings and having a transportation problem to be satisfactorily solved only through the use of a tractor and trailers. The mud difficulty must have been particularly pronounced at this plant at one time, as it is on low lying ground, at best but little above normal water level of the Hudson.

In order to get away from this difficulty, concrete roadways have been built throughout the plant. The accompanying illustration shows one of these roads with the tractor and a train of trailers on it. It was stated to the writer that, by the placing of this concrete, which cost but little more than the tractor and trailers, full, continuous and satisfactory plant transportation had been attained. As closely as can be figured, the whole installation must have paid for itself in less than two years.

TRACTOR AND TRAILERS ON CONCRETE ROADWAY, GRASSELLI CHEMICAL CO., RENSSELAER, N. Y.

Now, as to the other influences which the placing of this concrete had on plant conditions: A clean and dry path was provided at all times from building to building. The appearance of the plant was greatly improved. These two things improve both the workers' health and their morale. The reflection of these improvements is apparent throughout the plant in increased efficiency and lowered production costs. It is, however, impossible to separate the exact amount of improvement out into dollars and cents, and so this amount must remain unnamed, although the management states that there is no doubt that it exists.

Conclusions

Although this matter of trucks and good plant roads is a simple one, its importance should not be overlooked. The profits to be realized—directly through the use of proper plant transportation equipment in a proper way and indirectly through generally improved conditions—are well worth attainment by any manufacturer. Just because a thing has not been customary in the past is no reason why it should not, provided it is worth while, become customary in the future. It will be well for the chemical and allied industries for this once to pattern on the metal-working industries, where the great successes of the past two decades have been made possible by the pioneering spirit which adopted new equipment and methods as fast as these could be proved sound.

Comparison of Methods of Cleaning Blast-Furnace Gas*

By N. H. Gellert

THE value of clean blast-furnace gas as against dirty or raw gas for use in blast-furnace stoves or in boilers has been so well demonstrated as to cause the largest and most progressive steel companies to spend millions of dollars to install cleaners.

If the gas issuing from a blast furnace were a small item, overlooking its importance might be permissible, but the facts are these:

1. Forty-eight to 50 per cent of the thermal value of the coke charged into the blast furnace issues from it in the form of latent and sensible heat of combustible gases.

2. Thirty per cent of the gas generated is used for increasing the temperature of the blast.

3. Sixty per cent of the gas is used in boilers or engines for power.

*Abstracted from *Mechanical Engineering*, May, 1922.

TABLE I—AVAILABLE HEAT IN CLEAN AND DIRTY GAS

Kind of Gas	Dust Content, Grains Per Cu.Ft.	Moisture Content, Grains Per Cu.Ft.	Temp. of Gas, Deg. F.	Available Heat, Per Cent
Raw gas	3.0	35.0	400	77.03
Partly clean gas	...	saturated	125	74.33
Clean gas	0.2	7.98	70	79.51

TABLE II—PROPERTIES OF GASES

Name of Gas (1)	Specific Gravity (2)	Lb. Per Cu.Ft. at 29.92 in Hg At 32 Deg. F. (3)	Lb. Per Cu.Ft. at 29.92 in Hg At 62 Deg. F. (4)	Heating Value B.t.u. Per Lb. (5)	Heating Value B.t.u. Per Cu.Ft. At 32 Deg. F. (6)	Heating Value B.t.u. Per Cu.Ft. At 62 Deg. F. (7)	Air Required Lb. Per Gas (8)	Air Required Cu.Ft. Per Gas (9)	Oxygen Required Lb. Per Gas (10)	Oxygen Required Cu.Ft. Per Gas (11)	Cu.Ft. Gas Per Lb. At 32 Deg. F. (12)	Cu.Ft. Gas Per Lb. At 62 Deg. F. (13)
Carbon dioxide	1.5291	0.1234	0.1163								8.103	8.60
Carbon monoxide	0.9672	0.0781	0.0736	4,325	337.6	318.2	2.47	2.391	571	0.5	12.810	13.59
Hydrogen	0.0695	0.00561	0.00528	62,032	348.0	348.0	34.56	2.391	8.000	0.5	178.273	189.14
Oxygen	1.1054*	0.0892	0.0841								11.209	11.90
Nitrogen	0.9674*	0.0782†	0.0737								12.807	13.50
Air	1.0000	0.0807	0.0761								12.390	13.14
Aqueous vapor	0.6237	0.0503	0.0474								19.865	21.08
Methane	0.5545	0.0448	0.0422	23,513	1,053.4	992.2	17.28	9.564	4.000	2.0	22.324	23.70
Ethane	1.0496	0.0847	0.0799	22,230	1,882.9	1,776.1	16.13	16.737	3.733	3.5	11.807	12.51
Ethylene	0.9753	0.0787	0.0741	21,344	1,679.9	1,581.6	14.81	14.346	3.429	3.0	12.706	13.36
Acetylene	0.9056	0.0731	0.0688	18,196	1,330.1	1,251.9	13.29	11.955	3.077	2.5	13.680	14.63
Sulphur dioxide	2.2639	0.1826	0.1721								5.422	5.81
Sulphur				4,050			4.32		1.000			
Carbon				14,600			11.52		2.667			

* From Olsen's Manual. † Calculated. Columns 2 and 3, values from Liddell's Met. and Chem. Handbook; columns 4, 6, 7, 12, and 13, calculated; column 5, values from Poole's Calorific Power of Fuels; column 8, values from Babcock and Wilcox' Steam; columns 9, 10 and 11, from Pratt's Principles of Combustion

Consider for a moment what clean gas will do for hot stoves. At Duquesne tests were made on hot-stove operations using gas in three different conditions. The results obtained, as given in Table I, are at least interesting.

Dry Versus Wet Cleaning

Now if it is conceded, by force of common practice and such data as can be used for argument, that clean gas is to be preferred above dirty gas in stoves and boilers, there remains but one other question to be answered: Shall gas be cleaned by a wet process or a dry process?

Heat Value of Dry-Cleaned Gas.—Suppose we consider the operation of a 500-ton furnace here in the Birmingham district. If every ton of iron required 2,500 lb. of coke, the total coke tonnage per day will be 625 tons. If we take 48 per cent of this to be in the form of gas, then 301 tons must be used for fuel purposes outside of the furnace. Here is presented a possibility for control that should result in savings.

Now there will be about 170,000 cu.ft. of gas generated per ton of iron made. At a 500-ton furnace this would give 85,000,000 cu.ft. of gas per day, 3,540,000 cu.ft. of gas per hour, or 59,000 cu.ft. per minute, at 29.92 in. of mercury column pressure and 62 deg. F.

Assume the gas has a percentage analysis as follows: CO_2, 12.5; CO, 25.4; H_2, 3.5; N_2, 58.6. Assume also that the temperature of the gas in the mains is 400 deg. F. and the moisture at standard conditions is 35 grains per cu.ft.

The thermal value of the gas depends on (1) its latent heat of combustion and (2) its sensible heat; and if the products of combustion escape at, say, 600 deg. F., there will have to be subtracted from the total heat the sensible heat of the escaping products of combustion.

Latent Heat.—First consider the thermal value of the gas.

Table II, the author believes, is the first published attempt to assemble the data given from a number of sources so as to collect the most probable values of the constants involved. In addition values have been calculated to correspond to a temperature of 62 deg. F., the temperature at which most technical gas calculations are made.

By the aid of this table it now becomes a fairly simple task to develop the latent-heat value of the gas which is being considered.

We have available 59,000 cu.ft. of gas per minute at 62 deg. and 29.92 in. mercury column. Of this amount, 14,986 cu.ft. is carbon monoxide and 2,065 cu.ft. hydrogen. The hydrogen has a total latent-heat value of 676,100 B.t.u. and the carbon monoxide a total latent-heat value of 4,771,100 B.t.u., or for all the combustible elements, a total latent-heat value of 5,447,200 B.t.u. per minute. See Table III.

Since, however, the water vapor formed in the combustion of the hydrogen is not condensed in the products of combustion, the lower heat value, 52,920 B.t.u. per lb., should hold. There must therefore be subtracted the difference between these two values for the total latent heat, or (62,032 — 52,920 =) 9,112 × 10.9 = 99,320.8 B.t.u. must be deducted, making the net value of the latent heat 5,347,900 B.t.u.

TABLE III—LATENT HEAT OF COMBUSTION
(59,000 cu.ft. of blast-furnace gas per min.)

Constituent	Per Cent By Volume	Cu.ft. Per Min.	Weight Per Cu.Ft. at 62 Deg. F., Lb.	Total Wt., Lb.	Latent Heat in B.t.u. Per Cent By Weight	Latent Heat in B.t.u. Per Cu.Ft. at 62 Deg. F.	Latent Heat in B.t.u. Per Lb.	Latent Heat in B.t.u. Total
Carbon dioxide	12.5	7,375	0.1163	838.3	18.6	.....	.....	.....
Carbon monoxide	25.4	14,986	0.0736	1,103.2	24.6	318.2	4,325	4,771,100
Hydrogen	3.5	2,065	0.0053	10.9	0.2	328.0	62,032	676,100
Oxygen	0.0	0,000	0.0841	000	00	.....	.....	.....
Nitrogen	58.6	34,574	0.0737	2,548.3	56.6	.....	.....	.....
Total				4,500.7				5,447,200

Sensible Heat.—To this, however, must be added the value of the sensible heat of the gas. This may be determined from the formulas given in Table IV, which hold true for values of gases up to 2,000 deg. C. (3,600 deg. F.) in temperature.

TABLE IV—THERMAL CAPACITIES OF GASES PER POUND FOR TEMPERATURES UP TO 2,000 DEG. C. (3,600 DEG. F.)*

Gas	Pound-Calories	B.t.u.
Hydrogen	$3.370 + 0.0003t$	$3.370 + 0.00017t$
Nitrogen	$0.2405 + 0.0000214t$	$0.2405 + 0.0000119t$
Oxygen	$0.2104 + 0.0000187t$	$0.2104 + 0.0000104t$
Carbon dioxide	$0.19 + 0.00011t$	$0.19 + 0.00096t$
Carbon monoxide	$0.2405 + 0.0000214t$	$0.2405 + 0.0000119t$
Aqueous vapor	$0.42 + 0.000185t$	$0.42 + 0.000103t$

* Tabulated from data in Richards' Metallurgical Calculations.

We may approach our problem then in one of two ways:

1. We may find the mean specific heat of the gas between the limit $(0 — t_1)$, and also the mean specific

TABLE V—FORMULAS FOR SPECIFIC HEAT

Gas	B.t.u. Per Lb. Per Deg.
Hydrogen	$3.370 + 0.00017t$
Nitrogen and carbon monoxide	$0.2405 + 0.0000119t$
Oxygen	$0.2104 + 0.0000104t$
Aqueous vapor	$0.42 + 0.000103t$
Carbon dioxide	$0.19 + 0.00006t$

heat of the same gas between the limits (0 — t_2). From the total sensible heat found in the first instance we may subtract the total sensible heat in the second leaving us a net result. Or,

2. We may find the mean specific heat between the limits (t_1 — t_2) and use this direct to obtain our net sensible heat.

For ease in calculating specific heats the formulas in Table V may be used.

Take 500 lb. of carbon dioxide at 400 deg. F., to find its net sensible heat value if it enters a boiler when the air temperature is 70 deg. F. by the first method:

Specific heat of CO_2 (0°—400°) = 0.2140
Total sensible heat at 400 deg. F. = 0.2140 × 500 × 400
= 42,800 B.t.u.
Specific heat of CO_2 (0°—62°) = 0.1936
Total sensible heat at 62 deg. F. = 0.1936 × 500 × 62
= 6,002 B.t.u.
Net sensible heat (62°—400°) = 36,798 B.t.u.

Now calculating the specific heat of the gas at 400 deg. F., the following results are obtained:

	Mean Specific Heat in B.t.u. Per Deg. F. Per Lb.
Carbon dioxide	0.2140
Carbon monoxide	0.24526
Hydrogen	3.438
Nitrogen	0.24526
Aqueous vapor	0.4612

Let us see now how the values of the specific heats may be used in our calculations.

TABLE VI—DETERMINATION OF SENSIBLE HEAT OF BLAST-FURNACE GAS AT 400 DEG. F.

Given: 1. Total cu.ft. per min. at 62 deg. F. and 29.92 in. Hg dry basis = 59,000.
2. Moisture per cu.ft. dry basis (35 grains) = 0.005 lb.
3. Temperature of gas = 400 deg. F.
4. Percentage analysis, dry basis: CO_2, 12.50; CO, 25.40; H_2, 3.50; N, 58.60.

Constituent	Per Cent By Vol.	Cu.Ft. At 62 Deg. F.	Wt. Per Cu.Ft. At 62 Deg. F.	Wt., Lb.	Per Cent By Wt.	Specific Heat At 400 Deg. F.	B.t.u. Per Lb. At 400 Deg. F.	Total B.t.u.
CO_2...	12.5	7,375	0.1163	838.3	18.6	0.2140	85.6	71,750
CO....	25.4	14,986	0.0736	1,103.2	24.6	0.24526	98.1	108,220
H.....	3.5	2,065	0.0053	10.9	0.2	3.438	1,375.2	14,650
N.....	58.6	34,574	0.0737	2,548.3	56.6	0.24526	98.1	249,990
H_2O*...	....	.....	0.005†	295.0	.....	0.4612	184.5	54,430
Total	100.0	59,000		4,795.7	100.0	0.2414§	96.57‖	499,040

* Aqueous vapor.
† Per cubic foot on basis of dry gas.
§ Average calculated value mean specific heat dry blast-furnace gas of above analysis.
‖ Per cubic foot dry gas.

In Table VI we consider the weights of the components of the gas and the sensible heat they possess by reason of their specific heat at 400 deg. F., the temperature at which they are passed through the hot-stove and boiler burners for combustion.

This determination of sensible heat is based on values of specific heats between the limits 0 deg. and 400 deg. F. To get an exact value they should be based on limits: temperature of air and 400 deg. F. Since this temperature varies from day to day and season to season, no data developed would hold exactly true. For purposes of comparison the method of determination used should give just as accurate, if not more accurate, results than a method in which daily temperatures must be estimated.

TABLE VII—SENSIBLE HEAT OF BLAST-FURNACE GAS AT 62 DEG. F.

Constituent	Weight, Lb.	Sp. Ht. At 62 Deg. F.	B.t.u. Per Lb. At 62 Deg. F.	Total B.t.u.
Carbon dioxide.....	838.3	0.1937	12.0	10,100
Carbon monoxide.....	1,103.2	0.2412	14.9	16,460
Hydrogen.....	10.9	3.3805	209.6	2,380
Nitrogen.....	2,548.3	0.2412	14.9	37,970
Aqueous vapor.....	295.0	0.4264	25.4	7,480
Total	4,795.7	0.2505		74,390

Assume, however, that this average temperature is 62 deg. F. We can then compute the total sensible heat at limits 0 deg.—62 deg. F. as in Table VII, and this subtracted from the sensible heat at the limits 0 deg.—400 deg. F. gives:

Sensible heat of gas at 400 deg. F.
= 499,040 — 74,390
= 424,650 B.t.u. per min.

The total heat of the gas at 400 deg F. will therefore be:

(1) Net latent heat of combustion..5,347,900
(2) Sensible heat of gas..... 424,650

Total thermal value.....5,772,550 B.t.u. per min.

Combustion Products

Now in a previous table the most probable values have been used as obtained from a number of sources, while the air and oxygen required were obtained from a source in which air was taken to consist of 23.15 per cent by weight of oxygen and 76.85 per cent of nitrogen. Since, however, our data show oxygen to weigh 0.0841 lb. per cu.ft. at 62 deg. F., while nitrogen weighs 0.0737 lb. per cu.ft. at the same temperature, the proportional parts in a cubic foot of air will be as given in Table VIII.

TABLE VIII—AIR-OXYGEN RATIO

Gas	Per Cent By Weight	Wt. Per Cu.Ft.	Proportionate Volume	Per Cent By Volume	Air-Oxygen By Weight	Ratio By Volume
Oxygen....	23.15	0.0841	275	20.89	1.00	1.00
Nitrogen...	76.85	0.0737	1,043	79.11	3.32	3.79
Air.....	100.00	0.0761	1,318	100.00	4.32	4.79

If, therefore, gas be burned by the combination with air, there will be present in the products of combustion, in addition to the new compounds formed, inert nitrogen amounting to 3.32 times the weight of the oxygen combined with the burning gases.

The combustion products when burning carbon monoxide and hydrogen will be as given in Table IX.

TABLE IX—COMBUSTION DATA

Constituent	Symbol	Air Required Lb. Per Lb.	Cu.Ft. Per Cu.Ft.	Products of Combustion—Lb. Per Lb.—CO_2	H_2O	N_2	Cu.Ft. Per Cu.Ft.—CO_2	H_2O	N_2
Carbon monoxide	CO	2.47	2.391	1.58	....	1.89	1	..	1.891
Hydrogen.....	H_2	34.56	2.391	....	9.00	26.56	..	1	1.891

By developing the calculations further (see Table X) we find that when the gas is burned the total products of combustion are:

Carbon dioxide.....	2,581.3 lb. or 22,361 cu.ft.
Water.....	393.1 lb. or 8,289 cu.ft.
Nitrogen.....	4,922.7 lb. or 66,818 cu.ft.
Total products of combustion...	7,897.1 lb. or 97,468 cu.ft.

Sensible Heat of Combustion Products.—These escaping products of combustion take with them out of the stack and into the air a portion of the heat by virtue of their thermal capacities. To know what heat is available for useful work, the sensible heat of these products must be determined at a temperature of 600 deg. F. Using the formula in Table VI, we are able to obtain the following values bearing on this determination:

	Mean Specific Heat in B.t.u. Per Deg. F. Per Lb.
Carbon dioxide.....	0.2260
Aqueous vapor.....	0.4818
Nitrogen.....	0.24764

At 600 deg. each pound of product will have 600 times

TABLE X—PRODUCTS OF COMBUSTION OF BLAST-FURNACE GAS

(59,000 cu.ft. per min. at 62 Deg. F.)

Constituent	Symbol	Per Cent By Vol.	Per Cent By Wt.	Weight, Lb.	Volume in Cu.Ft. At 62 Deg. F.	Total Air Needed Lb.	Total Air Needed Cu.Ft.	Products of Combustion — Total Lb. CO_2	Total Lb. H_2O	Total Lb. N_2	Total Cu.Ft. At 62 Deg. F. CO_2	Total Cu.Ft. At 62 Deg. F. H_2O	Total Cu.Ft. At 62 Deg. F. N_2
Carbon dioxide	CO_2	12.5	18.6	838.3	7,375	.....	.....	838.3	.....	.....	7,375	.....	.....
Carbon monoxide	CO	25.4	24.6	1,103.2	14,986	2,724.8	35,832	1,743.0	..	2,084 9	14,986	..	28,339
Hydrogen	H_2	3.5	0.2	10.9	2,065	376.7	4,937	.....	98 1	289 5	.....	2,065	3,905
Nitrogen	N_2	58.6	56.6	2,548.3	34,574	.....	.....	.....	...	2,548 3	.....	...	34,574
Aqueous vapor	H_2O	.....	.....	295.0	.....	.....	.....	.....	295.0	..	..	6,224	....
Total		100.0	100.0	4,795.7	59,000	3,101.5	40,769	2,581.3	393.1	4,922 7	22,361	8,289	66,818

the thermal capacity here shown. The full analysis of the total thermal capacity of all the products can then be developed and this total sensible heat calculated to be 1,194,800 B.t.u., as shown in Table XI.

Here we must make the same corrections as made for the sensible heat of the gas. Our sensible-heat calculations for gases between the limits 0 deg. and 62 deg. F. are as given in Table XII and the net sensible heat of the products of combustion will be 1,194,800 — 114,380 = 1,080,420 B.t.u. per min. We then have:

TABLE XI—DETERMINATION OF SENSIBLE HEAT OF PRODUCTS OF COMBUSTION OF HOT GAS AT 600 DEG. F.

Constituent	Per Cent By Vol.*	Per Cent By Wt.*	Cu.Ft. At 62 Deg. F.	Total Weight, Lb.	Specific Heat At 600 Deg. F.	B.t.u. Per Lb. At 600 Deg. F.	Total B.t.u. Sensible Heat
Carbon dioxide	25.1	34.5	22,361	2,581.3	0.2260	135.60	350,020
Aqueous vapor.	.....	.....	8,289	393.1	0.4818	289.08	113,640
Nitrogen	74.9	65.5	66,818	4,922.7	0.2476	148.56	731,320
Total	100.0	100.0	97,468	7,897.1	0.2522		1,194,980

* Figured on a dry basis.

TABLE XII—SENSIBLE HEAT OF PRODUCTS OF COMBUSTION

Constituent	Weight, Lb.	Specific Heat at 62 Deg. F.	B.t.u. Per Lb. At 62 deg. F.	Total B.t.u.
Carbon dioxide	2,581.3	0.1937	12.0	31,000
Nitrogen	4,922.7	0.2412	14.9	73,400
Aqueous vapor	393.1	0.4264	25.4	9,980
Total	7,897.1	0.2341		114,380

Total value of the original gas for both latent and sensible heat	5,772,550 B.t.u.
Net sensible heat of the products of combustion	1,080,420 B.t.u.
Gross available B.t.u.	4,692,130 B.t.u.
Less 10 per cent lost because of original loss in gas	469,213 B.t.u.
Net available B.t.u. per minute	4,222,917 B.t.u.

Available Heat and Flame Temperature in Dry Cleaning

All these figures are based on the assumption that blast-furnace gas is delivered at 400 deg. F. to the burners of the hot stoves and boilers. This is, of course, what a dry-cleaning device would enable the operator to do. If, however, he is forced to clean his gas by a wet process there must necessarily be a reduction in temperature of the ingoing gas. This reduction in temperature, it is true, will reduce the moisture content of gas. Whether this reduction in moisture content is of any considerable value, or whether it can compensate for the losses in heat incident to the cooling of the gas, is something that might well be determined. To arrive at a conclusion approaching a semblance of accuracy, two things must be taken into account:

1. The comparison of the flame temperature of the burning gases.
2. The comparison of net available B.t.u. of the gas.

We have already started our study of the available B.t.u. of hot gas containing 35 grains of moisture per cubic foot at 62 deg. F. and 29.92 in. Hg.

Let us consider for a moment the theoretical flame temperature of this gas.

$$T = \frac{\text{B.t.u. produced}}{W \times S_m}$$

where T = the elevation in temperature;
W = weight of products of combustion, and
S_m = mean specific heat of products between temperature of fuel and air and that of products.

The exact value of S_m cannot be found until the value of T is known. For that reason a trial method of computation must be adopted.

The average temperature of the fuel and air will depend on the temperature at which each was delivered to the point of combustion. The gas was delivered at 400 deg. F.; the air at 62 deg. F., and the temperature of the mixture can be shown to be about 251 deg. This figure is interesting but not necessary to our calculations, as we already have the total thermal value of the gas before burning.

Proceeding now to the determination of flame temperature, let us assume 2,480 deg. F. as the correct value. Then, dividing the B.t.u. produced by the sensible heat per degree at 2,480 deg. F., as given in Table XIII,

$$T = \frac{5,772,500}{2,470} = 2,340$$

It is evident that this is the wrong temperature. Assuming 2,400 deg. as the flame temperature,

$$T = \frac{5,772,500}{2,446} = 2,360$$

Again, taking 2,380 deg.,

$$T = \frac{5,772,500}{2,440} = 2,370$$

For our purposes we may take the halfway point between 2,380 and 2,370, or 2,375 deg. F., as the correct flame temperature. Greater accuracy may of course be obtained by another trial.

TABLE XIII—SENSIBLE HEAT OF PRODUCTS OF COMBUSTION PER DEGREE

Constituent	Total Wt., Lb.	Sp. Ht. At 2,480 Deg. F.	Sensible Heat Per Deg.	Sp.Ht. At 2,400 Deg. F.	Sensible Heat Per Deg.	Sp. Ht. At 2,380 Deg. F.	Sensible Heat Per Deg.
Carbon dioxide	2,581.3	0.3388	875	0.3340	864	0.3328	860
Nitrogen	4,922.7	0.2700	1,330	0.2691	1,320	0.2688	1,320
Aqueous vapor	393.1	0.6754	265	0.6672	262	0.6651	260
Total		0.2138	2,470		2,446		2,440

Available Heat and Flame Temperature in Wet Cleaning

So far there have been determined for the gas which is considered as cleaned by a dry process:

1. A value for the available heat which has been found to be 4,222,917 B.t.u. per min. This is the net value after all losses are accounted for.
2. A value for the flame temperature which is 2,375 deg. F.

We now approach the discussion of these same values when the gas is wet cleaned. In this instance the gas will have the same analysis as before, but its temperature will be 70 deg. F. and its moisture content 7.98 grains per cu.ft. of dry gas at 62 deg. and 29.92 in Hg.

Latent Heat.—Its latent heat will be exactly as before, since the heat values of the combustible constituents of the gas have not changed. This gross latent-heat value was found to be 5,447,290 B.t.u. per min.

From this amount there was subtracted the difference between the gross and net value of the heat generated by the combustion of the hydrogen, since there was no condensation of the moisture in the products of combustion before escaping through the stock. In addition there was deducted a 10 per cent loss in gas itself.

With the deduction for the lower thermal value of hydrogen there was a net latent-heat value left of 5,347,900 B.t.u. This holds true with wet-cleaned gas also.

Sensible Heat.—When we consider the matter of sensible heat, however, we have some differences to take into consideration.

The mean specific heats of the component parts of the gas at 70 deg. F. as calculated by the formulas in Table V are as follows:

Carbon dioxide	0.1942
Carbon monoxide and nitrogen	0.2413
Hydrogen	3.3819
Aqueous vapor	0.4272

With these values and such other data as we have already obtained, we may develop a table similar to Table VII, giving a total of 77,620 B.t.u. per min. for the sensible heat of all the gases. The total heat of the 59,000 cu.ft. of gas per min., therefore, is 5,347,900 + 77,620 = 5,425,520 B.t.u. per minute.

Combustion Products.—Turning to the consideration of the products of combustion of this gas, we find that all the products will be the same excepting the moisture content which will be less by the difference between 295 lb. as found in gas containing 35 grains of moisture per cu.ft. and 67.3 lb. is found in gas containing only 7.98 grains per cu.ft. This difference is 227.7 lb. The products of combustion will therefore be:

Carbon dioxide	2,581.3 lb. or 22,361 cu.ft.
Aqueous vapor	165.4 lb. or 3,480 cu.ft.
Nitrogen	4,922.7 lb. or 66,818 cu.ft.
Total	7,669.4 lb. or 92,659 cu.ft.

These products must be assumed to escape at the same temperature as before in order to get a reasonably accurate comparison. If the stack temperature is 600 deg. F. as before, the specific heats of the products will be the same as before. The total sensible heat of each product will also be the same as before, excepting that of the aqueous vapor. In the previous calculation 393.1 lb. of aqueous vapor had a total sensible heat value of 113,640 B.t.u., or 289.08 B.t.u. per lb. Then 165.4 lb. of aqueous vapor will have a sensible-heat value of 47,814 B.t.u. and the total sensible heat of the combustion products will be: (CO_2, 350,020) + (N_2, 731,320) + (H_2O, 47,220) = 1,128,560 B.t.u. per min. From this total there must be subtracted the heat energy present at 62 deg. F.

This will be the same as before, excepting for the aqueous vapor. In the former case 393.1 lb. aqueous vapor had a heat energy of 9,980 B.t.u. per min. Then 165.4 lb. of aqueous vapor which we have to deal with in this latter case will have a heat energy at 62 deg. F. of 4,190 B.t.u. per min. and the total energy will be: (CO_2, 31,000) + (N_2, 73,400) + (H_2O, 4,190) = 108,590 B.t.u. per min.

The net sensible heat of the products will therefore be 1,128,560 — 108,590 = 1,019,970 B.t.u. per min.

It is now possible to determine our net available heat.

Latent and sensible heat of gas	5,425,520
Less net sensible heat of combustion products	1,019,970
Gross available B.t.u.	4,405,550
Ten per cent gas loss	440,555
Net available B.t.u. per min.	3,964,995

Savings.—We have already found that the net available B.t.u. per min. when burning hot gas with 35 grains of moisture per cu.ft. = 4,222,917, and now we have the net available B.t.u. per min. when burning cold gas with 7.98 grains of moisture per cu.ft. = 3,964,995, giving a difference in favor of hot gas of 257,922 B.t.u. per min. or 371,407,680 B.t.u. per day saving in using hot gas over wet-cleaned gas.

On the basis of 500 tons per day the saving will amount to 371,401,680 ÷ 500 = 742,820 B.t.u. per ton. Now Birmingham coke contains about 14,290 B.t.u. per lb. on a dry basis. This would mean that 742,820 ÷ 14,290 = 52.0 lb. of coke is saved per ton of iron made. It is not unfair to take $6 per ton as the price of coke charged into the furnace. Then the saving in the use of hot gas will be (52 ÷ 2,000) × $6 = $0.156 per ton of iron made for coke alone.

Flame Temperature.—We have now to consider the flame temperature of this wet washed gas and with this consideration we are through with our discussion as to heat values. Let us assume the flame temperature to have a value between 2,000 and 2,400 deg. F. See Table XIV.

TABLE XIV—FLAME-TEMPERATURE CALCULATIONS

Constituent	Total Lb.	Sp. Ht. 2,000 Deg. F.	B.t.u. Per Deg.	Sp. Ht. 2,200 Deg. F	B.t.u. Per Deg.	Sp. Ht. 2,400 Deg. F	B.t.u. Per Deg.	Sp. Ht. 2,380 Deg. F	B.t.u. Per Deg.
Carbon dioxide	2,581.3	0.3100	800	0.3112	805	0.3340	860	0.3328	860
Nitrogen	4,922.7	0.2643	1,300	0.2667	1,315	0.2691	1,320	0.2688	1,320
Aqueous vapor	165.4	0.6260	100	0.6466	105	0.6672	110	0.6651	110
Total			2,200		2,225		2,290		2,290

Dividing 5,425,520 respectively by the values 2,200, 2,225 and 2,290 from that table gives 2,460, 2,450 and 2,370 deg. F., and we may therefore accept the flame temperature at 2,375 deg. F., the mean between 2,370 and 2,380 deg. F.

Curiously enough, the flame temperatures of the dry-cleaned and wet-cleaned gases as discussed thus far are the same. Practical experience bears this out also, as Diehl's observations indicate that during reasonable test periods the combustion chamber temperatures are 2,040 deg. F. on wet-cleaned gas and 2,030 deg. on hot raw gas. If the latter had been cleaned, our calculations show it would have had as high a temperature as wet-cleaned gas.

Our discussion on heat values of gas may therefore be summed up as follows:

1. Dry-cleaned gas at 400 deg. F., even if it contains 35 grains of moisture per cu.ft., has a greater available heat value than wet-cleaned gas at 70 deg. F. and 7.98 grains moisture per cu.ft. This heat is 6.5 per cent greater for the former gas than for the latter. At $6 per ton for coke charged into the furnace it means a saving of $0.156 per ton of iron made, in favor of using hot-cleaned gas.

2. There is no difference in flame temperature between the two gases.

Fuel Oil Viscosimeters

By Winslow H. Herschel
Petroleum Technologist, U. S. Bureau of Standards

IT WAS formerly common practice to base fuel-oil specifications upon gravity, but since investigations by the U. S. Bureau of Mines[1] proved that this was not a reliable index of the actual quality of the oil, present government specifications[2] are based upon the viscosity.

The viscosity of fuel oils is often so high that it cannot be measured with the Saybolt Universal viscosimeter or other instruments intended primarily for lubricating oils. The standard instrument for testing fuel oils in England is the Redwood Admiralty or No. 2 viscosimeter, or "viscometer," which is expensive and difficult to obtain in the United States. There appeared, therefore,

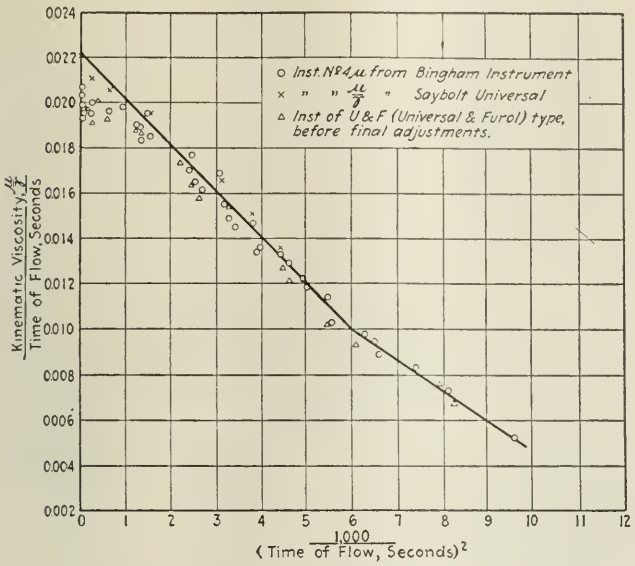
o Inst. N°4 μ from Bingham Instrument
× " " $\frac{\mu}{\rho}$ " Saybolt Universal
△ Inst of U&F (Universal & Furol) type, before final adjustments.
Kinematic Viscosity $\frac{\mu}{\rho}$ = Time of Flow, Seconds
$\frac{1,000}{(\text{Time of Flow, Seconds})^2}$

FIG. 1—HIGGINS DIAGRAM FOR SAYBOLT FUROL VISCOSIMETER

to be need of an American-made instrument to serve a similar purpose, and the Saybolt Furol viscosimeter was developed by George M. Saybolt in the spring of 1920 at the suggestion and with the co-operation of the Bureau of Mines.

The following paper will give an account of the standardization and calibration of this new type of viscosimeter as well as the calibration of the Redwood Admiralty type of instrument.

Saybolt Furol Viscosimeter

Saybolt Furol viscosimeter tube No. 4, submitted by George M. Saybolt, was measured at the Bureau of Standards, and on the basis of these measurements the standard dimensions of Table I were suggested to Mr. Saybolt by the bureau and accepted by him. The table also contains the dimensions of tube No. 4.

It will be seen that the standard dimensions are the same as for the Saybolt Universal viscosimeter[3] except d and d_3.

The shorter and larger the diameter of the outlet tube the greater must be the viscosity of the calibrating liquid, and while water could be used for the Ubbelohde

TABLE I—DIMENSIONS OF SAYBOLT FUROL VISCOSIMETERS

Dimension*	Standard — Normal, in Centimeters	Tolerance, in Centimeters	No. 4, in Centimeters
Diameter of outlet tube, d	0 315	±0 002	0 3153
Length of outlet tube, l	1 225	±0 01	1 233
Outer diameter of outlet tube, at lower end, d_3	0 43	±0 03	0 41
Height of overflow rim above bottom of outlet tube, h_1	12 50	±0 1	12 571
Diameter of container, D	2 975	±0 02	2 981
Average head, h (calculated)	7 36	±0 2	7 46

* The normal dimensions are exact figures set up by convention. A dimension may be said to be standard when it comes within the permissible tolerance from the normal.

viscosimeter, and ethyl alcohol solutions were made to suffice for the Engler and Saybolt Universal, it was necessary in the present case to use oils whose viscosity had been determined by the Bingham viscometer.[4]

Figs. 1 and 2 show calibration diagrams obtained by the usual methods.[5] Points near the left side of the diagrams are inaccurate on account of the drainage error of the Bingham instrument, and were disregarded in drawing the calibration lines which represent the equation

$$\text{kinematic viscosity} = 0.0222t - \frac{2.02}{t} \qquad (1)$$

The bend in Fig. 1 shows that this equation does not apply when the time of flow is less than 13 seconds or when Reynolds' criterion is greater than 139. It should be noted that the value of Reynolds' criterion at the critical velocity decreases as $\frac{l}{d}$ decreases and that this ratio has a value of only 3.9 for this instrument. Fig. 1 also shows tests with an instrument of the U. & F. (Universal and Furol) type[6], before it had been adjusted to normal dimensions.

Equation 1 does not strictly apply to an instrument of normal dimensions, but such an equation may be obtained by using values of the Couette correction and the coefficient of the kinetic energy correction the same as found from Fig. 2. Thus with the former equal to

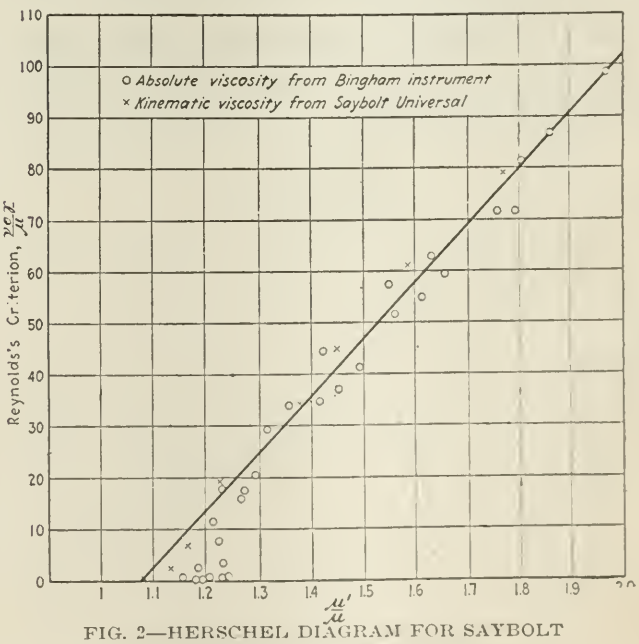
o Absolute viscosity from Bingham instrument
× Kinematic viscosity from Saybolt Universal
Reynolds's Criterion, $\frac{vDp}{\mu}$
$\frac{\mu'}{\mu}$

FIG. 2—HERSCHEL DIAGRAM FOR SAYBOLT FUROL VISCOSIMETER

Published by permission of the Director, U. S. Bureau of Standards.

[1] E. W. Dean, Reports of Investigations, Serial 2215 (February, 1921).

[2] Tech. Paper 305, Bureau of Mines, "Specifications for Petroleum Products Adopted by the Interdepartmental Petroleum Specifications Committee, p. 9 (1922).

[3] Winslow H. Herschel, Bureau of Standards Technologic Paper 112, p. 7 (1919); A.S.T.M. Standards adopted in 1920, p. 105: *Proc.*, A.S.T.M., vol. 21, p. 642 (1921).

[4] E. C. Bingham and R. F. Jackson, Bureau of Standards Scientific Paper 298 (1917). E. C. Bingham, *Proc.*, A.S.T.M., vol. 18, part 2, p. 374 (1918).

[5] Winslow H. Herschel, Bureau of Standards Technologic Papers 100, 112, 125; *Proc.*, A.S.T.M., vol. 17, part 2, p. 551; (1917). *Proc.*, A.S.T.M., vol. 18, part 2, p. 364; (1918). *Proc.*, A.S.T.M., vol. 19, part 2, p. 676; (1919).

[6] As made by the American Instrument Co., Washington, D. C.

0.311d and the latter equal to 1.128, it may be calculated from the dimensions of Table I that for an instrument of normal or average standard dimensions,

$$\text{kinematic viscosity} = 0.0220t - \frac{2.03}{t} \qquad (2)$$

Redwood Admiralty Viscometer

The Admiralty instrument is described by Redwood as follows:[7]

> The author has devised a modified form of his viscometer, which, with the authority of the Admiralty, will be known as the Admiralty type, for testing oil fuel. This instrument, as its name indicates, has been specially constructed for use in determining the viscosity of oil fuel for contract purposes, and is intended to be employed at a temperature of 32 deg. F. (0 deg. C.). The oil vessel is of the same dimensions as that of the original instrument, but the agate jet is longer and of larger bore, the new viscometer being designed to give an outflow in one-tenth of the time occupied in the outflow of a similar volume from the original pattern. The jet is so mounted as to be surrounded completely by the water in the bath. The water bath, which is of comparatively large size and is jacketed, has no lateral heating tube, but is provided with the usual rotating stirrer. . . . The oil to be tested should be subjected to prolonged cooling at 32 deg. F. by being kept in a refrigerator through the night or for at least 6 hours immediately before being placed in the oil cup, and should be thoroughly stirred before being transferred. When accurate results are desired, the viscometer should be placed in a refrigerating chamber, the temperature of which is maintained at 32 deg. F.

It will be seen that this instrument is inconvenient to operate and entirely unsuited for tests at 122 deg. F. (50 deg. C.), the standard temperature for fuel oils adopted by the American Society for Testing Materials.

Higgins[8] gives equations for the two types of Redwood instrument which indicate that the time ratio is 9.63, while the value indicated by the equations determined at the bureau is 9.20. It would therefore appear that Redwood's value of 10 is only approximate.

Dimensions of two instruments are given in Table II, but no published data have been found to give the standard length and diameter of the outlet tube.

The Bureau of Mines instrument was used in the following tests except in the case of five oils tested by the Standard Oil Company of California on its Redwood Admiralty instrument. The kinematic viscosity of all oils was determined at the Bureau of Standards by the Bingham viscometer.

Figs. 3 and 4 show calibration graphs corresponding to Figs. 1 and 2 for the Furol instrument. They indicate the equation

$$\text{kinematic viscosity} = 0.0239t - \frac{0.403}{t} \qquad (3)$$

and the bend in Fig. 3 locates the critical velocity at which the time of flow is 5 seconds and Reynolds' criterion is 830. This increase in value of Reynolds' criterion, as compared with the Furol instrument, is due to the longer outlet tube of the Admiralty viscometer, which is 13.2 diameters in length.

According to Dean, Furol time equals 1.17 Admiralty time, but he does not show how this value varies with the viscosity. Higgins' equation for the Admiralty instrument, when reduced to c.g.s. units, gives

$$\text{kinematic viscosity} = 0.027t - \frac{12}{t} \qquad (4)$$

while the Kinney Manufacturing Co.[9] give this as

$$\text{kinematic viscosity} = 0.027t - \frac{20}{t} \qquad (5)$$

in accordance with a private communication received from the National Physical Laboratory. It does not seem probable that the difference between these results and equation 3 was due to a difference in dimensions of instruments, and equations 4 and 5 disagree also both with each other and with diagram of McCoull.[10]

[7] B. Redwood, "A Treatise on Petroleum," vol. 2, p. 277 (1913).
[8] W. F. Higgins, Collected Researches, National Physical Laboratory, vol. 13, p. 265 (1916).

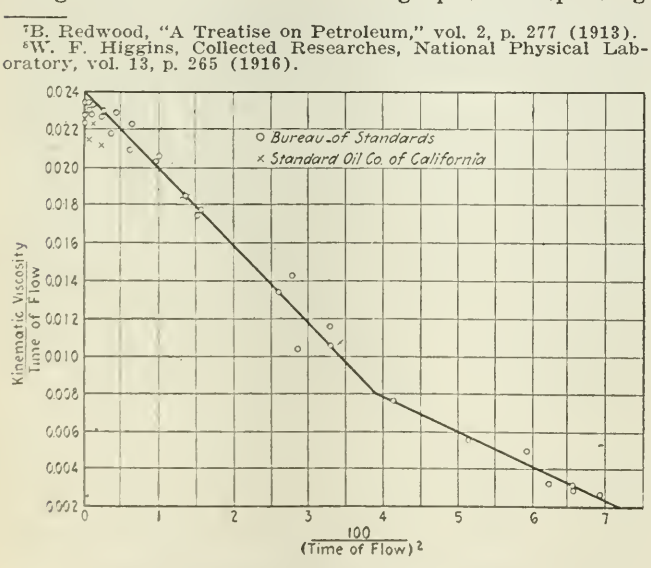

FIG. 3—HIGGINS DIAGRAM FOR REDWOOD ADMIRALTY VISCOMETER

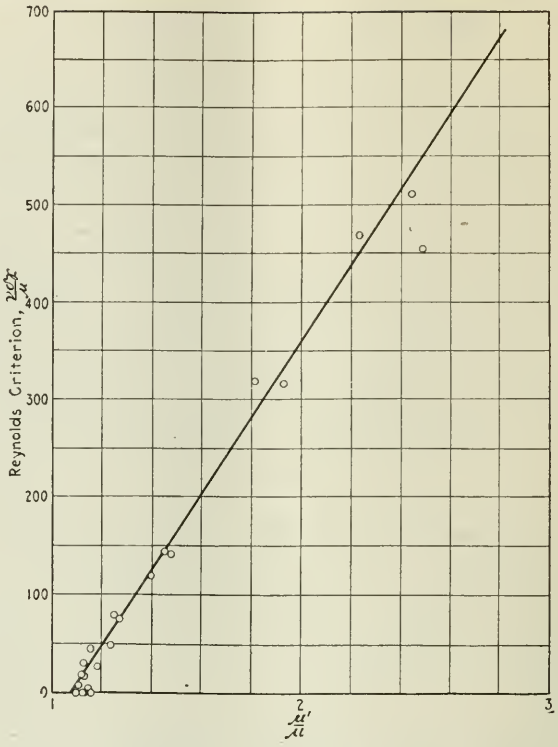

FIG. 4—HERSCHEL DIAGRAM FOR REDWOOD ADMIRALTY VISCOMETER

TABLE II—DIMENSIONS OF TWO REDWOOD ADMIRALTY VISCOMETERS

Dimension	Std. Oil Co., Cal.,* In Centimeters	Bureau of Mines,† No. 149, In Centimeters
Diameter of outlet tube, d	0.404	0.3896
Length of outlet tube, l	5.08	5.127
Height of gage point above bottom of outlet tube, h_1	13.36	13.457
Diameter of container, D	4.68	4.708
Average head, h (calculated)	.....	11.93

* Dimensions furnished by R. G. Smith.
† Measurements by Bureau of Standards of instrument loaned by E. W. Dean.

[9] "Friction Pressure Loss in Oil Pipe Lines" (1920).
[10] N. McCoull, "Lubrication," published by the Texas Co., vol. 7, p. 6 (May, 1921).

TABLE III—VISCOSIMETER CONVERSIONS

Multiplying Factors to Change Saybolt Universal Time to Furol or Redwood Admiralty Time

Saybolt Universal Time, Sec.	Kinematic Viscosity*	Time Ratio, Furol-Universal	Saybolt Universal Time, Sec.	Kinematic Viscosity*	Time Ratio, Admiralty-Universal
70	0.1283	0.1850	38	0.0362	0.1300
75	0.1410	0.1778	40	0.0430	0.1275
80	0.1535	0.1713	42	0.0495	0.1254
85	0.1658	0.1658	44	0.0559	0.1236
90	0.1780	0.1606	46	0.0621	0.1219
95	0.1901	0.1563			
100	0.2020	0.1524	48	0.0681	0.1204
110	0.2256	0.1456	50	0.0740	0.1185
120	0.2490	0.1399	52	0.0798	0.1172
130	0.2722	0.1354	54	0.0855	0.1160
140	0.2951	0.1314	56	0.0911	0.1148
160	0.3408	0.1256	58	0.0966	0.1138
180	0.3860	0.1211	60	0.1020	0.1128
200	0.4310	0.1174	62	0.1074	0.1117
225	0.4870	0.1142	64	0.1127	0.1109
250	0.5428	0.1118	66	0.1179	0.1098
300	0.6540	0.1084	68	0.1231	0.1094
350	0.7649	0.1063	70	0.1283	0.1084
400	0.8755	0.1048	75	0.1410	0.1068
450	0.9860	0.1040	80	0.1535	0.1054
500	1.096	0.1032	85	0.1658	0.1042
550	1.207	0.1027	90	0.1780	0.1032
600	1.317	0.1023	95	0.1901	0.1020
650	1.427	0.1019	100	0.2020	0.1012
700	1.537	0.1015	125	0.2606	0.0983
800	1.758	0.1013	150	0.3180	0.0965
900	1.978	0.1011	175	0.3747	0.0954
1,000	2.198	0.1007	200	0.4310	0.0946
1,500	3.299	0.1002	250	0.5428	0.0938
2,000	4.399	0.1000	300	0.6540	0.0933
....	.....	.....	400	0.8755	0.0928
....	.....	.....	500	1.096	0.0925
....	.....	.....	750	1.648	0.0923
....	.....	.....	1,000	2.198	0.0922
....	.....	.....	1,500	3.299	0.0921

* From Winslow H. Herschel and E. W. Dean, Reports of Investigations, Bureau of Mines, Serial 2201, p. 11, January, 1921.

TABLE IV—VISCOSIMETER CONVERSIONS

Multiplying Factors to Change Saybolt Furol to Saybolt Universal or Redwood Admiralty Time

Saybolt Furol Time, Sec.	Kinematic Viscosity	Time Ratio, Universal-Furol	Time Ratio, Admiralty-Furol
13	0.1298	5.46	0.586
14	0.1631	6.00	0.628
15	0.1947	6.44	0.658
16	0.2252	6.85	0.685
17	0.2547	7.18	0.709
18	0.2833	7.49	0.730
19	0.3112	7.73	0.748
20	0.3386	7.94	0.763
22	0.3917	8.30	0.789
24	0.4433	8.58	0.810
26	0.4939	8.79	0.826
28	0.5435	8.95	0.839
30	0.5923	9.08	0.850
32	0.6405	9.19	0.858
34	0.6883	9.28	0.865
36	0.7356	9.37	0.872
38	0.7826	9.43	0.877
40	0.8292	9.49	0.881
45	0.9449	9.60	0.888
50	1.059	9.68	0.894
55	1.173	9.74	0.898
60	1.286	9.77	0.902
65	1.399	9.81	0.905
70	1.511	9.84	0.908
75	1.623	9.86	0.910
80	1.735	9.89	0.911
85	1.846	9.90	0.912
90	1.957	9.92	0.913
95	2.069	9.93	0.915
100	2.180	9.94	0.915
150	3.287	9.99	0.921
200	4.390	10.00	0.921

Further doubt is thrown upon equations 4 and 5 by the fact that they cannot be calculated from the dimensions of Table II with any reasonable values of the Couette correction and the coefficient of the kinetic energy correction, for which the values $1.05d$ and 1.123 respectively were obtained and used in calculating equation 3. The large value of $1.05d$, as compared with $0.311d$ for the Furol instrument, may be due to increased surface tension, since the outlet tube of the Admiralty instrument is convex at the bottom and not closely restricted in outer diameter d_3 as is the Furol.

In a pamphlet entitled "Oil Flow in Pipe Lines," by R. S. Danforth of the Kinney Manufacturing Co., published in 1921, he made use of approximate equations which were the best available in May, 1921. These were:

TABLE V—VISCOSIMETER CONVERSIONS

Multiplying Factors to Change Redwood Admiralty Time to Saybolt Universal or Saybolt Furol Time

Redwood Admiralty Time, Sec.	Kinematic Viscosity	Time Ratio, Universal-Admiralty	Time Ratio, Furol-Admiralty
5	0.0389	7.77	...
6	0.0762	8.50	.....
7	0.1097	8.99	
8	0.1408	9.35	1.660
9	0.1703	9.63	1.585
10	0.1987	9.86	1.516
11	0.2263	10.03	1.462
12	0.2532	10.16	1.417
13	0.2797	10.25	1.377
14	0.3058	10.33	1.342
15	0.3316	10.39	1.316
16	0.3572	10.45	1.293
17	0.3826	10.49	1.272
18	0.4078	10.53	1.255
19	0.4329	10.57	1.242
20	0.4578	10.59	1.227
22	0.5075	10.64	1.205
24	0.5568	10.67	1.188
26	0.6059	10.70	1.175
28	0.6548	10.72	1.162
30	0.7036	10.74	1.153
35	0.8250	10.76	1.136
40	0.9459	10.78	1.125
45	1.067	10.80	1.117
50	1.187	10.81	1.112
55	1.307	10.82	1.107
60	1.427	10.83	1.103
65	1.547	10.83	1.100
70	1.667	10.84	1.098
80	1.907	10.85	1.094
90	2.147	10.85	1.092
100	2.386	10.86	1.090
150	3.582	10.86	1.086

$$\text{For the Furol, kinematic viscosity} = 0.0218t - \frac{1.72}{t} \quad (6)$$

For the Admiralty,

$$\text{kinematic viscosity} = 0.023t - \frac{0.36}{t} \quad (7)$$

These agree fairly well with equations 2 and 3.

Conversion Tables

According to the rule adopted by the American Society for Testing Materials, the Saybolt Universal is to be used instead of the Furol instrument for time of flow less than 25 seconds on the latter and not less than 32 seconds on the former instrument. It is therefore important to be able to make conversions between these two instruments, as well as with the Redwood Admiralty. Tables III to V have been calculated for this purpose from equations 2, 3 and

$$\text{kinematic viscosity} = 0.00220t - \frac{1.80}{t} \quad (8)$$

equation 8 being for the Saybolt Universal viscosimeter. The multiplying factors given in the last line hold good for all higher viscosities. Conversion factors for use with lower viscosities than given in the tables should not be obtained by extrapolation.

Conclusions

(1) The most probable equations for the Saybolt Furol and Redwood Admiralty viscosimeters are

$$\text{kinematic viscosity} = 0.0220t - \frac{2.03}{t} \quad \text{(Furol)}$$

$$\text{kinematic viscosity} = 0.0239t - \frac{0.403}{t} \quad \text{(Admiralty)}$$

where t is the time of flow in seconds and kinematic viscosity is expressed in c.g.s. units.

(2) These equations and the equation for the Saybolt Universal viscosimeter

$$\text{kinematic viscosity} = 0.00220t - \frac{1.80}{t}$$

have been used to calculate tables for making conversions between the three instruments.

Petroleum Laboratory,
U. S. Bureau of Standards,
Washington, D. C.

Söderberg Self-Baking Continuous Electrodes

Outline of Process of Manufacture of Continuous Electrodes at Furnace—Installations in Various Types of Furnaces: Ferro-Alloy; Carbide; Steel; Electric Pig Iron—Advantages Over Ordinary Carbon Electrodes—Cost Comparisons—Probable Trend of Future Developments

By C. W. SÖDERBERG and M. SEM
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THE Söderberg self-baking electrode is a continuous electrode, which is built, baked and renewed right in the furnace where it is being used. It is an everlasting electrode, which once installed in a furnace will continue to work without change year after year through the whole lifetime of the furnace.

Manufacture of the Electrode

The principal way of making the electrode is shown in Fig. 1. The electrode consists of a casing of small-gage sheet metal (usually iron) into which ordinary electrode mixture is tamped. The casing serves to give the electrode the right shape while tamping, to reinforce the unbaked part and to help carry the current from the electrode holder to the baked part of the electrode. It further serves to protect the electrode against air corrosion. In order to give the casing a sufficiently good mechanical and electrical contact with the electrode carbon it is given a rather peculiar shape, which is shown in Fig. 2. As will be seen, the casing is provided with ribs extending radially into the electrode. The electrode is suspended in the furnace by means of an electrode holder, which is constructed as a clasp holder that can easily be moved along the electrode. The electrode is very long, and its upper part is surrounded by a tamping platform or a closed tamping house, where the lengthening of the casing and the tamping in of new electrode mixture may be carried out as often as necessary, without the workmen being exposed to the heat from the furnace. The tamping is usually done by pneumatic rammers.

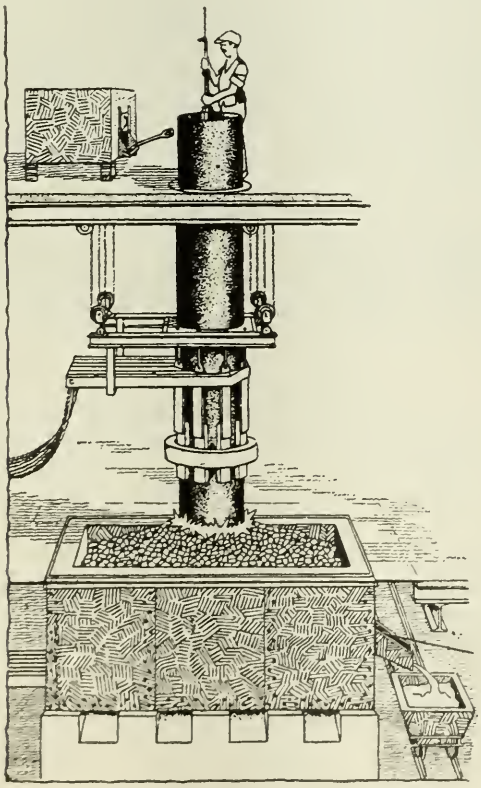


FIG. 1—METHOD OF MAKING SÖDERBERG ELECTRODES

The lower end of the electrode is placed in the smelting furnace, where it is baked by means of the heat from the furnace crater and by heat developed in the electrode itself through the electric current. The electrode will therefore consist of a lower (or internal) fully baked part, and an upper (or external) raw and unbaked part. The electrode holder is ordinarily placed on the lower baked part of the electrode, but may be placed anywhere if the cross-section of the iron casing is sufficient to conduct the current from the holder to the baked part of the electrode. When the holder is placed on the baked part of the electrode, the iron casing commonly used will average about 5 per cent of the weight of the baked carbon, the thickness of the iron in the casing being B.G. gage 22 to 16. Moving the electrode in the holder is done by simply loosening 3 or 4 screws on the holder until the electrode will gradually sink by its own weight. When the electrode has sunk sufficiently (usually 10 to 30 cm.), the screws are tightened. This operation is carried out at full current load, with no interruption in the working of the electrode, the current load being always maintained by means of the sliding contact between the electrode holder and the electrode.

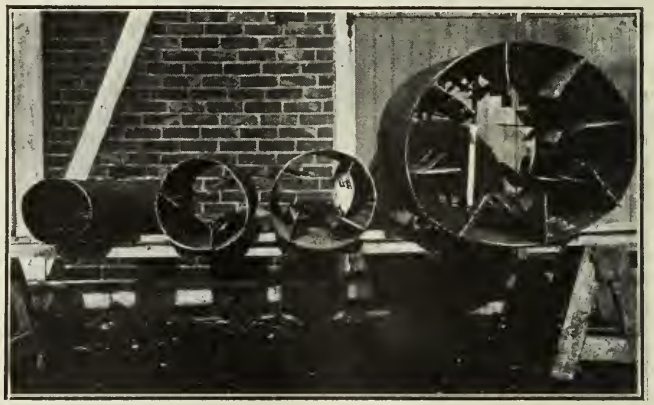


FIG. 2—CONSTRUCTION OF CASINGS

Joints Eliminated

When the electrode begins to get too short, a new section of iron casing is welded to its upper end and warm electrode mixture is tamped in. The old mixture

is still soft and will mix completely with the new mixture, making the electrode absolutely uniform and with no joints. Taking into consideration the fact that the joint is always a weak part of the ordinary threaded electrodes, it will be obvious that the Söderberg electrode has a great advantage over ordinary electrodes in this respect.

As in all open furnaces, the electrode holder is well water-cooled, and is suspended in a frame that may be moved up and down by means of a winch and regulated either automatically or by hand.

First Installation

The first furnace to use a Söderberg electrode was a ferrosilicon furnace which was put in operation by the A/S. Fiskaa Verk per Kristianssand S., Norway, in November, 1918. This first electrode was 600 mm. in diameter. In July, 1919, it was replaced by a 850-mm. electrode, and this electrode has been working continuously ever since without a single shutdown due to the electrode and without any electrode breakage—results which have hitherto been unobtainable. Electrode consumption is considerably reduced, and air corrosion is eliminated to a very great extent, due to the good protection afforded by the iron casing and the electrode holder. The baked electrode is equal in quality to the best ordinary electrodes. The cost of manufacture is relatively very low.

In May, 1921, a second electrode (rectangular, 1,150 x 500 mm.) was placed in the furnace. The furnace load was raised to about 2,000 kva. This rectangular electrode has also worked very well, with about the same efficiency and electrode consumption as the round electrode. Both electrodes are shown in Fig. 3. The furnace operates on three-phase current, Scott-connected.

Space does not permit consideration at the present

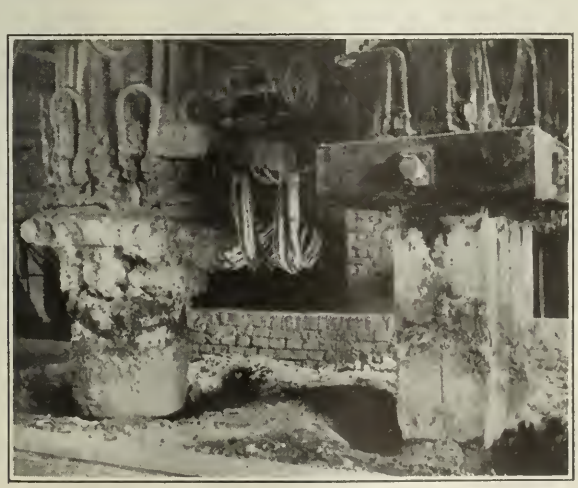


FIG. 3—FIRST INSTALLATIONS AT FISKAA VERK

time of many important and interesting details in connection with the manufacture and operation of the Söderberg electrode.[1]

Properties of the Electrodes

As mentioned above, the lower part of the electrode is perfectly baked when in use. The electrode works exactly as an ordinary carbon electrode, and needs no special attention of any kind. It looks like and has the properties of ordinary electrodes and differs in no way from them either with regard to specific gravity, electrical conductivity or mechanical strength. Common Söderberg electrodes show thus:

Specific gravity, about	1.5
Electric resistance, ohms per cu.cm.	0.007
Crushing strength:	
Kg. per sq.cm.	150
Lb. per sq.in.	2,200

The electric resistance given above is that of the cooled, baked electrode carbon. Due to the good conductivity of the iron casing, the total conductivity of the bake part of the electrode is still better than

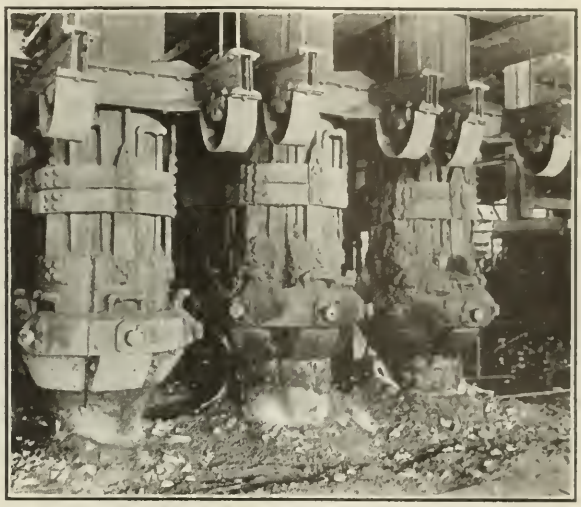


FIG. 4—ELECTRODES AT SOUTHERN MANGANESE CORP. PLANT

this figure indicates. The electric resistance of the hot electrodes (1,000 to 2,000 deg. C.) is about 0.003 ohm per cu.cm. It is therefore possible to operate the self-baking electrodes at a higher current density than ordinary electrodes, and it is further possible to regulate the electrical conductivity to a great extent by the weight of the iron casing in relation to the weight of the baked electrode carbon. In November, 1920, a 400-mm. rectangular electrode was operated continuously at a current density of 10 amp. per sq.cm. At intervals the current load was increased for a short period up to 18 amp. per sq.cm.

Due to the good electrical conductivity of the electrode and the short distance from the holder to the lower end of same, the voltage drop in the electrode is relatively low. At Fiskaa it is ordinarily between 1.3 and 1.9 volts. The heat loss in the cooling water is between 5 and 7 per cent of energy consumed in the furnace.

Other Installations

Söderberg electrodes have since been installed in furnaces all over the world. The first installation outside of Fiskaa was in a 300-kw. furnace for smelting nickel matte at Kristianssands Nikkelraffineringsverk, Kristianssand S., Norway.

Then followed an installation in a 1,800-kw. three-phase ferromanganese furnace at the Southern Manganese Corporation, Anniston, Ala. This furnace (Fig. 4), which was put in operation in July, 1920, for the manufacture of ferromanganese from Caucasian ore, was described by Prof. J. W. Richards in *Trans.*, Am. Electrochem. Soc., 1920, p. 351.[2]

[1] A detailed description may be found in *Teknisk Ukeblad*, Christiania, 1920, No. 25. See further J. W. Richards, *Trans.*, Am. Electrochem. Soc., 1920, p. 169.

[2] See also F. W. Andreae, *Schweizerische Bauzeitung*, 1921, p. 120.

About Sept. 6, 1920, an installation at A/S. Arendal Smelteverk, Eydehavn, Norway, was put in operation. The installation consists of two electrodes each 950 mm. in diameter in a two-phase 4,000-kw. furnace with two furnace craters. The furnace is running on ferrosilicon (50 and 75 per cent Si). In this furnace also the electrodes proved to be very much superior to ordinary electrodes in regard to both electrode consumption and furnace output. The consumption of Söderberg electrodes is about one-half that of ordinary electrodes, working on the same alloy in the same furnace. The direct savings obtained are so important that the total cost of the installation will be saved by less than one year's continuous running.

While the electrodes in the Arendal plant are 40 per

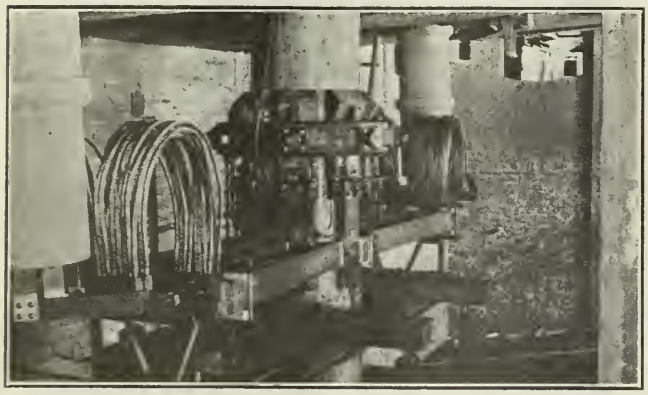


FIG. 5—GULLSPANG CARBIDE FURNACE

cent greater in cross-section than the largest ordinary single electrodes, there is no doubt that electrodes of still larger size can be made.

Application to Calcium Carbide Furnaces

Calcium carbide furnaces are also using Söderberg electrodes with excellent results. Fig. 5 shows the installation of a 850-mm. (34-in.) electrode in a 1,400-kw. carbide furnace at Gullspang, Sweden. The latest installation is in a 6,000-kw., three-phase carbide furnace in the Knapsack plant of the A/G. für Stickstoffdünger at Cologne, Germany. This furnace (Fig. 6) is provided with three 950-mm. (39-in.) electrodes, and was put in operation in August, 1921.

The electrodes are about 7 meters long, and the upper ends are surrounded by a tamping house with its floor 4.5 meters above the platform of the furnace. The house is built of reinforced concrete, and is completely closed except for a long passage leading to the outer air. Fresh air is provided through a ventilator. In order to be able to regulate the temperature in the tamping house, the concrete floor is reinforced by iron tubes for water-cooling. The temperature in the tamping house is always lower than in the smelting house.

The average results of three months' running show a reduction in the electrode consumption of about one-third. At the same time the output of the furnace per kilowatt-hour was raised considerably. At present the whole plant, consisting of nine furnaces each, rated at about 6,000 kw., is to be provided with Söderberg electrodes, and some of the furnaces are already being rebuilt.

It may be of interest to note that some carbide producers have referred to the fact that part of the iron from the iron casing of the electrode will pass into the carbide and reduce the quality of the product. This may at first glance seem to be a strong objection. However, a calculation shows that only 0.1 to 0.2 per cent of iron can be transferred to the carbide from this source, while ordinary carbide always contains about ten times as much iron. The amount in question is thus of no importance whatever.

Besides the installations described, Söderberg electrodes are at present installed or in course of installation in ferro-alloy and carbide furnaces in Sweden, Italy, France, Germany and South Africa.

Use in Electric Steel Furnaces

Also in closed furnaces the new electrodes have been tested and brought in permanent industrial use. In September, 1920, a 500-mm. (20-in.) Söderberg electrode was installed in a 7-ton Heroult steel furnace of the Stavanger Electro-Staalverk A-S., Jörpeland per Stavanger, Norway (Fig. 7). The electrode was first installed provisionally (the ordinary electrode holder of the furnace being used) and run together with ordinary electrodes. From the very beginning the results were so good that a permanent installation was made. In order to get comparative results the electrode was then run together with German electrodes of best steel furnace quality and other ordinary electrodes. The year

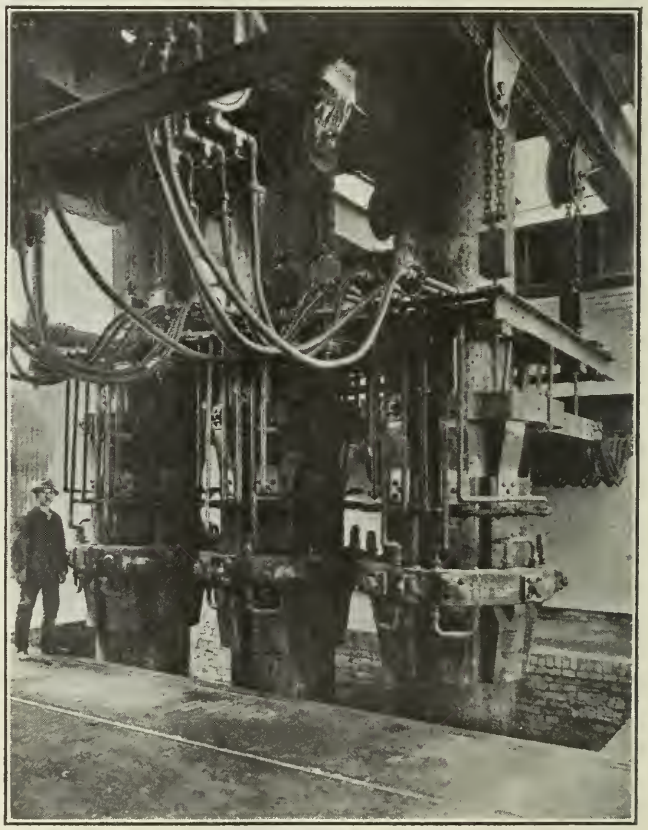


FIG. 6—6,000-KW. CARBIDE FURNACE AT KNAPSACK

1921 shows an electrode consumption for the Söderberg electrodes which is only 58 per cent of that for the German electrodes used in the same furnace, although the Söderberg electrodes were made of very poor raw materials, so that the ash content was about 15 per cent. As will be seen from Fig. 7, lengthening of the electrodes on the top of the furnace has not been provided for. The electrodes are lengthened outside the furnace, which may easily be done when using small Söderberg electrodes. When using big electrodes the changing will, however, be rather difficult, and it may

be more practical to provide a tamping platform which will tilt with the furnace and which may be removed from the furnace by means of a crane when the roof of the furnace has to be renewed. It may also be possible to arrange the platform fixed to the wall in the furnace house, in which case the platform will have to be constructed in such a way as to permit the electrodes to be tilted with the furnace. It will depend upon local conditions which arrangement will be most satisfactory from the standpoints of electrode renewal and furnace operation.

Further installations in steel furnaces are at present being made in Germany, and others are under consideration in England, France and Italy.

Another step to utilize the Söderberg electrodes in closed furnaces is the installation of 2,700-mm. (29-in.)

FIG. 7—APPLICATION TO TILTING STEEL FURNACE

electrodes in an electric pig-iron furnace of the Elektrometall type in Domnarfvet, Sweden. These electrodes were run from September to November, 1921, at which time the furnace had to be shut down owing to lack of water power. During the whole time the electrodes worked without a single breakage and with an energy load about 40 per cent higher than the load used for the ordinary electrodes in the same furnace. The potential required for the proper working of the Söderberg electrodes was about 5 volts (per set of two electrodes) lower than with ordinary electrodes, evidently due to the better contact between electrode holder and carbon and to the good conductivity of the electrodes. At present six Söderberg electrodes are being installed in this furnace.

It is therefore obvious that the utilization of the Söderberg electrodes also in the existing closed furnaces shows very great advantages. It should prove of still greater importance in the future development of closed furnaces. It is now possible to increase the size of the furnaces without increasing the number of the electrodes. This fact is thought to be of special importance in developing types of closed furnaces for the manufacture of calcium carbide and ferro-alloys.

Summary of Advantages

Operating data on Söderberg electrodes indicate the following advantages:

1. The cost of the electrodes is reduced very much.
2. The cost of special mounting and protecting the electrodes against air corrosion is avoided.
3. The baking is done without cost, as it is done by waste heat from the furnace crater. (The heat loss through the electrode is in fact less than for ordinary carbon electrodes.)
4. The electrode consumption is reduced:
   (*a*) Because the Söderberg electrodes have no electrode butts.
   (*b*) Because the air corrosion is very small.
   (*c*) Because fractures do not occur.
5. The running of the furnace is more regular because there are no stops due to change of electrodes and other troubles experienced with ordinary electrodes.
6. Every individual plant will be independent of electrode factories and will be able to make its own electrodes of the quality and shape most suitable.
7. The number of laborers can generally be reduced and the working conditions are improved, as the laborers are not so much exposed to heat.
8. It is possible to make new furnace constructions, which opens up possibilities for further development of the smelting industry.

Comparative Costs

The electrodes can be installed in most electric melting and smelting furnaces and can be built in all shapes and sizes, both round and rectangular. The cost of installation is relatively low—for two electrodes in a 2,000-kw. ferrosilicon furnace it would be about $6,000 and the time required would be from 1 to 2 months.

The cost of electrodes mounted in the furnace and ready for use is estimated at about 2 to 3c. per lb., including amortization and interest. This estimate will of course depend upon the prevailing prices of anthracite, coke, tar, pitch and labor.

The price given above is calculated for electrodes of about 34-in. diameter. Smaller electrodes will be somewhat more and larger electrodes somewhat less expensive. The electrodes may be produced still more cheaply if no anthracite is used in the electrode paste, in which case the electrodes will have to be made of foundry coke together with retort carbon or similar material. Such electrodes have been used with very good results in Fiskaa Verk for several months.

It may be of interest to show by an example what savings may be expected from the use of Söderberg electrodes instead of ordinary carbon electrodes. In most open furnaces now with 25 per cent of electrode butts, the electrode consumption will be reduced at least 35 per cent, in which case 10 per cent of the reduction is due to less air corrosion of the Söderberg electrodes. If ordinary electrodes cost 4c. per lb., the savings will be as follows:

Price of ordinary electrodes per 2,000 lb.	$80.00
Cost of mounting and protection against air	10.00
	$90.00
500 lb. of electrode butts obtained worth $10 per 2,000 lb.	2.50
Cost of 1,300 lb. electrodes consumed in furnace	$87.50
Cost per 2,000 lb. consumed electrodes	$135.00
Cost of 2,000 lb. Söderberg electrodes	40.00
Direct savings	$95.00

To these direct savings should be added the indirect

savings due to elimination of electrode changing; less repair on contacts, cables, etc.; more regular running; easier operation of the furnaces; higher output, etc.

Probable Trend of Developments

It was mentioned above that the Söderberg electrode makes possible new furnace constructions which may lead to new developments for the electric melting and smelting industry. In trying to picture the possibilities of development which the new electrode embodies for the electric furnaces, it is first necessary to review the drawbacks of the ordinary electrodes. The most prominent drawback is that they are limited in regard to length and section. It is impossible to make electrodes larger than about 7 ft., in length and 32 in. in diameter. It is, of course, possible to join electrodes over the furnace by the aid of thread and nipple, and in this way certain types of furnaces have continuously working electrodes, but this method cannot be successfully applied to other than round electrodes, and consequently not to electrode packets, and secondly the electrode joints even if ever so carefully made are liable to be the cause of trouble and fractures. To join electrodes over open furnaces is a difficult job.

Larger Furnaces Possible

Söderberg electrodes are not limited in regard to length or to section. Accumulated data all seem to indicate that electrodes are more steady and satisfactory in operation the larger they are. If there are no limits to the size of the electrodes, there will be no limits to the size of the furnaces either, and this being the case the self-baking electrodes have broken down the barrier which up to this time has impeded the evolution of large sized furnaces. When alternating currents are used for smelting, there is certainly a limitation to the size of the electrodes, or rather to the number of amperes, owing to the phase-displacement and the skin-effect, which will be quite noticeable at very high current load. Thorough investigations show, however, that when using a 50-cycle current, it is possible to make round electrodes of 1.75-meter (71-in.) diameter, if the current density in the central part is permitted to become 50 per cent less than at the surface. A 39-in. electrode would show a divergence of 10 per cent. By using twenty-five or fifteen-cycle current and allowing a divergence in the current density of 50 per cent, it is possible to make electrodes of 2½ meters (100 in.), or 3.20 meters (130 in.) respectively. An electrode of 3.20-meter diameter will at a current density of 3 amp. per sq.cm. (20 amp. per sq.in.) conduct a current of 240,000 amp., which at a voltage of 60 would develop—by means of this single electrode—14,400 kva.

Special Shapes Possible

With this last figure the ultimate limit is not by any means reached. It will be possible to reduce the number of cycles still more, or even work with direct current. Besides, the electrodes may be given such shapes that the skin-effect will be less—for example, by making the electrodes rectangular with one side much longer than the other, or by giving the electrodes the shape of hollow cylinders. It is thus clear that the electrodes can be made considerably larger than they are made today. With the increase in the size of the electrodes follows the possibility of giving the electrodes special shapes to meet the requirements of each special process. This possibility can be utilized in different ways. Being shaped directly over the furnaces in which they are used, the electrodes may thus be provided with channels running throughout their whole length. For larger electrodes such a channel may be made so wide that it will fulfill the object of the furnace shaft, serving, for example, for drawing off the furnace gases or for charging the furnace, putting on either the whole charge through the channel or only a certain part of the same. At present these forms of the electrodes are only future possibilities, but it has already been experimentally proved that hollow electrodes can be run without difficulties.

To meet present requirements it is necessary to concentrate the work on the application of the electrodes to furnaces and furnace types in operation. There is, however, no doubt that what are today the more remote possibilities of the new electrode will soon be drawn into practical use. The Söderberg electrode will become of fundamental importance to the electric smelting practice and may open up a new field of modern electrothermic industry.

Synopsis of Recent Chemical & Metallurgical Literature

Machines for Men.—In the *Gas Age-Record* for May 27, 1922, Floyd W. Parsons states editorially that great economies can be made to result from the substitution of machines for men, especially in material-handling operations. Machines do not strike, and when given proper attention they seldom or never lie down on the job.

One remedy for excessive labor costs is more machines. Here in the United States we boast of our mechanical aptness, but the truth is that in many of our industries we have been backward in adopting material-handling equipment. Not more than one-half of our manufacturers are familiar with modern mechanical methods for handling materials. If mechanical means for loading and unloading railroad cars were to be provided, so that one hour might be saved each day for each car, it is a fact that the total savings would amount to something like 2,600,000 car-hours per day, which would be equivalent to adding more than 100,000 cars to our present supply of rolling stock. The annual wage cost of handling freight in this country is more than $900,000,000. We could save 40 per cent of this sum through the installation of material-handling equipment. On the antiquated piers in New York it costs more per ton to handle food and merchandise than it costs to transport it 1,000 miles by rail.

The important thing here is not the operating cost of ships, cars and other utilities, but the cost of keeping them idle. It would be a splendid thing if every manufacturer were immediately to start making a thorough investigation of every operation inside and outside his plant, with the idea of discovering where and how men might be dispensed with and machines substituted for the work in hand. Handling practices are crude in many plants, and large economies would result from modernizing methods and equipment.

German Experience With White Alloys. — *Engineering* reports a recent discussion of die-casting alloys, in which was voiced much complaint as to the durability of many "war substitutes" and more recently exploited compositions. Sand-cast articles of the same alloys have also given considerable trouble. The long-known castings of tin-lead alloys are not strong, have low melting points and must not be heated above 100 deg. C. subsequently, but they shrink little and keep their exact dimensions. Pure zinc is not suitable for die casting; alloyed with tin, or with copper or aluminum, it answers; but tin and aluminum do not go together in general. Tinfoil containing more than 0.2 per

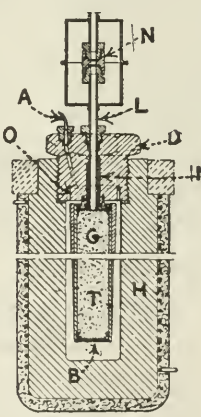
cent of aluminum may crumble in a few days. In complex alloys of zinc and aluminum the influence of tin is less clear. Zinc-tin alloys (for the mouthpieces and horns of telephone apparatus) should not be varnished at temperatures above 150 deg. C., lest a tin alloy sweat out in beads. The Siemens Co. exhibited a great many specimens of alloys, essentially of zinc-aluminum, both sand and chilled castings, which had failed, cracked, expanded or shrunk and had become distorted. The Al percentages varied between 2 and 70 in these products, which contained also copper, lead, and sometimes tin. It was mentioned that in America the use of alloys of Al-Zn, with medium Al-percentages, had been abandoned by some firms. Some new alloys are treated with acids to produce a fairly non-corrodible surface. Aging processes are advisable, and purchasers should receive full instructions as to use and be informed also as to the date when the goods were cast and after what period they might safely be mounted. That, of course, might preclude the utilization of hastily ordered parts. One zinc alloy containing 4 per cent of copper, 1 per cent of aluminum and 8 per cent of tin, and particularly the new durolith, the composition of which was not stated, were said to give full satisfaction as to strength, hardness and constancy of dimensions.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Building, Chancery Lane, London, England.

Ammonia Synthesis.—To facilitate the renewal of the catalytic material employed for the synthesis of ammonia, the inner tube containing the catalyst is rigidly secured to the removable head of the permanently fixed outer pressure tube. The inner tube *T* containing the catalytic material *G* is mounted on the exit tube *L*, which passes centrally through the screwed head *D* of the pressure tube *H*. By unscrewing the head *D*, the inner tube *T* is withdrawn and can be refilled, after removal of the gage plug; or else the whole combination *T D* may be immediately replaced by another in which the catalytic material has already been "formed," preferably by means of the pressure hydrogen issuing from the last catalyzing tube of the plant. To insure a firm screw connection between the head *D* and the pressure tube *H*, the head *D* is kept cool by passing the cold entering gases directly through it by orifice *A* and annular conduit *O*, at the same time keeping the hot exit gases out of contact therewith by employing an asbestos lining *M* for the exit tube. The screw-thread on the head *D* may be continuous but is preferably interrupted. The connection *N* between the catalyzing tube and the ammonia liquefier is immersed in cold water. Specification 171,970 and 171,972 are referred to. (Br. Pat. 174,041. Not yet accepted. Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude, Paris. March 8, 1922.)



Artificial Silk, Fire and Water Proofing.—So-called "staple fiber" which is obtained by cutting up filaments prepared from cellulose solution, etc., is rendered non-flammable by treating the formed filaments at a stage prior to the cutting up with fireproofing solutions such as are ordinarily employed in fireproofing textile materials. The treatment may be carried out after the usual drying process, or in the case of viscose filaments optionally while the filaments are in the gel condition, or in the case of nitrocellulose filaments immediately after the denitration. According to examples, sodium tungstate is deposited on the filaments by treatment with a solution of this salt in acetic acid, and aluminum tungstate by treatment with a solution of aluminum acetate and sodium tungstate in acetic acid. To waterproof the threads, an excess of aluminum acetate may be employed in the second case, or formaldehyde may be added to the bath; or the threads may be treated subsequently with formaldehyde. (Br. Pat. 175,746. W. P. Dreaper, London. April 20, 1922.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process for Producing Alumina and Potash.—Harry P. Bossett uses the following illustration of his patented process: Feldspar, or any other silicate of alum and potash compound, is ground to 100 mesh and heated with excess sodium carbonate and enough sodium sulphate to take care of the potassium. Soluble potassium sulphate and sodium silicate are leached from the insoluble sodium aluminum silicate. Sodium silicate is removed from solution with lime and the potassium salt separated by evaporation. The insoluble silicate is treated with caustic soda, together with lime, to replace sodium and iron oxide to replace aluminum in the silicate. Solution of sodium aluminate is boiled, agitated, filtered and the precipitate of $Al(OH)_3$ is dried. This gives very pure products, according to the claims. (1,410,642; March 28,. 1922.)

Crude Petroleum Distillation.—In order to obtain from crude petroleum oil a maximum yield of valuable products, it is generally required that the oil be distilled to the point of dryness—that is, until the residue of distillation is petroleum coke. Offsetting the higher yield of valuable products obtained in this fashion, however, there are attendant disadvantages, which become more and more serious as the specific gravity of the crude oil increases. Thus, in a case of the ordinary quality of Mexican crude petroleum now produced and having a Baumé gravity of from 21 to 23 deg., there is obtained a coke residue very high in sulphur and amounting to as much as 14 to 18 per cent of the weight of the crude distilled with an accompanying gas loss of 2 to 5 per cent. Under many conditions this coke residue may be worth less than the cost of removing it from the stills.

Many of the large refiners, therefore, prefer merely to "skim" the ordinary grade of Mexican crude petroleum—that is, distill off only about 15 per cent—which is less than the total content of naphtha and refined oil, marketing the whole of the 85 per cent residue as a low-grade fuel oil. Aside from the waste of the valuable lubricant fractions and wax of the crude oil inherent in the use of this skimming process, there is a further disadvantageous result of considerable economic importance. This is the failure to produce a supply of a heavy petroleum oil satisfactory for use in the more highly developed cracking processes for the production of gasoline or naphtha. One reason this reduced Mexican crude is unsatisfactory in most cracking processes is that the accumulation of carbon in the cracking stills is so rapid that the amount of gasoline which can be produced before cleaning is required is cut to a very small figure. The present invention, however, provides a method of obtaining from crude oil, and particularly from heavy asphaltic-base crudes, such as Mexican, a maximum yield of valuable hydrocarbons, including heavy hydrocarbons suitable for use as a charging stock in cracking stills, without encountering any of the difficulties met with in the usual process of running such crude down to coke. In brief, the present process contemplates arresting the distillation at the point where the crude oil is reduced to a high-melting-point pitch, and then fluxing this pitch with a quantity of fuel oil sufficient to produce a product which is fluid at ordinary temperatures and capable of being marketed as a liquid fuel product. (1,413,260; Edgar M. Clark, assignor to the Standard Oil Co. of New York; April 18, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Bakelite, Redmanol and Condensite Companies Merge to Form Bakelite Corporation

The Bakelite Corporation has taken over the General Bakelite Co., the Condensite Co. of America and the Redmanol Chemical Products Co.

The merger is the result of a suit for infringement of the Bakelite patents brought against one of the customers of the Redmanol company, the General Insulate Co. of Brooklyn. This suit resulted in an unqualified victory for the Bakelite company and the entry of a decree in the United States District Court for the Eastern District of New York on May 11.

The Bakelite patents which are thus broadly sustained cover the molding in general of phenolic condensation products by heat and pressure and the use in such products of fibrous bodies such as wood flour, asbestos, etc. In a previous suit against George J. Nicholas & Co. the Bakelite patents covering the manufacture of varnishes and solutions had been broadly sustained.

The decision against the General Insulate Co. and the bringing of other suits against Redmanol customers made it impracticable for the Redmanol company to continue its business and in order that the value of the good will, plant and organization might not be lost, it was decided to consolidate its business, including the personnel, with that of the General Bakelite Co. The Redmanol company owns a controlling interest in the Condensite company, so the inclusion of that company in the merger was possible. The Condensite company had been operating under the Bakelite patents for several years, paying royalties as the result of suit against it in 1913.

In many respects the products of the three companies are not identical; each supplements the others in important particulars. Thus formaldehyde and "hexa" are made only by Redmanol; galalith is made only by Redmanol; chlorine substitution products are made only by Condensite and transparent material is made by Bakelite and Redmanol but not by Condensite. Their phenolic condensation products also differ somewhat in their method of manufacture.

The three companies entering the merger will continue separately to manufacture and market their products, which are well known under the names of Bakelite, Condensite and Redmanol; these have found wide applications in the radio field, the automotive and electrical industries and for a large number of mechanical uses. As a result of the merger much new development and research work is already under way, from which in due course the industries using these products will greatly benefit.

L. H. Baekeland is the president of the new Bakelite Corporation, with Philip Schleussner, A. Karpen and Kirk Brown vice-presidents, the latter being also general manager. Dr. Baekeland remains also president of the General Bakelite Co., Kirk Brown president of the Condensite Co. of America and Dr. L. V. Redman president of the Redmanol Chemical Products Co.

Federal Specifications Board Forms Metals Committee

The Federal Specifications Board has organized a metals committee. G. K. Burgess, head of the Metallurgical Division of the Bureau of Standards, has been elected as chairman. The committee is to take up the following subjects in the order named: Ingots, castings, wrought metal and chains. The committee recommends that the methods of chemical analysis adopted by the American Society of Testing Materials be used for government check analyses.

Passage of Bill Providing for Helium Conservation and Development Urged by Secretary Fall

The Secretary of the Interior has given his unqualified indorsement to the bill recently introduced by Representative Kahn, chairman of the Military Affairs Committee, providing for the conservation of helium gas. Not only does he approve the bill but he urges "as a matter vital to the best interests of the country" that the bill be passed.

In his letter to Representative Sinnott, chairman of the Public Lands Committee, which has jurisdiction, Secretary Fall points out that we are in the fortunate position of having practically a natural monopoly of helium—an exceedingly valuable asset which should not under any circumstances be dissipated. He also points out that he has submitted the bill to the President and that the Chief Executive also strongly indorses the measure.

Secretary Fall points out that no commercial companies have attempted to separate helium from natural gas. For that reason the needs of the army and navy must be supplied by the government. He calls attention to the fact that of the $5,000,000 asked, $4,000,000 is needed for conservation and $1,000,000 for drilling wells, the necessary pipe lines and the construction of the plant on or adjacent to the gas field, which it is proposed to purchase, for the purpose of processing such amounts as may be necessary to supply the helium requirements of the army and navy. He mentions that the $4,000,000 for conservation is but a temporary outlay, as it is contemplated that the entire amount will be returned to the government through the ultimate sale of natural gas from the lands the purchase of which is under consideration.

The investigations of the Bureau of Mines have shown conclusively, Secretary Fall states, that helium can be conserved most effectively by holding the helium-bearing gas under ground.

With reference to the construction of a new extraction plant, Secretary Fall refers to the progress which has been made possible by the cryogenic research laboratory and the extensive development work which has led to great efficiencies resulting in decreased costs. There is every reasonable assurance, he says, that a plant for the extraction of helium now can be constructed in which both the initial cost and the cost of operation will be much reduced. Another economy would be effected by the bill, since it places all of the work under one department. Heretofore the work has been divided among the War, Navy and Interior departments.

Ominous Calm in Coal Strike Situation as Government Watches for Settlement

All directly interested in the coal strike seem to have paused, seeming to sense that something is about to happen. The quarter from which the break is likely to come does not seem to be indicated. The production of coal is climbing slowly. The country is coasting on its stocks to the extent of two or three million tons a week. The larger consumers are still very well supplied with coal, but some distress is being reported from smaller plants in the regions distant from the non-union fields. The Administration does not believe that the time has been reached when it should force a settlement. Every opportunity should be given, it is stated in Administration circles, for the parties to the strike to reach a settlement uncoerced. It is very evident, however, that there will be no hesitancy to call upon the parties to the strike to arbitrate their differences whenever the point is reached where additional coal production is essential to the public welfare.

Technical Photographic and Microscopical Society Holds Luncheon-Meeting in New York

Strikingly representative of the chemical and allied industries was the gathering of about fifty members and guests of the Technical Photographic and Microscopical Society at the luncheon-meeting of the organization at the Hotel Astor, New York, on June 14. Although the society was organized only 2 months ago, a great deal of interest in its activities and plans has been manifested by individuals and companies using photography and photomicrography in the solution of their research problems.

The incidents and events which led to the formation of the society were described by John H. Graff, its vice-president. Mr. Graff described some of the unique and valuable work that is being done today with the aid of photography. He urged that the society plan an exhibition of technical and industrial photography which will cover all the fields of its application. He remarked that great credit is due to the commercial photographer in developing the technique of the art to its present place and hoped that the society would co-operate with the commercial photographer to the mutual advantage of both.

C. E. K. Mees, of the Eastman Kodak Co., pointed out that the problems of technical photography and photomicrography are distinct in the art and said he therefore welcomed the advent of the society and predicted that through its activities it would accomplish much toward the improvement and progress of photography. He described several of the unusual and interesting problems that have been presented to the Eastman company by technical and scientific workers. Among these were requests for special emulsions for astronomical observations and other highly scientific purposes. He described the research work done in the laboratories of his company to supply these special needs, and added that although the work did not always hold prospects of immediate profit, it frequently paid richly by the newly created field.

Miss Susan B. Leiter, microscopist for the General Electric Co. at its research laboratory in New York, spoke of the extremely interesting problems that fall to the lot of her laboratory. Often, she said, problems which are beyond the scope of any of the other research departments come to her for solution, and frequently the microscope proves equal to the task. Examples of unusual problems described were those of determining the reason for failure on insulation by photographing the ends of the fibers through the microscope and of photographing the inside surface of electric lamp bulbs.

Henry Green, of the New Jersey Zinc Co., Palmerton, Pa., described the photomicrographic laboratory of that company and its work on pigments. He told of the work that is being done in his laboratory in measuring the grain size of pigments. In studying the suspension of carbon in rubber, it is necessary to use a film of rubber $\frac{1}{2}$ micron thick so that it will transmit light. A remarkable degree of accuracy has been attained in this work. The so-called superfine zinc oxide is composed of grains of $\frac{1}{10}$ micron diameter, finer than the particles composing tobacco smoke, which are being measured and studied by photomicrography.

A business session followed, during which the constitution and bylaws were adopted and steps taken to arrange for the exhibit which is to be given at the National Exposition of Chemical Industries in September. The next meeting of the society will be held in conjunction with the exposition. The following committee was appointed to arrange for the exhibit: General chairmen; J. McDowell, New England Section; A. E. Buchanan, New York Section; Textiles, New York Section—W. O. Jelleme, K. B. Cook, B. H. Foster; textiles, New England Section—R. T. Fisher, E. D. Walen, F. L. Babcock, Grimshaw; paper—J. H. Graff, D. A. Smith, T. J. Keenan; photography—J. A. Lucas, C. E. K. Mees, F. F. Renwick, A. B. Hitchins; microscopy—S B. Leiter, E. J. Wall; metallurgy—H. Green, A. E. Buchanan, G. Hiers; leather—J. A. Wilson, M. W. Cohen; rubber—K. B. Cook, B. H. Foster; testing laboratories—H. B. Gordon, Wehmer; explosives—B. Grotta; apparatus—Scheik; microchemistry—E. M. Chamot, H. Green, A. Zimmerli.

Opinions in House Differ on Muscle Shoals Offers and Construction of Dam

Agreement among the conferees on the War Department appropriation bill to provide $7,500,000 for the reopening of construction work on the Wilson dam at Muscle Shoals probably will be advanced as a reason why an immediate vote should not be taken on the acceptance of Henry Ford's offer for the government's Muscle Shoals properties. Since several years will be required to complete the dam, the steering committee in the House and the majority leaders of that body are expected to take the position that there is little to gain in rushing to a vote on the McKenzie bill. On the other hand, the supporters of the McKenzie and Wright bills will argue that there are great advantages to the public in tendering the property to Henry Ford—advantages which may be lost through the withdrawal of the offer if there be extended delay.

A statement to the effect that the President is opposed to a vote on the McKenzie bill at this time, which was published widely, was denied emphatically on the floor of the House by Majority Leader Mondell. He declared that the President had expressed no opinion as to the disposition of Muscle Shoals and that the majority leaders had not reached any conclusion as to the action they might take in regard to it. Enough is known of their views, however, to make the assumption general that they will oppose a vote on the McKenzie bill. On the other hand, there are enough friends of the Ford proposition, counting those who favor the offer minus the Gorgas steam plant, to constitute a formidable force. It is entirely within the range of possibility that they may be able to force a vote on the matter.

The Wright and McKenzie Bills

The McKenzie bill would make it mandatory upon the Secretary of War to sell and lease to Henry Ford the various Muscle Shoals properties and rights of the government. It excludes from any offer the government's equity in the steam plant on the Warrior River at Gorgas. Arrangements are being made to circulate a petition among members of the House asking for the consideration of the bill. If the signature of a majority of the members of the House can be obtained, it would make it very embarrassing for the leaders to refuse to permit consideration of the bill. In view of the fact that the House now is marking time, awaiting Senate action on the tariff bill and other measures, the chances favor success in obtaining consideration of the measure.

The eight members of the Military Affairs Committee who signed the principal minority report have reserved the right to amend the McKenzie bill so that it will include the government's interest in the Gorgas steam plant. While a bill introduced by Representative Wright of Georgia embodies the exact views of the minority, the fight will be on the McKenzie bill, introduced at the instance of the majority, which can be amended, if sufficient strength can be mustered, so as to express the views of the minority of the committee.

The Majority and Minority Opinions

It is very apparent from the report made by the majority of the committee that those members believe Mr. Ford will take over the properties if they were offered to him definitely, even were the Gorgas plant eliminated. The minority contends that the elimination of the Gorgas plant is equivalent to a rejection of the Ford offer. The minority questions the sincerity of the Alabama Power Co. in offering $2,500,000 for the Gorgas plant, but even if that amount could be obtained for it, it should not be permitted, these members say, to stand between the public and the great advantages which would accrue to it through the acceptance of the Ford offer.

"The money consideration," the majority states in commenting on the offer of Mr. Ford, "is not the vital one. If that were all, the committee would not have spent 2 hours in the consideration of the matter. It is the continuing considerations to be performed by Mr. Ford and his company over a long period of 100 years which give to his proposal its merit."

Thirteenth Annual Convention of the American Oil Chemists Society

The American Oil Chemists held their annual convention this year at New Orleans, in the Grunewald Hotel, June 5 and 6. Although only fifty-two members were present, the small attendance did not interfere with the success of the meeting. Many of the activities of the society are closely related to the work of the Interstate Cottonseed Crushers Association, and much of the time of the convention was taken up with the discussion of committee reports and papers relating directly to the chemical control of the vegetable oil industry.

The reports of the various committees were distributed in printed form, and as these had nearly all been previously published in *The Cotton Oil Press*, little time was lost in acting on their recommendations.

President's Address

C. B. Cluff, chief chemist of the American Cotton Oil Co., in his presidential address spoke feelingly of the society's loss in the deaths of Dr. F. N. Smalley and Dr. Charles Baskerville. In Mr. Cluff's opinion the fact that the membership of the organization had increased in spite of hard times was an indication of its growing strength. It had not been necessary to raise the membership dues, as seemed probable a year ago, largely because of this increase in members.

The most important matter which had come before the governing committee was the question of incorporation. This was later discussed in the convention meeting, and the officers, including the editor, were authorized to sign the charter papers for incorporation under the laws of the State of Louisiana.

The activities of the society are such as bring the officers in direct business contact with members and outsiders and may at any time result in the necessity of defending a suit. Any member of a non-incorporated society, which is legally a partnership, is liable for judgments against the society, but when the organization is incorporated, individual responsibility ceases, and for this reason it was thought advisable to incorporate.

Committee Reports

Dr. David Wesson, technical director of the Southern Cotton Oil Co., as chairman of the referee board, reported on the certification of individual chemists and firms as qualified for arbitration work. He recommended that in the future no certificates be issued to analysts connected with manufacturing concerns, as they were not eligible to act in arbitrations.

The report of the editor of the Chemists' Section of *The Cotton Oil Press*, by Herbert Bailey, chief chemist of the Southern Cotton Oil Co., recommended that suitable reprints of original articles be furnished the authors, free if possible, and if not, at cost. As the Chemists' Section was becoming better known as a medium through which to reach a large number of chemists interested in fats, oils and oil products, it is now easier to secure high-grade articles with which to fill its pages.

The color of oil and meal committee's report was presented, in the form of a paper illustrated with lantern slides, by Dr. Wesson, the chairman. He exhibited the E K. colorimeter, which has been developed by the Eastman Kodak Co., and discussed its advantages and disadvantages over the present Lovibond glasses for the grading of color of oils. This instrument has three gelatine wedges—a red, a yellow and a neutral tint—which may be superimposed in one half of the optical field. The other half is colored by light passing through a standard column of the oil to be graded.

Photographs and diagrams of another color instrument now being perfected by Carl Keuffel, of the Keuffel & Esser Co., were thrown on the screen. This apparatus is not a color comparator, but rather a color analyzer or spectrophotometer. With it the color of a sample would be analyzed rather than compared with an arbitrary standard.

Dr. Wesson showed numerous color-absorption curves made by Mr. Keuffel on oils and Lovibond glasses. One especially interesting point brought out was that with this instrument it was possible to say whether or not a cottonseed oil had been treated with fullers earth and also when a given prime summer yellow oil was bleachable.

H. P. Trevithick, chief chemist of the New York Produce Exchange, reported for the bleach test and fullers earth committee that it had done a little work looking toward the standardization of the official method for making a bleach test. It was decided that next year's committee be instructed to study various mechanical agitators in connection with the test, and if possible recommend a standard type of paddle and rate of stirring.

The oil extraction committee recommended a change in the type of container for meal samples. Dr. Felix Paquin, the chairman, said he had obtained satisfactory results by using a regular paper thimble with a cone of filter paper either outside or inside of it. He also stressed the necessity of weighing the flask before and after the extraction, under identical conditions, and suggested that the time of extraction be increased to 4 hours.

Methods for Cotton Seed Analysis

D. C. Pickard, in his report on methods for cotton seed analysis, discussed the large amount of work done by his committee on three methods (the Smalley-Copes, Pickard and Malowan) for determining the percentage of oil (gasoline extract) and ammonia in seed. The first two of these use only a 5-g. sample, while in the Malowan procedure 25 g. are taken. The agreement of chemists using the first two methods is about 0.60 per cent when the average of three determinations is taken, but the difference between individual determinations made by the same chemists may be over 1 per cent. For large samples the Malowan method is to be recommended.

In the absence of H. C. Moore, chemist of Armour Fertilizer Works, who is chairman of the ammonia committee, his printed report[1] was received and the specific recommendations considered. The c.p. sodium carbonate and ammonium sulphate which the society is now selling as basic standards for ammonia work he believes should be made official standards. Discussing the ammonia results on thirty samples of meals analyzed by eighty-eight collaborators, Mr. Moore's report points out that on the first set of ten samples one chemist did not miss the accepted average more than 0.04 per cent NH_3 on any sample, a second only 0.05 per cent, the third and fourth 0.06 per cent. In the other two groups of ten samples each the maximum variation of the analyst coming closest to the accepted average was 0.03 per cent NH_3 in each group. On the third group of samples four men came within 0.03 per cent or less of the actual NH_3 content of every meal as calculated from the reports of eighty-eight chemists.

Work of Oil Constants Committee

Dr. George S. Jamieson, chemist in charge of the oil, fat and wax laboratory of the U. S. Bureau of Chemistry, reported the results of the analysis of twenty-two samples of authentic peanut oils collected during the past 3 years. This is the work of the oil constants committee, of which Dr. Jamieson is chairman.

The society's co-operative analytical program has been carried on, since the death of Dr. F. N. Smalley, by Herbert Bailey. His report[2] was not read, but the continuance of the work was fully discussed and finally referred to the governing committee. The committee has since arranged that next year only thirty meal samples be distributed and only three certificates and the loving cup be awarded. The compilation of results and all details, except the preparation and distribution of samples, will be in the hands of the ammonia committee. The samples of crude oils for refining tests, and of fats for determination of iodine number and titer, will be distributed by J. H. Morrison, chemical director of the Procter & Gamble Co. His committee will also tabulate the results as reported and handle all details of this work.

Mr. Bailey's recommendation that in the future the co-

[1] *Cotton Oil Press*, vol. 6, No. 1, p. 46.
[2] *Cotton Oil Press*, vol. 6, No. 1, p. 36.

operative analytical program be known as the Smalley Foundation, in honor of the late Dr. Smalley, who had so unselfishly given a great deal of time and energy to this work, was unanimously approved.

R. H. Fash, vice-president of the Fort Worth Laboratories, as chairman of the refining test committee, submitted brief reports by W. G. McLeod, of Morris & Co., on corn-oil refining, and on coconut oil by A. Porter Lee, New York Produce Exchange, in addition to the cottonseed oil report by J. H. Morrison, previously published.[3] The year's work on corn-oil refining covered a comparison of results obtained with straight and curved paddle agitators and uniform stirring speed versus a slowing down of the agitation after the break. So far as the few results reported go, variations in paddles and stirring procedure have no appreciable effect on refining losses.

Mr. Lee stated that in studying the effect of varying the concentration of caustic soda solution on the refining loss of coconut oils, he had observed in some oils a material which was neither meal nor hull fiber. This varied from 0.01 to 0.1 per cent in different oils and seemed to be a partly waxlike body and partly a water-soluble gum.

Co-operation With the Government and Research Institutions

During the past year a committee of the Oil Chemists Society, of which Dr. J. H. Shrader, director of the Bureau of Chemistry and Food, Baltimore City, is chairman, and a similar committee from the Interstate Cottonseed Crushers Association, Edward Barrow, of Barrow-Agee Laboratories, Memphis, chairman, have worked together in co-operation with the government on basic research problems. Dr. Shrader's report outlines four problems already accepted by the U. S. Department of Agriculture for investigation: (*a*) Breeding cotton seed to increase oil content; (*b*) crude oil investigations; (*c*) rancidity investigation, and (*d*) cottonseed meal investigations. Mr. Barrow reviewed briefly the progress already made by Dr. Jamieson on crude cottonseed oil, and offered resolutions of appreciation to the Secretary of Agriculture for his interest and valuable assistance in the solution of problems of the vegetable oil industries. Two papers, one by Dr. Wesson and one by Dr. Jamieson, were read in connection with this work. The former will be published in a subsequent issue of this magazine.

Determining Neutral Oils

Dr. Jamieson, in the course of his remarks, made the following statements:

> Every chemist who applies the official refining test to crude vegetable oils often wonders why there is not more of a proportional relation between the refining loss and the percentage of free fatty acids. The reason in most cases is not that the crude oil with the high loss and low acidity contains more impurities and less oil than the oil with low loss and higher acidity. The reason is inherent in the test.
>
> It is possible, however, to determine, among other things, the absolute amount of neutral oil in the crude. When a crude vegetable oil, dissolved in petroleum ether, is shaken with a large excess of an aqueous potassium hydroxide solution, the free fatty acids are neutralized, the coloring matter is precipitated and certain compounds of fatty acids other than glycerides are decomposed. Addition of a considerable quantity of 50 per cent alcohol causes the mixture to separate into two layers upon standing, an upper clean petroleum ether solution of refined oil and a lower alcohol alkali layer containing the saponified fatty acids, the coloring matter, more or less precipitated matter and other impurities.
>
> This treatment does not decompose fatty acid glycerides. When the method was applied to absolutely dry and neutral refined oils, 100 per cent recovery of neutral oil was obtained. When applied to commercially refined cottonseed oil, a refining loss amounting to 0.20 to 0.22 per cent resulted.

Award of Certificates and Presentation of Cup

Following his report as chairman of the co-operative analytical program, Mr. Bailey awarded in behalf of the society a number of certificates for proficiency in the analyses of oils, fats, meals and fertilizers. The winners of these certificates were chemists who had excelled all other contestants in the co-operative work. Later, at the banquet, he also presented to Dr. H. B. Battle the silver loving cup which is annually given to the chemist who had the highest standing in the check meal work. In connection with this presentation Mr. Bailey paid tribute to the late Dr. Smalley, stating that in his opinion the greatest good accomplished by the society for the chemists in the oil industry was that resulting from the check meal work. Dr. Smalley, with his wonderful far-sightedness, had seen the advantages which would be obtained if all the chemists of the society would analyze every week a portion of a uniform sample of some oil-bearing material. He had given an immense amount of time and thought to the details of this analytical contest and the increase in accuracy as indicated by the results reported each successive year was evidence of the great good which had been accomplished.

Photo by Edmonston, Washington, D. C.

L. M. TOLMAN, CHIEF CHEMIST, WILSON & CO., CHICAGO, AND NEWLY ELECTED PRESIDENT OF AMERICAN OIL CHEMISTS SOCIETY

Election of Officers

Election of officers for the ensuing year, held during the closing day of the convention, resulted in the following new officers:

President, L. M. Tolman, chief chemist, Wilson & Co., Chicago; vice-president, Dr. H. B. Battle, the Battle Laboratories, Montgomery, Ala.; secretary-treasurer, Thomas B. Caldwell, Law & Co., Wilmington, N. C. Later, at the meeting of the governing board, Herbert S. Bailey was re-elected editor of the Chemists Section of *The Cotton Oil Press*.

The convention was concluded on Tuesday night when the members of the society, the New Orleans Section of the American Chemical Society, their wives and friends enjoyed a delightful banquet at the New Orleans Yacht Club. Following the dinner, Mr. Tolman, the newly elected president, acting as toastmaster, introduced a number of speakers, including several of the past presidents as well as the newly elected officers of the society.

[3] *Loc. cit.* p. 49.

Dedication of State Ceramic Building at Rutgers—Dean of Ceramic Industry Honored

Tuesday, June 13, was not only a history-making day in the ceramic industry in New Jersey, but one of memorable record for the entire field of ceramics in all parts of the country. Through a culmination of events, on this day there was dedicated the finest ceramics building, school and research station of which the industry can boast and signal honor was accorded to the dean of this profession, through the conferring of the degree of Doctor of Science by Rutgers College, New Brunswick, N. J., at its one hundred and fifty-sixth commencement year.

To Edward Orton, Jr., Columbus, Ohio, formerly of Ohio State University, fell the privilege and honor of being the first ceramic engineer ever honored with a degree in this country. It was conferred by W. H. S. Demarest, president of the institution, during the commencement exercises at the morning session, in "recognition of ability and achievements, particularly in the line of ceramic research work for the State of Ohio, and as a director of the first college of ceramics in this country."

As an associate for this honor, Dr. Orton was preceded by Thomas A. Edison, who received a similar degree.

In commenting upon the honor conferred, Dr. Orton said at the alumni luncheon following that he deemed it not as a personal gift or achievement, but rather as a mark of recognition for the ceramic industry that would go to inspire his fellow workers in the craft, as well as the young men coming along who might be considering the ceramic field as one of their choice for the future.

Dedication of Ceramics Building

Located on the Neilson Campus, on line with the chemistry building and Ballantine gymnasium at the institution, the new ceramics building, shown in the accompanying illustration, has been in course of construction for about a year past. The structure was made possible by a state appropriation of $100,000, to which has been added at least $25,000 in contributions from companies and individuals in the industry in the state, embracing both funds and materials. In all, more than eighty companies contributed to make the new building a success.

NEW CERAMICS BUILDING, RUTGERS COLLEGE

The occasion of the official dedication was fittingly arranged for 3 p.m., and faced by an assemblage of more than 150 persons, President Demarest opened the ceremony with a few appropriate remarks. He said that the dedication commemorated the twentieth anniversary of the ceramics department at Rutgers College, and that the fulfillment of the desire for a suitable structure to represent this branch of learning was not only due to the state, but to the energy and untiring efforts of prominent members of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society.

Principal Address by LeRoy H. Minton

The principal address was made by LeRoy H. Minton, president of the New Jersey Clay Workers' Association. He said that in outlining the work of the organization in connection with the new structure the industries of the state were divided roughly into nine groups. These included the sanitary ware manufacturers, embracing porcelain and chemical stoneware materials; electrical porcelain manufacturers; terra cotta manufacturers; brick and fireproofing manufacturers; firebrick and refractory manufacturers; floor and wall tile manufacturers; general ware manufacturers; sand and gravel producers. He commented upon the work of Prof. George H. Brown, director of the department and secretary of the association, and said that the building would stand always as a monument to his work.

Other Speakers

Former Senator Thomas A. Brown, who was instrumental in having the appropriation bill for the ceramic building pass the state legislature and receive the Governor's approval, spoke about the value of the institution to the state and its significance to the younger generation coming forward in the ceramic industry.

He was followed by Frank H. Riddle, president of the American Ceramic Society, who made a brief address of congratulation to men in the clay-working industry in the state in achieving their aims in the completion of the new building, and its immediate utility for research and students.

Dr. Orton Pays Tribute to Pioneers

Edward Orton, Jr., the last speaker on the program, traced the growth of the ceramic industry in this country from 1883 when, as a college student, he was given the task of preparing a chapter upon the clays and clay-working industries of Ohio for a volume on economic geology that was to be issued by the state. He paid high tribute to the small group of men who in 1894 approved his plan for the establishment of the first technical school for the clay workers in America. Among these he mentioned Ernest Mayer and F. W. Walker, Beaver Falls, Pa.; Homer Laughlin, East Liverpool, Ohio; Stanley G. Burt, Cincinnati, Ohio; Charles A. Bloomfield, Metuchen, N. J.; A. O. Jones and R. C. Burton, Zanesville, Ohio.

In conclusion he said: "Has ceramic engineering made a permanent place for itself in the field of permanent education? That question may be answered by another, What is permanent? Nothing is permanent in nature—all is in a state of flux. But, with the constantly increasing substitution of the products of the forests by the great group of silicate products, ministering increasingly to the needs of man and requiring with the passing of the decades and centuries always a more critical conservation of thermal energy and greater economy of human labor, we can be sure that they will require trained direction in increasing proportion. Courses of study and names of subjects will change, but that technical schools will cease to produce that kind of educated leadership which we now know as the ceramic engineer is not thinkable."

The Ceramics Building

The new ceramics building is 45x102 ft., of fireproof construction throughout, two-story and basement. The exterior is of red brick, with buff terra cotta trimming, including a base course at the first floor, a stringer course around the second floor, and terra cotta cornice. Terra cotta medallions, depicting certain branches of the clay-working industry, later will be inserted between the windows at the tops and there will be a terra cotta doorway at each entrance. The interior walls of the structure are of common brick, with hollow tile ceilings and floors throughout.

The basement comprises physical testing room, brick machinery room, sagger and plaster shops and miscellaneous operating departments.

The first floor contains a pottery laboratory, pottery storeroom and ceramic materials laboratory. A stairway leads from the pottery laboratory to the kiln room. At one end of the first floor there is a class room and four research laboratories.

The second floor is arranged with offices, library, drafting room, chemical laboratory and at one end, a museum or assembly room extending across the entire end. This

room, 25x42 ft., is finished throughout with tile, including a red tile floor, tile paneling and inserts around the ceiling, with tile fireplace and mantel.

Summer Meeting of New Jersey Clayworkers' Association

To permit visiting ceramists from different parts of the country to be present at the regular summer meeting of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society, this gathering was arranged on the day following, Wednesday, June 14, at the Country Club, Trenton, N. J.

The opening address was a paper by LeRoy H. Minton, president of the association, on the subject of the Royal Berlin Porcelain Works, Germany, which he visited on a recent trip abroad. The paper was illustrated with a number of interesting lantern slides. In this line of hard porcelain manufacture, it was pointed out, the principal clay used is the Halle variety, originating from a decomposition of granite rock and mixed abundantly with sand and other materials. The "flow" of operation through the plant was described, including the settling tanks, preparation of body, filter presses, period of aging, drying and firing of bisque ware, glazing and color decorations. Particular reference was made to the different types of kilns installed at the plant, including three-story kilns, each chamber forming an individual operating unit. A chamber kiln of twenty-two compartments is also in service.

Past, Present and Future

Departing from the usual custom of a set program, President Minton said that the time was opportune for comments on the "Past, Present and Future" of the ceramic industry, and he allotted these subjects to Charles A. Bloomfield, A. V. Bleininger and Frank H. Riddle, respectively.

Mr. Bloomfield spoke interestingly of the days gone by, of the obtaining of an appropriation for the first ceramic department at Rutgers College 20 years ago, in which he was instrumental, and of the growth of the ceramic industry and ceramic education up to the present time.

At this point Mr. Bleininger gave a pertinent résumé as to present-day happenings. He said that the trend decidedly was toward research and investigation, of the study of clays in different forms. A more definite understanding of plasticity is being obtained, and of the absorption of gases and liquids. Firing conditions, he pointed out, are still poor, and better kilns must be secured in the days to come; better temperature control is essential and other phases of firing the ware. The investigation of the more obscure phenomena, such as now going on, cannot help but bring about immeasurable benefit and profit.

Frank H. Riddle, of the Champion Porcelain Co., Detroit, Mich., president of the American Ceramic Society, said that the future would show a development of plant control, an amalgamation of plant management and the technical end of the business. The mechanical phases of the ceramic industry also, he said, presented great possibilities, and machinery of improved type for different features of manufacture naturally would come as a result of research and practical investigations. He said that in the years soon to come what are now known as "super-refractories" will be known as normal materials, for the general trend is toward the development of refractories for higher temperatures. Other fluxes, he prophesied, will come into use—materials which are now available but little known. Magnetic separation is another matter offering great possibilities, and one that is destined to receive concerted interest and attention in the future. Tunnel kilns and kilns of other types are open to big improvement, and this will come as the industry advances. Still another subject of importance is the control of gas conditions, so necessary in high temperatures, and this will ensue as a natural order of development. He prophesied that oil-gas producers will come into far more extensive use in the future.

Dr. Edward Orton, Jr., was the next speaker, and he commented extensively upon the new ceramics building and what it meant to the state and to the industry. He pointed out the necessity for getting the right kind of students, and the advantage of actual shop work during the term of technical training. He said that the ceramic manufacturers in the state should co-operate intelligently in selecting bright men from their plants for a course of instruction at the institution.

Ross C. Purdy, secretary of the American Ceramic Society, followed Dr. Orton, and congratulated the association members on their attainments in connection with the new ceramics building. He spoke at length upon the society he represents, and features of research now going on through different committees.

Succeeding speakers were Charles Howell Cook, president of the Cook Pottery Co., Trenton, and August Staudt, head of the Perth Amboy Tile Works, Perth Amboy, N. J., both past presidents of the association.

Chemical Warfare Service Appropriation Urged on Basis of Research Need

Testifying before the Senate Appropriations Committee in support of appropriations for the Chemical Warfare Service, Brigadier-General A. A. Fries, chief of that branch, stressed the importance of continued research on chemical warfare. Whether or not the army uses this weapon, it is important that all information possible be available for defensive measures. He referred to mistakes made in the war by both sides in the use of poison gas, all of which were due to lack of research. He also emphasized the importance of fundamental research in other fields in which the government is directly concerned.

The War Department's estimate as presented to the committee provides 272 combat troops for the Chemical Warfare Service. Senator Hitchcock of Nebraska was moved to ask why there should be combat troops in that branch of the service. General Lassiter, replying for the department, explained that the chemical warfare troops are authorized by law. The department is considering the question of reducing the number to a point necessary to comply with the terms of the treaty. The law calls for 100 officers and 1,200 enlisted men in the Chemical Warfare Service for an army of 280,000 men. The Service now has 87 officers and 550 men.

General Lassiter agreed with the comment of Senator Sutherland that the treaty does not involve the abandonment of all research along chemical warfare lines, interpreting it as providing only against the use of gases in warfare. He stated that the War Department would present a project on the Chemical Warfare Service personnel to Congress later.

Associations to Meet at Chemical Exposition

Several leading associations of the chemical industry have definitely arranged to meet at the Eighth National Exposition of Chemical Industries, which will be held during the week of Sept. 11 to 16 at the Grand Central Palace, New York. The special meetings which have already been scheduled to be held at the Grand Central Palace during the week of the exposition include a meeting of the American Ceramic Society, the Technical Association of the Pulp and Paper Industry and the Salesmen's Association of the American Chemical Industry. Other technical and commercial groups connected with the chemical and allied industries are also expected to meet at the time of the exposition, but definite arrangements for the latter have not as yet been made.

The exposition was purposely scheduled to come between the meeting of the American Chemical Society in Pittsburgh, Sept. 6 to 9, and that of the American Electrochemical Society in Montreal, Sept. 21 to 23, so that September will as usual be a busy month in chemical circles.

Helium Manufacture Described by Moore in England

The English press gave prominent notice to the public lecture delivered at the University College of London on May 24 by R. B. Moore, chief chemist of the U. S. Bureau of Mines. Dr. Moore's topic was "Commercial Manufacture of Helium by the Government of the United States."

Consideration of Dye Embargo in Senate Tariff Discussion Again Delayed

While some delay in taking up the dye embargo feature of the tariff bill has been occasioned by a variety of causes, it can be stated definitely that the effort of its opponents to have it go over until the administrative provisions of the bill are reached has been unsuccessful.

It has been stated that the proponents of the embargo, secure in their position by reason of the indefinite extension of the existing embargo, are unconcerned as to the delays and really are hopeful that the bill itself might be recommitted so that the dye industry could be assured for a considerable time at least of that restriction on imports. Anyone who has had contact with the dye manufacturers who have come to Washington in connection with this legislation is in a position to refute such a charge, as their entire effort has been to obtain the speedy adoption of the bill and the termination of the uncertainty. Senator Frelinghuysen, who is leading the fight to make possible the maintenance and encouragement of the domestic chemical industry, has been almost abrupt on several occasions in demanding that further delay in taking up the question be prevented.

When Senator King was in the midst of a denunciation of what he terms the lobby in the interest of the embargo, Senator Frelinghuysen asked why he did not give some attention to the agents of the German dye interests who seem to have been extended office facilities in the Senate Office Building.

Revise Potash Schedule

Further revision of the potash schedule in the tariff bill has been decided on by the Finance Committee. In place of the proposed duties for 5 years as previously agreed on, the committee has decided to place potash on the free list and substitute for a tariff a bounty to American producers to aid them in producing potash. The change was explained to the Senate by Chairman McCumber of the Finance Committee. He said that Senator Hale of Maine had asked that potash be placed on the free list. The committee tentatively proposes, in lieu of the tariff, to encourage the American industry by granting a bounty equivalent to the tariff rate originally proposed. He stated that if the annual production of potash were 50,000 tons a year, the bounty would amount to not more than $2,500,000 for the first and second years, $2,000,000 for the third year, $1,500,000 for the fourth and $1,000,000 for the fifth year.

Tungsten and Chromium Rates

The Senate adopted a duty of 60c. a pound on the tungsten content and 25 per cent ad valorem on ferrotungsten, metallic tungsten, tungsten powder, tungstic acid and other compounds of tungsten.

During the tariff debate Senator Walsh of Montana inquired why a duty had not been placed on chrome ore. Senator Smoot of Utah explained that it is due to the fact that chrome ore production is scattered and the American product is inferior to the imported. Senator Walsh did not agree, saying there is no limit to the amount of the ore that could be produced and that it is equal in quality to that produced elsewhere.

Shortridge Resolution Would Give President Power to Act on Reparation Dyes

A resolution has been introduced by Senator Shortridge granting broad powers to the President to be used in meeting the reparations dyes situation. Senator Shortridge is chairman of the sub-committee which has just completed its investigation of the dye situation.

The resolution provides that the President be authorized and requested to take such measures as may be required to obtain for the United States the dyestuffs and drugs to which it is entitled under Sec. 1, Art. XI of the treaty of peace between the United States and Germany.

The need for immediate and decisive action in arranging for a satisfactory receiving system for the reparations dyes before June 30, when the present arrangement terminates, was brought out during the investigation.

Summary of Chemical and Oil Companies Organized

During the month of May twenty new companies were organized, with individual capitalization of $50,000 or more, to manufacture chemicals, chemical byproducts, drugs and affiliated products. The aggregate indicated investment was $3,671,000, as compared with $20,055,000 in the preceding month, when exactly the same number of such concerns were formed. During the same month of a year ago the total capitalization of such new companies was $12,400,000.

Seventy-three companies were organized in May with capitalization of $50,000 or more, to engage in different branches of the oil industry, with total indicated investment of $105,595,000.

Personal

Dr. Robert Calvert is now in charge of the Celite Products Co.'s laboratory at Lompoc, Cal.

F. E. Coombs, consulting chemical engineer of San Francisco, Calif., has accepted a position with the Department of Commerce. After some months in Washington he will be stationed in Havana, Cuba.

E. P. Gillan has resigned his position as chief chemist with the American Cereal Syrup Co. to accept one with the Chicago Starch Co.

James B. McNair, chemist with the Bureau of Internal Revenue, has been transferred from Washington, D. C., to Chicago, Ill.

George N. Moore, president of the Shaffer Oil & Refining Co., Chicago, Ill., has resigned. He will become head of a new oil-refining company now being organized.

J. C. Pearson, chief of the cement investigations of the Bureau of Standards, has just returned from a long Western trip. While in California he arranged for the investigation of cement sewer pipe which the bureau is to make during the coming year.

Prof. Charles Hyde Warren has been elected by the Yale Corporation as director of the Sheffield Scientific School to succeed Russell H. Chittenton. Prof. Warren is an alumnus of Yale, class of 1896, and since 1900 has been on the faculty of the Massachusetts Institute of Technology. Since 1915 he has been professor of mineralogy. Dr. Chittenton's retirement follows a determination made when he offered his resignation a year ago. He has been a member of the Yale faculty since his graduation from Sheffield Scientific School 47 years ago has been head of Sheff. since 1898.

Obituary

S. C. Ellis of Dallas, Tex., chemist and bacteriologist, formerly in charge of the municipal laboratory at the City Hall, died on May 31, at San Angelo, Tex., where he had gone on account of poor health. He was 30 years of age, and served 18 months overseas in the World War. Mr. Ellis is survived by his wife and young daughter.

A. H. Kersting, president of the Clinton Sugar Refining Co., Clinton, Iowa, died suddenly at his home on June 1, as a result of a stroke of apoplexy.

Alexander H. Smalley, chief chemist of the Nucoa Butter Co., Bayonne, N. J., died on June 8, as a result of injuries received in an explosion, followed by fire, in the chemical laboratory at the plant on the date noted. He was 25 years of age and a graduate of Cornell University.

E. R. Kemp, chairman of the board of directors, Sinclair Oil & Gas Co., Tulsa, Okla., died on June 9 at Roosevelt Hospital, New York, following an operation for appendicitis. He was 50 years of age, and widely known in the Middle Western oil-refinery industry. Mr. Kemp is survived by his wife and three children.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Studies of Depreciation and Obsolescence Offer a Promising Field for Chemical Trade Associations

Depreciation and obsolescence are stumbling blocks in almost every cost-finding system, but particularly in the chemical industries are their difficulties most evident. The cost accountant in these industries is often confronted with other very serious problems, such as those arising from joint products and byproducts, inter-departmental transfer of materials, off-standard products, etc., and in the maze of these difficulties he is likely to accept without question some very arbitrary method of handling depreciation and obsolescence charges. Or, as is the case with some chemical firms, these items are not regarded as proper elements of current costs and are taken into consideration only at the end of the year or some other fiscal period, when a definite sum is written off against profits to cover depreciation and obsolescence. And very often this amount is influenced by the amount of profits shown on the credit side of the ledger.

A Plan for Group Studies

For tax purposes, however, there is a very definite need for accurate methods of determining these charges and particularly in such a manner as will receive the indorsement of the Treasury Department. In the hope of assisting manufacturers in this connection, the Fabricated Production Department of the Chamber of Commerce of the United States has worked out a plan for handling these problems through the agency of the trade associations within the different industries. The plan provides for the appointment of a committee on depreciation, which should preferably consist of from five to seven engineers, cost accountants and plant superintendents selected from the industry. This committee would prepare a questionnaire providing for the listing of equipment and other units of utility[1], their cost, estimated scrap value and years of useful life.

Before sending this questionnaire to the manufacturers, the department recommends that certain preliminary points, such as the following, should be cleared up:

(*A*) *Method of Charging Maintenance, Renewals and Depreciation.* It will not do merely to average the various estimates of useful life provided by the manufacturers of a given line, because the methods of charging maintenance, renewals and depreciation may not be the same. Thus one manufacturer may charge as maintenance all repairs and partial renewals. By this method the laying of a new roof on a building would be charged as maintenance. Another manufacturer may charge to maintenance only such items as tend to keep the property in the same general condition. The laying of a new roof adds to the life of the asset and accordingly would be charged to the depreciation reserve. The first method gives a high maintenance rate and a low depreciation rate. The second method gives a low maintenance rate and a high depreciation rate. Suppose the first manufacturer charges 2 per cent for depreciation and the second 8 per cent. It will not do to average these rates and set 5 per cent as the guide for the industry. That would not give a true picture of actual conditions.

The Elements of Depreciation

(*B*) *A Statement of the Elements of Depreciation.* Accompanying the questionnaire should be a statement of the elements entering into depreciation, wear and tear, and obsolescence.

Wear and tear is defined as "that uniform wear-out and decay which repairing is unable to check" and it is dependent upon the amount of use, the amount of care, the quality of the installation and the natural hardships to be overcome.

Obsolescence arises from "an inability to compete in kind, in quality or in cost of desired results with later forms of the same utility." Allied there is that change in demand which displaces the whole life of the equipment.

The department points out that it is important for the depreciation committee to obtain sufficient facts for it to come to a conclusion as to which is the factor, obsolescence or wear and tear, determining the useful life of a given unit of utility. Certain chemical equipment is often not given the opportunity to wear out, it is replaced so rapidly because of improvements in the art. Clearly obsolescence is here the determining factor.

(*C*) *Determining Stated Conditions of Use.* Guide rates of depreciation for an industry presuppose stated conditions of use—the number of days of operation in a year, the number of hours of operation per day, a standard of maintenance, external conditions such as climate and road, etc.

With the normal conditions of use stated, it will be possible to provide for variances thereof upon a scale of percentages. Thus during the war additional rates of depreciation were allowed for overtime operation, and when depreciation can be based on an incident of production, capacity or performance, it may be feasible to scale the rate of depreciation for subnormal production.

After these questionnaires have been returned by the manufacturers, the committee is expected to prepare a digest of them, which is submitted to the industry for criticism and comment. Upon revision a conference can be arranged with experts of the Treasury Department in order that the depreciation data may be checked by them. When so checked the rates of depreciation should be promulgated as guide rates for the industry. It should be thoroughly understood, of course, that these depreciation rates would be merely suggestive and not mandatory and that in the last analysis the manufacturer must determine depreciation allowances from his own individual experiences.

Chemical manufacturers wishing to perfect this phase of their cost systems will do well to consult the Fabrication Production Department's very interesting pamphlet on "Depreciation—Its Treatment in Production." More general in character but of equal importance to the chemical industries is the report of the cost accountants' committee of the American Dyes Institute, which was published in 1920 under the title "Uniform Cost-Accounting Methods."

[1] "Unit of utility" is defined by the Treasury Department to mean a single purposed mechanism or part of a construction, subject to such like conditions of use that it would naturally be repaired or replaced as a unit.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	156.89
Last week	157.93

June, 1917	222	June, 1918	272
June, 1920	274	June, 1921	147
April, 1918 (high)	286	April, 1921 (low)	140

During the past month this index number has receded almost 4 points—from the recent high of 160.49 on May 24 to 156.89 for the current quotation. Of the 25 commodities on which this index is based, lower prices were recorded during the past week for 6—viz., formaldehyde, glycerine, potassium carbonate, soda ash, caustic soda and linseed oil.

Organization and Financing of the International Carbon Corporation

A new corporation to be known as the International Carbon Corporation has been organized to acquire control of the Darco Corporation and the patent rights for the manufacture of this decolorizing carbon. The operation of the manufacturing plants of the new corporation is under the direct supervision of the Atlas Powder Co., of Wilmington, Del., and the management of the Darco Sales Corporation is under the direction of the Columbian Carbon Co.

The authorized capitalization of the International Carbon Corporation consists of $2,500,000 of 8 per cent cumulative preferred stock, of which $863,300 is outstanding, and 300,000 shares of no par value common stock, of which 231,000 shares are outstanding.

Darco, the product to be manufactured, is produced from lignite by a patented process. It is used as a substitute for animal charcoal in the refining, decolorizing and deodorizing of a large number of staple products. Included in the list of industries in which decolorizing carbons are already finding use are sugar, glucose, maltose, lactose, sirups, glue, gelatine, vegetable oils (cottonseed oil, corn oil, peanut oil, coconut oil, olive oil, soya bean oil), fish oils, lard and butter substitutes, glycerine, alcohol, acids, wines, pharmaceutical chemicals, dye intermediates and photographic and other synthetic organic chemicals.

A unit producing a ton a day has been in operation for more than a year at Marshall, Tex. It has just been announced that a 4,000 ton per year plant has been constructed and has commenced operation. The plant is adjacent to a large deposit of lignite and it is reported that an ample supply of natural gas is available for fuel.

New Financing for Atlantic Refining

A group of New York bankers, including the Equitable Trust Co. of New York, Cassatt & Co. and Blair & Co., Inc., recently purchased $15,000,000 15-year 5 per cent noncallable gold debentures of the Atlantic Refining Co. On the first day they were offered for sale the issue was largely oversubscribed and the subscription lists have since been closed.

The Atlantic Refining Co., it will be recalled, owns and operates refineries at Philadelphia, Franklin, Pa., Pittsburgh, and Brunswick, Ga., besides owning extensive sales equipment, warehousing and storage facilities throughout Pennsylvania, Delaware and the New England states. Its total deadweight tonnage of tank steamers and various marine equipment is estimated at 75,000 tons. A subsidiary of the Atlantic is interested in the production of crude oil in Mexico.

American Metal Reports Earnings in First Four Months of 1922

Consolidated profit and loss account for the first four months of 1922, according to C. M. Loeb, president of the American Metal Co., Ltd., shows net earnings for that company of $762,708, after allowances have been made for depreciation, etc.

After completing the financing that is now under way, the American Metal Co. will have $5,000,000 preferred stock authorized and outstanding and 536,000 shares of an authorized issue of 1,000,000 shares of common stock having no par value.

The New York Market

NEW YORK, June 19, 1922.

Business during the past week in the chemical market has been generally quiet due to the influence of a number of different elements. The coal strike, the uncertainty of tariff legislation, the possibility of a railroad strike and the failure of the loan negotiations in Europe have combined in causing a general slackening in industry. With the exception of a few commodities, the entire chemical list showed no outstanding features. Flouride of soda and acetate of soda recorded net advances for the week, while prussiate of soda, nitrite of soda, formaldehyde and bleaching powder were quoted lower under keener competition and an abundance of spot stocks. The export inquiry for caustic soda showed considerable improvement and so too did the domestic inquiry.

Crude coal-tar products continue firm and in good demand. Producers of cresylic acid, benzene, solvent naphtha and toluene are experiencing a steady call from the various consuming industries. Intermediates, on the other hand, are quite irregular. Aniline oil, beta naphthol and para nitraniline are much easier under a slackening of demand and are subject to pronounced shading.

INDUSTRIAL CHEMICALS

Ammonium Carbonate—First hands are holding stocks well in hand at 8¾c. per lb., and quote the market on the basis of 8¾@9c. per lb. Second hands offer odd lots at 8½c.

Arsenic—Prime white powdered material on spot is held firm by leading dealers at 7¼@7½c. per lb. A moderate consuming inquiry is reported, with trading fairly active.

Bichromate of Potash—A few small-lot sales were recorded by resale merchants at 9¾c. per lb. Large quantities were quoted down to 9½c. Business in this product has not shown any appreciable change during the past week.

Bichromate of Soda—Trading is quiet for both export and domestic consumption. Spot goods are quoted at 7¼@7½c. per lb., with a few small resale lots as low as 7⅛c. per lb.

Caustic Potash—Business has been moderate during the interval and several sales were reported at 5¾c. per lb. for 88-92 per cent goods. Shipments were quoted around $5.65 per 100 lb.

Caustic Soda—The export market is being strongly maintained at $3.80@$3.85 per 100 lb., f.a.s. Inquiries have been more abundant during the past week and producers are looking forward to a better volume of business. Domestic quotations remain practically unchanged.

Copper Sulphate—The general condition of this market is exceedingly firm, with only a few odd lots available. The demand is very active for spot and near futures, with prices for standard large crystals ranging around 6@6¼c. per lb.

Fluoride of Soda—The market has recorded an advance of 1c. per lb. Leading factors report sales of small quantites to the consuming trade at 10@10½c. per lb. Demand is fairly active.

Nitrite of Soda—Most trading has been done on a small quantity basis, with resale merchants quoting 8¼@8½c. per lb. for imported material. Domestic prices are held around 9c. per lb.

Prussiate of Soda—Demand has eased off considerably and spot prices were much lower. Imported goods was quoted as low as 20½c. per lb. with the prevailing figure at 21½c. per lb. Recent arrivals have had a detrimental effect on the spot market.

Soda Ash—The market for this commodity is reported quiet by leading factors. Light 58 per cent, in single bags, is quoted at $1.80 per 100 lb. in carload lots on spot. Contracts remain unchanged.

Sodium Acetate—The lowest price for spot material is around 5½c. per lb. The demand has shown considerable improvement during the past few weeks and producers report a temporary shortage of spot supplies.

COAL-TAR PRODUCTS

Benzene—Resale material is exceedingly scarce, with a few light offerings of the 90 per cent held around 35@40c. per gal. Producers continue to quote contracts of the 90 per cent at 28@32c. per gal. and the pure at 30@35c.

Cresylic Acid—Resale 97-99 per cent material on spot is quoted as high as 65c. per gal. Several sales were recorded at this level. The general condition of this market is very firm, with offerings limited. Producers are quoting 56@58c. per gal. for the 97-99 per cent and 51@53c. for the 95 per cent, dark, f.o.b. works.

Alpha Naphthol—The refined material sold at $1.10@$1.15 per lb. during the past week. Small lots seemed to feature the market. Technical goods remained dormant, with sellers asking $1@$1.05 per lb.

Beta Naphthol—There has been no improvement in the market for the technical variety and the general condition is very irregulaar. Spot material is quoted around 23c. per lb.

The Iron and Steel Market

PITTSBURGH, June 16, 1922.

The general iron and steel situation underwent no particular change in the past week. Pressure upon the mills for deliveries may have increased a trifle, while the volume of sales and purchases probably decreased slightly. The steel market is not especially active, from a tonnage standpoint, not nearly as active as in April.

The urgency of steel buyers for deliveries is probably not a measure of their immediate requirements, but rather represents anxiety lest something occur to prevent shipment later, such as a decrease in steel production due to the coal strike. There is no evidence that any consumers of steel are really short of steel or are having their operations restricted on this account.

HAS THERE BEEN AN ACCUMULATION OF STOCKS?

As to the general position of the steel market, its strength and its prospects for the nearby future, the discussion still centers around the question of how much steel buyers have accumulated. Production in the past 3½ months almost equals production in the 6 months preceding. It is pointed out that part of the so-called accumulation of stock is in steel which buyers have gathered together for construction and other work, in accordance with ordinary practice, and this prevents the steel from being considered speculative, or as accumulated merely because there is a coal strike.

While the condition can be explained and defended, the bare fact remains that the steel market is more or less on the defensive—that is, there is a call, admitted to be reasonable, for an explanation of why the market is as strong as it is. Steel ingot production at the present rate, about 39,000,000 tons a year, is 30 per cent in excess of the average rate in the two largest tonnage years before the war, 1912 and 1913, and 55 per cent above the output in the next best year, 1910, yet one could scarcely say that the surface indications are that steel is being actually consumed in the same tonnage as in those years.

THE STEEL MARKET

The steel market has been gradually growing quieter as to tonnage turnover. The trend can be attributed to the increasing unwillingness of mills to obligate themselves farther, as they are well sold up now and the coal strike is not ended, to the disposition of buyers not to commit themselves as far ahead as they used to do, and to the approach of the usually dull midsummer period.

Prices are very firm all along the line, and if prices do not show a general advancing tendency there is at least a little more disposition for early deliveries to command premiums, and there is an advancing tendency in manufactured steel products, such as bolts, rivets, spikes, cold-finished bars, etc., attributed to the higher prices now ruling for the raw materials involved.

The market is quotable as follows: Bars, shapes and plates, 1.60@1.80c.; hoops and bands, 2.25@2.40c.; blue and annealed sheets, 2.40@2.50c.; black sheets, 3.15@3.30c.; galvanized sheets, 4.15@4.30c.; automobile sheets, 4.50@4.75c.; tin plate, $4.75; nails, $2.40@$2.50; standard steel pipe, 71 per cent basing discount.

PIG IRON AND ORE PRICES

The pig iron market continues very dull, and is not quotably changed, as follows: Bessemer and basic, $25; foundry, $24@$25 f.o.b. valley furnaces.

Lake Superior iron ore prices for the 1922 season have been developed at 50c. decline from the 1921 and 1919 prices, or $1.50 under the 1920 schedule. The new prices, f.o.b. Lake Erie docks, are: Old range bessemer, $5.95; old range non-bessemer, $5.20; Mesabi bessemer, $5.70; Mesabi non-bessemer, $5.05. Approximately half the reduction from last year is borne directly by the ore producers, the remainder being in reduced transportation cost. The transportation tax has been off since the beginning of the year, involving a saving of about 5c. a ton. Rail rates from mine to dock have been reduced 10 per cent, equal to 10c. on Vermilion and Mesabi ores, the net lake vessel rate is down 10c. and the Lake Erie dock charge, added to the vessel rate, is down 1c., making the total lake rate 70c. plus 13c., or 83c. This brings the ore to the market prices being in essence at the rail of the vessel, and then there is a reduction in the dock charge from rail to car from 8½c. to 8c., a direct saving to the ore buyer in addition to the 10 per cent reduction in rail rates from Lake Erie which went into effect June 15.

The Chicago Market

CHICAGO, Ill., June 15, 1922.

Firmness characterizes the industrial chemical market, even though sales show no particular increase in volume. Demand continues only routine, although buyers display a little more confidence in the market. Stocks are not generally heavy and it is difficult to locate any supplies at all of some items. Prices are maintained in nearly every direction, even the small broker being reluctant to cut his schedule. Imported material is very firm, with arrivals lighter than usual.

GENERAL CHEMICALS

The alkali market is unchanged, with the movement of supplies fairly active. *Caustic soda* is firm at $3.85@$3.95 per 100 lb. for the solid and $4.35@$4.50 for the ground or flake. *Caustic potash* continued firm, with small lots of the 88-92 per cent material offered at 6¾c. per lb. *Soda ash* is reported to be moving well at $2.20@$2.30 per 100 lb. for the 58 per cent material in cooperage.

Alums are in an easy position, although holders maintained their schedules. *Ammonia alum* is available at 3½@4c. per lb. for the lump and 4@4½c. for the powdered. *Potash alum* is in light demand and lacks quotable change. The lump is quoted at 4½c. per lb. and the powdered at 5½c., the latter grade moving in a somewhat better volume. Barium compounds, while very firm, are in a somewhat easier position. Small lots of *barium chloride* are available at $110@$120 per ton. *Copper sulphate* continues exceedingly firm, with spot stocks light. Small lots were quoted at 6@6½c. per lb. There is a small demand for ammonium carbonate and the lump is available at 13@13½c. per lb. *Sal ammoniac* is moving in a routine way at 7¾@8c. per lb. for the white granular. The lump sal ammoniac was firm at 17@18c. per lb. *White arsenic* is somewhat easier at 8c. per lb. *Carbon bisulphide* is moving slowly at 7@7½c. per lb. for drums. *Carbon tetrachloride* is enjoying a somewhat better demand and is quoted at 10c. per lb. in large drums.

There is little or no change on bichromates, the market presenting an easy appearance. *Potash bichromate* is quoted at 11¾c. in single-cask lots and the *soda* in similar quantities at 9c. *Potash permanganate* is easy, with U.S.P. material available at 16c. per lb. The prussiates continue very firm and scarce, with prices higher on both kinds. *Yellow prussiate of potash* is quite scarce and only small or medium lots can be located at 34@36c. per lb. The *red* remains off of the market, with nothing in sight for future delivery. *Potash chlorate* is moving slowly at 8c. per lb. for the powdered and 9@10c. for the crystals. *Rochelle salts* are in an easy position and imported powder is available at 20c. per lb. *Hyposulphite of soda* is dull at $3.85 per 100 lb. for the pea crystals in barrels.

LINSEED OIL

Linseed oil is moving a great deal more freely and the outlook is brighter. Single drums of the boiled oil are quoted at 98c. per gal and the raw in similar lots at 96c.

NAVAL STORES

Turpentine is none too plentiful, and the local market was very firm. A prominent factor in the market predicts higher prices with increasing scarcity. A good movement is reported at $1.06 per gal., basis single drums. *Rosins* were in a position similar to turpentine and are reported to be moving freely. The WW grade is quoted in less than carlots at $9 per 280 lb.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride	lb.	.... –	$0.38 – $0 40
Acetone	lb.	$0 08 – $0 09	.09½– .10
Acid, acetic, 28 per cent	100 lbs.	2 25 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	8 50 – 9 00	50 – 9 75
Boric, crystals	lb.	.11 – .11½	.11½– .12
Boric, powder	lb.	.11 – .11½	.11½– .12½
Citric	lb.	.... –	.45 – .46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½– .12
Lactic, 44 per cent tech	lb.	.09½– .10	.10½– .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½– .05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		.... –	.... – ....
Nitric, 40 deg.	lb.	.06 – .06½	.06¾– .07
Nitric, 42 deg.	lb.	.06½– .06¾	.07 – .07½
Oxalic, crystals	lb.	.14 – .14½	14½– .15
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½– .09½
Picric	lb.	.22 – .24	.24½– .30
Pyrogallic, resublimed	lb.	.... –	1 65 – 1 75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	.... – ....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	.... – ....
Sulphuric, 66 deg., tank cars	ton	15 00 – 16 00	.... – ....
Sulphuric, 66 deg., drums	ton	19 00 – 20.00	20 50 – 21 00
Sulphuric, 66 deg., carboys	ton	.... –	.... – ....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	.... – ....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22 50	23.00 – 24 00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33 00 – 34 00
Tannic, U. S. P.	lb.	.... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	.... –	.28½– .29
Tartaric acid, imported, powdered	lb.	.... –	.29½– .30
Tartaric acid, domestic	lb.	.... –	.... – .30
Tungstic, per lb. of WO	lb.	.... –	1.00 – 1 10
Alcohol, ethyl (Cologne spirit)	gal.	.... –	4.75 – 4 95
Alcohol, methyl (see methanol)		.... –	.... – ....
Alcohol, denatured, 188 proof No. 1	gal.	.... –	.26 – .30
Alcohol, denatured, 188 proof No. 5	gal.	.... –	.26 – .30
Alum, ammonia, lump	lb.	.03½– .03¾	.04 – .04¼
Alum, potash, lump	lb.	.03½– .04	.04¼– .05
Alum, chrome lump	lb.	.05¼– .05¾	.06 – .06½
Aluminum sulphate, commercial	100 lb.	1 50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½– .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06½– .07½	.07½– .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.30½– .31
Ammonium carbonate, powder	lb.	.07 – .07¼	.07½– .08
Ammonium nitrate	lb.	.06 – .06½	.06¾– .07½
Amylacetate tech	gal.	.... –	2.00 – 2.25
Arsenic, white, powdered	lb.	.07¼– .07½	.07¾– .08
Arsenic, red, powdered	lb.	.12 – .12½	.12½– .13
Barium carbonate	lb.	.03 – .04	.04½– .05
Barium chloride	ton	90.00 – 95.00	100 00 – 105 00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½– .22
Barium nitrate	lb.	.07 – .07¼	.07½– .08
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½– .04¾
Blanc fixe, dry	lb.	.04 – .04½	.... – ....
Blanc fixe, pulp	ton	45 00 – 55.00	.... – ....
Bleaching powder	100 lb.	1 60 – 1.75	1 85 – 2.50
Blue vitriol (see copper sulphate)		.... –	.... – ....
Borax	lb.	.05¼– .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		.... –	.... – ....
Bromine	lb.	.27 – .28	.28½– .35
Calcium acetate	100 lbs.	1 75 – 2 00	.... – ....
Calcium carbide	lb.	.04½– .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01¾– .01¾	.02 – .02½
Calcium peroxide	lb.	.... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	.... –	15 – .16
Camphor	lb.	.... –	.79 – .83
Carbon bisulphide	lb.	.06½– .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.09½– .10	.10½– .12
Carbonyl chloride, (phosgene)	lb.	.... –	.60 – .75
Caustic potash (see potassium hydroxide)		.... –	.... – ....
Caustic soda (see sodium hydroxide)		.... –	.... – ....
Chalk, precip.—domestic, light	lb.	.04½– .04½	.... – ....
Chalk, precip.—domestic, heavy	lb.	.03½– .03¾	.... – ....
Chalk, precip.—imported, light	lb.	.04½– .05	.... – ....
Chlorine, gas, liquid-cylinder (100 lb.)	lb.	.05 – .05½	.05¾– .06
Chloroform	lb.	.... –	.30 – .32
Cobalt oxide		.... –	2.00 – 2 10
Copperas	ton	20 00 – 22 00	23 00 – 30 00
Copper carbonate, green precipitate	lb.	19 – .20	20½– .21
Copper cyanide	lb.	.... –	.58 – .60
Copper sulphate, crystals	100 lb.	6.00 – 6.15	6.25 – 6 50
Cream of tartar	lb.	.... –	.24 – .25
Epsom salt (see magnesium sulphate)		.... –	.... – ....
Ethyl acetate com. 85%	gal.	.... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	.... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.08¼– .08½	.08¾– .09
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	.... – ....
Fullers earth—imported powdered—net	ton	30.00 – 32.00	.... – ....
Fusel oil, ref.	gal.	.... –	2.25 – 2 65
Fusel oil, crude	gal.	.... –	1.25 – 1 45
Glauber's salt (see sodium sulphate)		.... –	.... – ....
Glycerine, c. p. drums extra	lb.	.... –	.14¾– .15¼
Iodine, resublimed	lb.	.... –	4.20 – 4 25
Iron oxide, red	lb.	.... –	.12 – .18
Lead acetate	lb.	.... –	.09⅝– .12
Lead arsenate, powd.	lb.	13½– 14	.14½– .15
Lead nitrate	lb.	.... –	.15 – .20
Litharge	lb.	.07½– .08	.08 – .09
Magnesium carbonate, technical	lb.	.08½– .08¾	.09 – .09½
Magnesium sulphate, U. S. P.	100 lb.	2 50 – 2 60	2.65 – 2 85
Magnesium sulphate, technical	100 lb.	.... –	1.10 – 1 80
Methanol, 95%	gal.	.... –	.57 – 58
Methanol, 97%	gal.	.... –	.59 – 60
Nickel salt, double	lb.	.... –	11 – .11½
Nickel salt, single	lb.	.... –	10 – .10½
Phogene (see carbonyl chloride)		.... –	.... – ....
Phosphorus, red	lb.	.... –	.40 – .45
Phosphorus, yellow	lb.	.... –	.30 – .35
Potassium bichromate	lb.	.09¾– .10	.10½– .10
Potassium bromide, granular	lb.	.... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – 16
Potassium carbonate, 80–85%	lb.	.04½– .05	.05½– .06
Potassium chlorate, powdered and crystals	lb.	.06½– .07	.07½– .08
Potassium cyanide	lb.	.... –	.45 – .50
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6 25– 6.50
Potassium iodide	lb.	.... –	3.30 – 3.40
Potassium nitrate	lb.	.06¾– .07	.07½– .08
Potassium permanganate	lb.	.14 – .14½	.14¾– .15½
Potassium prussiate, red	lb.	.... –	.80 – .85
Potassium prussiate, yellow	lb.	32 – .32½	.32½– .33
Rochelle salts (see sodium potas. tartrate)		.... –	.... – ....
Salammoniac, white, granular	lb.	.06¾– .07	.07½– .08
Salammoniac, gray, granular	lb.	.07¾– .08	.08¼– .08½
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	20.00 –25.00	.... – ....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1.80 – 1.90	1.95 – 2 40
Soda ash, dense, in bags, resale	100 lb.	1.90 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.05½– .06	.06¼– .06¾
Sodium bicarbonate	100 lb.	1.75 – 1.85	1.90 – 2.30
Sodium bichromate	lb.	.07½– .07½	.07¾– .08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½– .04½	.04¾– .05¼
Sodium chlorate	lb.	.06¼– .06¾	.07 – .07½
Sodium chloride	long ton	12 00 –13 00	.... – ....
Sodium cyanide	lb.	.22 – .23	.23½– .25
Sodium fluoride	lb.	.10 – .10¼	.10½– .11
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.80 – 3.85	–3.90 – 4.20
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	–4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	–4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03½	.03¾– .04
Sodium nitrite	lb.	.08¼– .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½– .04	.04¼– .04½
Sodium potassium tartrate (Rochelle salts)	lb.	.... –	.18 – .21
Sodium prussiate, yellow	lb.	.21 – .21½	.22 – .23
Sodium silicate, (40 deg. in drums)	100 lb.	.80 – 1.00	1.05 – 1.25
Sodium silicate, (60 deg. in drums)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glanbers salt)	100 lbs.	.95 – 1.05	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.04⅜– .04½	.04½– .05
Sodium sulphite, crystals	lb.	.03½– .03⅝	.03¾– .04¼
Strontium nitrate, powdered	lb.	.09½– .10	.10½– .12
Sulphur chloride, yellow	lb.	.04½– .05	.05¼– .06
Sulphur, crude	ton	18.00 –20.00	.... – ....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	.... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	.... –	2.00 – 2.75
Talc—imported	ton	30 00 –40 00	.... – ....
Talc—domestic powdered	ton	18 00 –25 00	.... – ....
Tin bichloride	lb.	.09 – .09½	.09½– .10
Tin oxide	lb.	.... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14¾– .15¾
Zinc chloride, gran.	lb.	.05¼– .05½	.05¾– .06½
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½– .08	.08¼– .08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$1.00 — $1 05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.14 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.80 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.50 — .55
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.23 — .26
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.56 — .65
Cresylic acid, 95-97%, dark, in drums	gal.	.51 — .58
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Di nitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Dipnenylamine	lb.	.59 — .65
H-acid	lb.	.80 — .95
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.00 — 1.20
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½— .07
Naphthalene, balls	lb.	.08 — .08
Naphthionate of soda	lb.	.58 — .65
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
N-W acid	lb.	1.15 — 1.30
Ortho-amidophenol	lb.	.40 — 2.50
Ortho-dichlor-benzene	lb.	2.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	$0 10 —	$0.13
Ortho-toluidine	lb.	.14 —	.18
Para-amidophenol, base	lb.	1 25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.17 —	20
Paranitroaniline	lb.	.72 —	.75
Para-nitrotoluene	lb.	.55 —	.65
Para-phenylenediamine	lb.	1.55 —	1 60
Para-toluidine	lb.	.90 —	1.00
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	15
Pyridine	gal.	1 75 —	2 75
Resorcinol, technical	lb.	1.30 —	1 35
Resorcinol, pure	lb.	1.75 —	1.80
R-salt	lb.	.60 —	.70
Salicylic acid, tech., in bbls	lb.	.25 —	.25½
Salicylic acid, U. S. P	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	.27 —	.32
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.18
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax	lb.	$0.21 —	$0.22
Beeswax, refined, dark	lb.	.30 —	.32
Beeswax, refined, light	lb.	.34 —	.35
Beeswax, white pure	lb.	.38 —	.40
Candelilla, wax	lb.	.28 —	.30
Carnauba, No. 1	lb.	.42 —	.44
Carnauba No. 2, North Country	lb.	.24 —	.25
Carnauba, No. 3, North Country	lb.	.16 —	.16½
Japan	lb.	.16 —	.16½
Montan, crude	lb.	.04½ —	.04¾
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ —	....
Paraffine waxes, crude, scale 124-126 m.p	lb.	.02¾ —	....
Paraffine waxes, refined, 118-120 m.p	lb.	.03⅜ —	.03¾
Paraffine waxes, refined, 125 m.p	lb.	.03½ —	.03¾
Paraffine waxes, refined, 128-130 m.p	lb.	.04 —	.04¼
Paraffine waxes, refined, 133-135 m.p	lb.	.04½ —	.04¾
Paraffine waxes, refined, 135-137 m.p	lb.	.05 —	.05¼
Stearic acid, single pressed	lb.	.09 —	.09¼
Stearic acid, double pressed	lb.	.09½ —	.09¾
Stearic acid, triple pressed	lb.	.10½ —	.10¼

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.25 —	$5.35
Rosin E-I	280 lb.	5.60 —	5.65
Rosin K-N	280 lb.	6.15 —	6.70
Rosin W. G.-W. W	280 lb.	7.60 —	8.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	1 00 —	1.01
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.00
Pine oil, pure, dest. dist	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref	gal.		.52

Fertilizers

Prices remain same as previous report.

Crude Rubber

Quotations remain same as June 14th report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.11 —	$0.11½
Castor oil, AA, in bbls	lb.	.12 —	.12½
China wood oil, in bbls	lb.	.13¾ —	.14
Cocoanut oil, Ceylon grade, in bbls	lb.	.08½ —	.08¾
Cocoanut oil, Cochin grade, in bbls	lb.	.09¼ —	.09½
Corn oil, crude, in bbls	lb.	.11¼ —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	$0.10 —	$0.10
Cottonseed oil, summer yellow	lb.	.11¾ —	.12
Cottonseed oil, winter yellow	lb.	.12 —	.13
Linseed oil, raw, car lots (domestic)	gal.	.80 —	.81
Linseed oil, raw, tank cars (domestic)	gal.	.76 —	.78
Linseed oil, boiled, in 5-bbl. lots (domestic)	gal.	.85 —	.86
Olive oil, denatured	gal.	1 15 —	1.17
Palm, Lagos	lb.	.07½ —	.07
Palm, Niger	lb.	.06½ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10½
Peanut oil, refined, in bbls	lb.	.12½ —	.12¾
Rapeseed oil, refined in bbls	gal.	.84 —	.85
Rapeseed oil, blown, in bbls	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.12½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10¼ —	....

FISH

Light pressed menhaden	gal.	$0.51 —	....
Yellow bleached menhaden	gal.	.53 —	.54
White bleached menhaden	gal.	.55 —	.56
Blown menhaden	gal.	.61 —	....
Whale O l, No. 1. crude, tanks, coast	gal.	.45 —	.48

Refractories

Prices remain quotably unchanged.

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225 00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 78-82% Mn, domestic	gross ton	67.00 —	69.00
Ferromanganese, 78-82% Mn, German	gross ton	66.00 —	66 50
Spiegeleisen, 19-21% Mn	gross ton	36.00 —	....
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2 25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	58.00 —	60.00
Ferrosilicon 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	.....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.00 —	3.50

Ores and Semi-finished Products

Fluorspar, gravel, f.o.b. mines New Mexico, net ton, $15.00.
Fluorspar, standard, domestic washed gravel, Kentucky, and Illinois mines, net ton, $17.50—19.00
All other prices remain unchanged.

Miscellaneous Materials

Shellac, orange fine	lb.	80 —	.81
Shellac, orange superfine	lb.	.82 —	.84
Shellac, A. C. garnet	lb.	.67 —	.68
Shellac, T. N	lb.	.78 —	.80

All other quotations remain same as previous report.

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb
Copper, electrolytic	13.875
Aluminum, 98 to 99 per cent	19.00-20.00
Antimony, wholesale lots, Chinese and Japanese	5.25-5 30
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32 00–33.00
Nickel, ingot and shot, resale	29 00–31.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.125
Lead, New York, spot	5.75
Lead, E. St. Louis, spot	5.625
Zinc, spot, New York	5 75
Zinc, spot, E. St. Louis	5.425

All other quotations are unchanged

OTHER METALS

Silver (commercial)	oz.	$0.71¾
Cadmium	lb.	1.15–1.20
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3 25
Magnesium, ingots, 99 per cent	lb.	1.10
Platinum	oz.	87.50
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00@ 57.50
Mercury	75 lb.	55.00@ 56.00

FINISHED METAL PRODUCTS

All quotations remain unchanged.

Structural Material

Prices remain same as previous report.

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

GLASS—The United States Glass Co., Tiffin, O., has fired a second furnace at its plant, increasing the output from 52 to 80 per cent of normal. The works have been placed on full time operating basis, in different departments, giving employment to about 400 men.

The Interstate Window Glass Co., Smethport, Pa., is arranging for the early resumption of operations at its local plant, following a curtailment for some time past.

Following the refusal of a request from operatives for a wage increase, the Consolidated Window Glass Co., Mount Jewett, Pa., has closed its local plant until further notice.

CERAMIC—The Finzer Brothers Clay Co., Sugarcreek, O., manufacturer of face brick and kindred products, is increasing operations at its plant. During the month of May the company made a record output comprising 137 carloads of material, aggregating 1,305,000 bricks.

The Fords Porcelain Works, Perth Amboy, N. J., manufacturer of sanitary ware, is running full at its two local plants, as well as factory at Fords, near Perth Amboy.

RUBBER—The Republic Rubber Corp., Youngstown, O., is increasing production in its mechanical rubber goods department. The Canton, O., works is running on an advanced working schedule, with output averaging 1,500 automobile tires daily.

The Burdick Tire & Rubber Co., Noblesville, Ind., will commence operations at its local plant in July. The works has been completed for a number of months, but has been kept idle until conditions warranted manufacture. The plant has a capacity of 5,000 tires a day, and it is expected to develop this output at an early date. Employment will be given to about 100 men for initial production.

All plants at Akron, O., devoted to the manufacture of mechanical rubber goods, have been placed on a capacity basis with regular operating forces.

The Howe Rubber Corp., New Brunswick, N. J., is increasing operations at its plant in the line of automobile tires. Sales during the month of May were the largest in the history of the company.

The McGraw Tire & Rubber Co., New York, N. Y., has advanced production at its plant to 2,200 casings and 1,500 inner tubes per day. It is expected to make further increase in this output at an early date.

IRON AND STEEL—The Carnegie Steel Co. is arranging for the resumption of operations at six additional open-hearth furnaces and one blast furnace at its Sharon, Pa., plant, bringing production up to close to normal, or full capacity basis. About 1,000 men will be added to the working force.

The United Alloy Steel Corp. has resumed operations at the plant of the Canton Sheet Steel Co., Canton, O., recently acquired, placing four mills in service. Other mills and departments will be reopened at an early date. It is expected to employ a regular working quota of 1,800 men.

The Youngstown Sheet & Tube Co., Youngstown, O., is making ready for operations at its Hubbard plant, which has been idle for some time past. It is said that both blast furnaces will be blown in as soon as the coal supply improves.

The British Empire Steel Corp. is increasing operations at its plant at Sydney, N. S., giving employment to 1,900 men as against a working force of 1,200 on May 1. Additions will be made to this number in the near future.

The Wheeling Steel Corp., Wheeling, W. Va., has reopened the sheet mill at the plant of its Whitaker-Glessner division, Martin's Ferry, O., following a shutdown since the spring of 1921. It is expected to reach the full working quota of 800 men in the near future. The company has advanced the wages of all hourly workers at its different plants at Steubenville, Beech Bottom and Martin's Ferry about 10 per cent.

The National Tube Co., Lorain, O., has increased production to about 80 per cent of capacity at its local plant, which, due to works expansion, exceeds regular production during the pre-war period.

The Eastern Steel Co. is making repairs to the machinery in the blooming mill at its Pottsville, Pa., works, and plans to place the unit in service at an early date. Work will be resumed at the 28-in. mill at the same time.

The Republic Iron & Steel Co. is arranging for the resumption of operations at its rerolling bar mill at Moline, Ill., after a shutdown since early in 1921.

MISCELLANEOUS—The Glidden Co., Cleveland, O., manufacturer of paints, varnishes, etc., is running its five plants on a full-time capacity basis, with 24-hour working schedule.

The Bartlesville Zinc Co., Bartlesville, Okla., is arranging for the resumption of operations at its Blackwell, Okla., smelting plant, following a suspension since last January. Employment will be given to about 400 men.

The Alabama By-Products Corp., Birmingham, Ala., is operating at full capacity and has plans under way for the early erection of twenty-five additional Koppers coke ovens to increase the output by about 50 per cent.

The International Nickel Co., New York, N. Y., has resumed operations at its Port Colborne, Ont., refining plant, after a shutdown for a number of months past. Production at the smelting plant at the works will be deferred for the present.

The United States Cast Iron Pipe Co. has advanced production to about 80 per cent of capacity at its plants at Bessemer and Anniston, Ala., and Chattanooga, Tenn.

The American Smelting & Refining Co. is increasing production at its Perth Amboy, N. J., plant. The working force has been advanced to close to 1,000 men, and further additions will be made at an early date.

Construction and Operation

Alabama

LA PINE — The A. E. Davis Permanent Ink Co. has recently organized under Delaware laws, with capital of $100,000, and is arranging for the establishment of a local plant for the manufacture of ink products, and is making inquiries for equipment, including ink-mixing machines, with capacity of about 75 gal. each. A. E. Davis, Sellers, Ark., is president; and T. A. Bullard, La Pine, general manager.

California

RICHMOND—James Hyslop has leased the local plant of the Coast Brick Co., and will operate the works for the manufacture of glazed and colored tile, and other burned clay products.

LOS ANGELES—Water-softening equipment, air compressors, cooling coils, brine tank, pumping machinery, etc., will be installed in the new plant to be constructed by the Mutual Dairy Co., Maomi and Walnut Sts. Clifford A. Truesdell, Jr., Purington & Newton, 303-7 San Fernando Bldg., associated engineers, are preparing plans.

Florida

MIAMI—The Tropical Fruit Conserving Co., 1444 West Miami Ave., will commence the immediate erection of a new 1-story plant, 75x180 ft., for the manufacture of coconut sirup and kindred specialties. The installation will include pressure cookers, aluminum vats, mixing machinery, etc. Samuel V. Aston is general manager.

GAINESVILLE—The Vego-Hair Mfg. Co., manufacturer of fiber products, is arranging for the rebuilding of the portion of its plant recently destroyed by fire, to comprise three 1-story buildings, each about 30x60 ft. A. H. Selle is general manager.

Illinois

CHICAGO—A 1-story foundry, 60x100 ft., to cost close to $50,000, will be constructed by the Chicago Hardware Foundry Co., 546 West Washington Blvd., at its plant at North Chicago.

CHICAGO—The Chicago Pottery Co., 1924 Clybourn Ave., has filed plans and commenced excavations for the erection of its proposed 2-story addition, 113x190 ft. Contract has been let to Bulley & Andrews, 25 North Dearborn St. L. E. Russell, 25 North Dearborn St., is architect.

LITCHFIELD—The City Council will call for bids about July 15, for the construction of a new filtration plant in connection with improvements in the waterworks system, estimated to cost about $300,000. The Pierce, Greeley & Hanson Engineering Co., 39 South Adams St., Chicago, is engineer.

Indiana

NOBLESVILLE—The New Process Steel Co. is completing construction work on its new local plant, and plans to have the works ready for operation early in July. Employment will be given to about 100 men for initial operations.

Kansas

LEAVENWORTH—The Great Western Stove Co. will build a 2-story and basement addition to its plant at 2nd and Choctaw Sts., to be equipped as an enameling department. W. R. and M. K. Foth, Leavenworth, are architects.

Louisiana

NEW ORLEANS—The Baldwin Petrinite Roofing Tile Co., manufacturer of composition roofing tiles and kindred products, is planning for the installation of additional machinery at its new local plant. Enos Baldwin is general manager.

Maine

TOPSHAM—The Pejepscot Paper Co., operating mills at Topsham, Pejepscot, Lisbon Falls and Bowdoin, Me., for the manufacture of newsprint, pulp, etc., has preliminary plans under way for extensions and improvements for considerable increase in capacity. The work is estimated to cost close to $1,000,000. Edgar Rickard is president, and Fred C. Clark, vice-president and general manager. The company is a subsidiary of the International Development Co.

Massachusetts

MARLBORO — The Dennison Mfg. Co., Framingham, has construction under way on its proposed new local plant for the manufacture of paper specialties, and plans to occupy the structure at the earliest date. It will be 4-story, reinforced-concrete, 70x300 ft., and estimated to cost close to $100,000, including machinery.

Michigan

FLAT ROCK—The Ford Motor Co., Highland Park, has plans in progress for the erection of a new local 1- and 2-story plant at Flat Rock, for the manufacture of glass products, including windshield glass, etc., for Ford automobiles. It is estimated to cost close to $1,000,000, including machinery. Albert Kahn, 1,000 Marquette Bldg., Detroit, is architect.

KALAMAZOO—The Kalamazoo Vegetable Parchment Co., manufacturer of parchment papers, is taking bids on a general contract for the erection of a 2-story plant addition, estimated to cost close to $400,000, including machinery. Billingham & Cobb, Press Bldg., Kalamazoo, are architects. J. Kindleberger is president and general manager.

KALAMAZOO — The Birmingham & Prosser Co., paper products, will construct a new building at its works, 54x166 ft., to cost about $75,000.

Missouri

POPLAR BLUFF—W. S. Hooper, president of the Ozark Ore & Mfg. Co., is at the head of a project to construct and operate a plant near St. Louis, for the manufacture of general chinaware products, estimated to cost in excess of $250,000, including machinery. It is said that a company will be organized to operate the proposed plant.

KANSAS CITY—The Standard Foundry & Mfg. Co., 204 Security Bldg., recently organized, will soon commence the erection of a new 1-story foundry, 90x120 ft., for

the manufacture of a general line of castings. W. H. Simpson is president, and J. B. Harden, secretary and treasurer.

New Jersey

TRENTON—The Unitco Pottery Co., Frazier St., will make extensions and improvements in the kiln department at its plant.

BAYONNE—The chemical laboratory at the plant of the Nucoa Butter Co., Ave. A and 4th St. was damaged by fire, caused by an explosion, June 8. An official estimate of loss has not been made.

Ohio

GOSHEN—S. P. Myers and S. O. McFall, officials of the Uhrichsville (Ohio) Sewer Pipe Co., have acquired the partly completed plant of the H. C. Schneider Sewer Pipe Co., Goshen, designed for the manufacture of vitrified sewer pipe, and adjoining clay properties. The new owners will organize a company to operate the plant, and purpose to complete the final plant units at an early date. The property was purchased for a consideration said to be $146,000.

AKRON—The International Lead Co., a subsidiary of the Anaconda Copper Co., 25 Broadway, New York, N. Y., is investigating local sites with view to the erection of a new plant for the manufacture of zinc oxides and compounds used in the production of rubber products. The proposed works will consist of a number of buildings, estimated to cost close to $1,000,000, including machinery. William Wraith is president.

Pennsylvania

PHILADELPHIA — The Philadelphia Paper Mfg. Co., River Rd., has broken ground for the erection of a new 1-story plant, 120x270 ft., at Umbria, Nixon and Founton Sts., estimated to cost about $60,000. The Hughes-Foulkrod Co., 1201 Chestnut St., has the construction contract. John Jacobs, Jr., is president.

PITTSBURGH—The Young Paper Mfg. Co., 34th St. and the Allegheny Valley Railroad, manufacturer of prepared roofing papers, etc., has preliminary plans under way for the rebuilding of the portion of its plant destroyed by fire, June 8, with loss approximating $100,000, including equipment. The same fire also destroyed a section of the foundry of the Pittsburgh Malleable Iron Co., 34th and Smallman Sts., with loss of about $40,000.

PHILADELPHIA—The Grasselli Chemical Co., 908 Chestnut St., has leased the 3-story building at 909 Sansom St., and will equip the structure for general operating service. Headquarters of the company are in the Guardian Bldg., Cleveland, O.

MARCUS HOOK—The Sun Co., Finance Bldg., Philadelphia, Pa., has commenced the rebuilding of the grease-manufacturing plant at its oil refinery, Marcus Hook, recently destroyed by fire, with loss approximating $60,000, including equipment. The new building will be 75x168 ft.

PHILADELPHIA—The National Ammonia Co. of Pennsylvania, Van Kirk St., has filed plans for the construction of a new building at its plant, to cost about $30,000. The erection contract has been let to E. E. Hollenbeck, Inc., 1804 Brandywine St.

PHILADELPHIA — The Wittman-Moriarty Co., 4th and Vine Sts., manufacturer of leather products, has construction under way and plans for the early occupancy of the new 1- and 2-story addition to its tannery at Ontario and C Sts., estimated to cost about $75,000. J. P. Wittman is president and treasurer.

PHILADELPHIA — The Hurlock Brothers Co., 3436 Market St., manufacturer of cardboard specialties and kindred products, has work under way on an addition to its plant, to cost about $10,000.

South Carolina

GREENVILLE—The Boll-We-Go Mfg. Co., recently organized, has plans under way for the establishment of a local plant for the manufacture of chemical compound products. Homer L. Todd is president.

Tennessee

COPPERHILL—The Tennessee Copper Co., 61 Broadway, New York, N. Y., has work under way on plant additions, including flotation expansion, with capacity of about 500 tons. J. N. Houser is general manager.

Texas

EL PASO—The J. M. Booth Chemical Co., manufacturer of sal soda and kindred products, has preliminary plans under way for the construction of an addition to its plant. Joseph M. Booth is president.

DALLAS—The Lignite Industries Corp., St. Paul, Minn., has organized a subsidiary company to be known as the Texas Lignite Co., for the construction and operation of a series of six plants in this state, to be located at Dallas, Fort Worth, Galveston, Houston, Greenville and one other point to be selected. Plans are under way for the initial works for the production of pressed briquets, with large chemical byproduct plant to be used for ammonia, carbolic acid, lubricating oil and paraffin manufacture. The entire project is estimated to cost close to $200,000, including equipment. Carl Jaeger is president and chemical engineer.

DALLAS—The Dallas Gas Co. has preliminary plans under consideration for extensions and improvements in its plant and system, to cost in excess of $300,000.

Virginia

RICHMOND—The Fibre Board Container Co., 3200 Williamsburg Ave., has plans under way for extensions in its plant, to double, approximately, the present output. D. J. Donati is president.

BUENA VISTA—The United Chemical Products Co., Chamber of Commerce Bldg., Pittsburgh, Pa., is taking bids for the construction of a new local plant, 1-story, 41x145 ft., estimated to cost close to $50,000. F. B. Doane is company engineer.

HEATHSVILLE—The Cherrystone Fish Oil Co., recently organized, has acquired the plant of the Cherrystone Oil & Guano Co., and will operate the works for the production of commercial fish-oil products. Improvements are being considered. T. H. Fallin, Coan, Va., is president; and A. J. Lewis, vice-president.

West Virginia

PIEDMONT—The Potomac Fire Brick Co. has commenced the installation of new machinery at its plant for considerable increased capacity.

WELLSBURG—The Hammond Bag & Paper Co., recently organized with a capital of $500,000, has plans in preparation for the construction of a new 1-story plant, 125x500 ft., for the manufacture of paper products. T. H. Hammond is president; and D. A. Burt vice-president.

LANSING—The Shawner Construction Co. has commenced the erection of a new 1-story plant on local site, for the manufacture of cement bricks, blocks and kindred products. A list of equipment for installation is being arranged. J. A. Ellison is general manager.

Canada

TODMORDEN, ONT.—The Don Valley Paper Co., Ltd., Don Mills section, is planning for the rebuilding of the portion of its plant, destroyed by fire, May 31, with loss approximating $100,000, including equipment.

New Companies

THE BERKSHIRE COATED PAPER CO., Great Barrington, Mass., has been incorporated with a capital of $75,000, to manufacture paper products. Jeremiah H. Whitehouse, 77 Firglade Ave., Springfield, Mass., is president and treasurer.

THE S. & S. CHEMICAL CO., care of William Charlton, 404 Guarantee Trust Bldg., Atlantic City, N. J., representative, has been incorporated under state laws with capital of $50,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are Lionel C. Schener, Arthur G. Walker and M. H. Sachs, all of Atlantic City.

THE AERO RUBBER PRODUCTS CORP., care of B. E. Reardon, Yonkers, N. Y., representative, has been incorporated under state laws with capital of $150,000, to manufacture rubber products. The incorporators are I. R. Davies, J. P. and I. Todd, all of Yonkers.

THE ATLAS ASBESTOS CO., Norristown, Pa., has been incorporated with a capital of $25,000, to manufacture asbestos products. J. C. Johnston, Norristown, is treasurer.

THE LATHROAL SOAP CO., Tallahassee, Fla., has been incorporated with a capital of $10,000, to manufacture soaps and affiliated products. The incorporators are J. A. O'Berry and Robert Hancock, both of Tallahassee.

THE FLEXIBLE CORK PRODUCTS CO., Jersey City, N. J., has been incorporated with a capital of 7,000 shares of stock, no par value, to manufacture cork specialties. The incorporators are John C. and Grier P. Manning, and John P. Taggart, 737 Communipaw Ave., Jersey City.

THE REIBER-ZIEGLER CORP., care of Louis Levy, 277 Broadway, New York, N. Y., representative, has been incorporated under state laws with capital of $20,000, to manufacture chemicals, paints, etc. The incorporators are M. and S. A. Reiber, and E. D. Ziegler, all of New York.

THE MILLION DOLLAR CHEMICAL CO., Cleveland, O., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Joseph H. Crowley and Sidney N. Weitz, Tenth Floor, B. of L. E. Bldg., Cleveland.

THE SOUTHWESTERN OIL PRODUCING CORP., care of Arley B. Magee, Dover, Del., has been incorporated under state laws with capital of $9,000,000, to manufacture petroleum products.

THE ELECTRO-MOULDED PRODUCTS CORP., Arlington, Mass., has been incorporated with a capital of 50 shares of stock, no par value, to manufacture composition and molded specialties. Charles E. Clarke is president; and Laurence M. Pitman, 1117 Appleton St., Arlington, treasurer.

THE P. & M. BRICK MFG. CO., care of A. Simmons, New Rochelle, N. Y., attorney, representative, has been incorporated under state laws with capital of $20,000, to manufacture brick, with plant at Saugerties, N. Y. The incorporators are W. Picker, J. and R. Malakoff.

THE CHICAGO FANCY LEATHER SPECIALTIES MFG. CO., 600 Blue Island Ave., Chicago, Ill., has been chartered under state laws to manufacture leather products. The incorporators are Soren D. Mortensen, George L. Frebn and George J. Prehn.

THE KAY OIL CO., Blackwell, Okla., has been incorporated with a capital of $75,000, to manufacture petroleum products. The incorporators are W. M. Vickery, David Schonwald and H. S. Curley, all of Blackwell.

THE TEXTILE RUBBER CO., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture rubber products. John E. Shannon is president; and Charles V. McManus, Lynn, Mass., treasurer and representative.

THE ALUMINUM CONTAINER CORP., care of Piper & Pendergast, Fulton, N. Y., representatives has been incorporated under state laws with a capital of $200,000, to manufacture aluminum products. The incorporators are F. A. Stafford, S. M. Stevenson and C. Jensvold, all of Fulton.

THE PERUVIAN COMPOSITION PRODUCTS CORP., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated with a capital of $1,250,000, to manufacture brass, steel and affiliated products.

THE LIMESTONE PRODUCTS CO., Menominee, Mich., has been incorporated with a capital of $25,000, to manufacture lime products. The incorporators are N. S. Meyers, H. J. Grami and E. P. Smith, 312 Main St., Menominee.

THE LAKE SHORE RUBBER CO., Newark, N. J., has been incorporated with a capital of $150,000, to manufacture rubber products. The incorporators are George P. Labie, Frederick G. Kautz and Henry Pomerehne, 20 Clinton St., Newark.

THE WILLMOTT OIL CORP., Okmulgee, Okla., has been incorporated with a capital of $400,000, to manufacture petroleum products. The incorporators are C. S. Willmott, John Caruthers and Joseph M. James, all of Okmulgee.

THE UTAH POTASH CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., has been incorporated under state laws with capital of $8,200,000, to manufacture potash products, with plant in the Utah potash fields.

THE AARD ASBESTOS COVERING CO., 2644 Wellington Ave., Chicago, Ill., has been incorporated with a nominal capital of $1,500, to manufacture asbestos specialties. The incorporators are Earl J. and Lester J. Mulligan, and M. J. Black.

THE MARTIN MINERAL PRODUCTS CO., Newark, N. J., has been incorporated with a capital of $125,000, to manufacture cleansers, chemical compounds, etc. The incorporators are William S. Wilde, Otto G. Mathede and Samuel C. Martin, 31 Clinton Street, Newark.

THE SEYD FERTILIZER & CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemical specialties, etc. The company is headed by R. Bryce Gemmel and Harold H. Seyd, P. O. Box 1936, Boston.

THE KENTUCKY-INDIANA OIL CORP., Richmond, Ind., has been incorporated with a capital of $100,000, to manufacture petro-

leum products. The incorporators are George N. Snyder, S. G. Smelser, Richmond; and Z. O. Avery, Lexington, Ky. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE HOLLAND OIL CO., Jamestown, N. Y., has been incorporated with a capital of $50,000, to manufacture refined oil products. The incorporators are C. A. Johnson, J. Sampson and A. W. Beckstrom, all of Jamestown. The company is represented by C. S. Grover, Jamestown, N. Y.

THE HOLLAND MAGNETO PRODUCTS CO., 337 West 12th St., Holland, Mich., has been incorporated with a capital of $25,000, to manufacture magnesite products, hollow tile and kindred specialties. The incorporators are Harry E. and Cecil Huntley, and William E. Dunn.

THE BRYER METALLIC POLISH CO., Boston, Mass., has filed notice of organization to manufacture polishes and kindred products. The company is headed by George Bryer, 97 Sudbury St., Boston.

THE LIFE SERVICE CHEMICAL LABORATORIES, INC., care of the United States Corporation Co., Pennsylvania Bldg., Philadelphia, Pa., representative, has been incorporated under Delaware laws with capital of $100,000, to manufacture chemical products, with headquarters at Philadelphia. The incorporators are Harold Colson and Harry R. Lee, Philadelphia.

THE MYERS LEHMAN CO., New York, N. Y., care of Harry Kutscher, 50 Broad St., representative, has been incorporated under state laws to manufacture paints, oils, etc. The incorporators are A. and E. Lehman, and H. F. Myers.

THE STOVER RUBBER CO., 1409 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of 500 shares of stock, no par value, to manufacture rubber products. The incorporators are M. C. Suhr, E. E. Levy and I. K. Stover.

THE NEWARK ASBESTOS PRODUCTS CO., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture asbestos specialties. The incorporators are Henry C. Schnening, Walter A. Cross and Myer N. Semel, 29 Essex St., Newark.

THE G. B. HAYNES OIL CO., Monroe, La., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of $250,000, to manufacture petroleum products.

THE LO-CO-MO OIL CO., 130 North Wells St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture oil products. The incorporators are A. S. and Jean D. Salkey, and B. E. Langan.

RHODIA, INC., New York, N. Y., care of S. V. Ryan, Albany, N. Y., representative, has been incorporated with a capital of $5,000, to manufacture essential oils and affiliated products. The incorporators are A. F. Von Bernuth, J. H. Purdy, Jr., and C. A. Marshall, New York.

THE MADISON PAPER CORP., care of D. E. Keller, 51 Chambers St., New York, N. Y., has been incorporated under state laws with capital of $20,000, to manufacture paper specialties. The incorporators are E. M. Miller, J. Orozoco and M. S. Somers, all of New York.

THE PALM BEACH OIL CO., West Palm Beach, Fla., has been incorporated with a capital of $10,000, to manufacture oil products. B. D. Hartsfield is president; H. P. Jones, vice-president, and M. M. May, secretary, all of West Palm Beach.

THE CLIFTWOOD POTTERIES, INC., Morton, Ill., care of Evans, Galbraith, Sutherland & Evans, Lehmann Bldg., Peoria, Ill., has been incorporated with a capital of $60,000, to manufacture pottery and affiliated burned clay products. The incorporators are Matthew, John W. and Carl M. Rapp, all of Morton.

THE PREMAX PETROLEUM CORP., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., has been incorporated under state laws with a capital of $100,000, to manufacture petroleum products.

THE WOOD FIBRE PRODUCTS MFG. CO., New York, N. Y., care of Geza Eichhorn, 309 Broadway, representative, has been incorporated with a capital of $20,000, to manufacture fiber products. The incorporators are A. Horowitz and E. Rosenbaum.

THE TIGER OIL CO., Eldorado, Ill., has been incorporated with a capital of $30,000, to manufacture oil products. The incorporators are E. B. Brouilet, John A. Erwood and Samuel W. Latham, Eldorado. The latter is representative for the company.

THE LIBERTY CORK TILE CO., care of R. Packet, 2494 Morris Ave., New York, N. Y., representative, has been incorporated under state laws with capital of $100,000, to manufacture cork products. The incorporators are M. Rose and W. W. Meuer. Headquarters will be in Brooklyn, N. Y.

THE HY-TEST REFINING CO., Pittsburgh, Pa., represented by Charles W. Frankel, 415-19 Bakewell Bldg., is being organized under state laws to manufacture refined oil products. The company is headed by Marshall J. Vernet, I. T. Weill and Frank W. Besselman, all of Pittsburgh.

THE AMERICAN SHELLAC CO., New York, N. Y., care of M. J. Cahn, 200 Fifth Ave., has been incorporated with a capital of $20,000, to manufacture shellacs, varnishes, etc. The incorporators are J. Rosen and H. A. Solomon.

Capital Increases, etc.

THE ALLEN TIRE & RUBBER CO., Allentown, Pa., has filed notice of increase in capital from $1,000,000 to $2,500,000, for expansion.

THE JEWETT & SOWERS OIL CO., 20 West Jackson Boulevard, Chicago, Ill., has filed notice of increase in capital from $150,000 to $200,000.

THE HOME OIL CORP., San Antonio, Tex., has filed notice of change of name to the Laurel Refineries, Inc.

The plant and property of the KOSKO CLAY PRODUCTS CO., River Rd., Piscataway (Middlesex County), N. J., manufacturer of hollow tile, etc., will be sold by the receiver Victor W. Main, 147 Market St., Perth Amboy, N. J.

THE GWYNN'S FALLS PAPER CO., Gwynn's Falls, Baltimore, Md., has filed notice of increase in capital to $1,150,000.

Officials of the Beaver Board Companies, Inc., Beaver Rd., Buffalo, N. Y., have organized a subsidiary company, to be known as the BEAVER PRODUCTS CO., INC., to take over the operation of the plants of the parent corporation, for the manufacture of composition board specialties. A bond issue of $2,000,000 is being sold by the new company for general operations, expansion, etc.

THE CALLAHAN ZINC-LEAD CO., 61 Broadway, New York, N. Y., has increased its capital from 500,000 to 1,000,000 shares of stock, the proceeds to be used for plant extensions and general expansion. John Borg is president.

THE SOUTH PENN OIL CO., 424 Sixth Ave., Pittsburgh, Pa., has acquired the plants and property of the Eddystone Oil Corp., West Virginia, for a consideration said to be about $1,000,000. The property will be operated, and general expansion is planned.

THE MALLINKRODT CHEMICAL WORKS, INC., 3600 North Second St., St. Louis, Mo., is arranging for an increase in capital from $250,000 to $5,000,000, for general expansion. Edward M. Mallinkrodt is president.

THE NATIONAL OIL CO., Jersey City, N. J., has filed an involuntary petition in bankruptcy.

EDWARD ENGELMANN, INC., 37 East Houston, St., New York, N. Y., manufacturer of lithographing and other inks, has made an assignment to Edwin Weinberger, 965 Simpson St., New York.

THE REPUBLIC RUBBER CORP., Youngstown, O., has arranged for a security issue of $1,500,000, the proceeds to be used for general financing, operations, etc.

Arthur J. Stevens, president of the PARSONS PULP & LUMBER CO., Finance Bldg., Philadelphia, Pa., has been appointed receiver for the company. The company is said to have debts totaling $4,000,000, and assets in excess of $5,000,000.

Industrial Notes

The law offices of CHARLES W. HILLS, Chicago, announce that Russell P. Fischer has become associated with them in the practice of patent, trade mark, copyright, unfair competition and corporation law.

THE BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y., has recently acquired the coppersmithing business formerly conducted by the W. A. Case & Son Mfg. Co. of Buffalo, including the copper shop equipment. This new department enables the Buffalo Foundry Co. to render a more complete service to customers, as it can now furnish all kinds of copper work, including copper-distilling apparatus, copper evaporators, copper kettles, copper vacuum pans, copper coils, etc., and do a general coppersmithing business either in new work or repairs.

J. M. Kryl, present president of the Kryl Bridge & Crane Works, Chicago, and W. H. Eichelman, until recently chief engineer of the Hamler Boiler & Tank Co. of Chicago, have recently formed a partnership which has been established in Chicago under the name of KRYL & EICHELMAN. Both men are graduate engineers, experienced in fabricating steel plate and structural iron with present facilities for handling water tanks, oil tanks, stacks, process kettles of all kinds for chemical equipment, ornamental iron and structural steel.

THE CONSOLIDATED PRODUCTS CO., New York, dealer in machinery, was the largest purchaser of equipment at the government auction sale at Nitro, W. Va., during the week of May 22. The sale brought a total of over one-half million dollars and the Consolidated company's purchases were in the neighborhood of $100,000, giving it one of the largest dealers' stocks of chemical equipment.

THE COMBUSTION ENGINEERING CORP., New York, announces that A. D. Halporn, who has been associated with the Philadelphia sales staff for some time, is now a member of the New York sales force.

THE PITTSBURGH TESTING LABORATORY announces the opening of a sales office with a complete inspection bureau at 1864 Railway Exchange Bldg., St. Louis, Mo., and the appointment of Colonel N. C. Hoyles as district manager. Colonel Hoyles is a graduate of Queens University and has also taken a post-graduate course at the University of Toronto. He entered the service of this company as an inspector at the Birmingham office; in 1914 was transferred to the Vancouver office; and at the breaking out of war he entered the service of the Canadian Army, serving with the British Pioncer Engineers Corps in France. He received decorations from both the French and British governments, and upon his release from the army in 1919 was appointed assistant sales manager at Cleveland. Since that time he has been consecutively assistant sales manager at New York and manager at Cincinnati, until his appointment to this new position.

THE AMERICAN GAS ASSOCIATION'S headquarters will be located at 342 Madison Ave., New York City, after July 1.

ORTON & STEINBRENNER CO., Chicago, Ill., manufacturer of locomotive cranes, grab buckets and coal crushers, have moved its offices from the 11th to the 19th floor of the Transportation Bldg., 608 South Dearborn St.

Coming Meetings and Events

ALPHA CHI SIGMA fraternity will hold its seventh biennial conclave at the Marquette Hotel, St. Louis Mo., June 22, 23 and 24.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters are at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet-at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE
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The Cost of Technical Control

AT ONE of the recent technical sessions of the Institute of Metals a paper was read describing the very complete technical control of foundry operations connected with experimental developments on army aircraft. While admitting that such close supervision was unnecessary in commercial foundries working with somewhat standardized methods and common analyses, a question was asked from the floor, "What does technical control in the foundry cost?"

The question might be answered from the autobiography of no less an ironmaster than ANDREW CARNEGIE. He was describing the many difficulties encountered during the early operation of the Lucy furnace—an undertaking they "would have postponed if we had realized its magnitude." Little furnaces could be run by rule of thumb and guess, but not such a monster as the Lucy. Finally he employed a Dr. FRICKE, a German chemist, to assist the manager, and straightway "Lucy furnace became the most profitable branch of our business, because we had almost the entire monopoly of scientific management. It was years after we had taken chemistry to guide us that it was said by the proprietors of some other furnaces that they could not afford to employ a chemist. Had they known the truth then, they would have known that they could not afford to be without one."

Burying the Borax Bugaboo

ALTHOUGH the enemies of American potash probably will continue to echo the borax refrain for some time to come, we are glad to record and give wide publicity to the fact that American potash now meets the standard of purity set by the United States Department of Agriculture. Borax is no longer a deleterious constituent of the American product. In fact for two years the borax content of Searles Lake potash has ranged from 0.27 to 0.5 per cent, comparing favorably with the borax content of sodium nitrate, which is widely used in fertilizing American crops.

We are glad that the Bureau of Soils has seen fit to place its official stamp of approval on American potash, particularly with regard to its borax content, because it was through the investigations of this bureau that borax was found to be the offending element of the domestic product that caused crop injury in Maine and North and South Carolina in 1919. When the producers at Searles Lake had their attention directed to the injurious nature of the borax, they improved their methods of production and eliminated that constituent. For the past two years the Bureau of Soils has analyzed the Searles Lake product with the results given above, and now makes the statement that "under the present method of producing potash at Searles Lake, California, there no longer exists the former danger to crops from the presence of borax in the fertilizer."

This will disarm the propagandist for German potash of one of his favorite arguments against the domestic product. But he will continue to hark back to the old story, and it will be necessary to spread the latest news broadcast in order effectually to bury the borax bugaboo and kill the prejudice that exists in the minds of the farmers. It should be the pleasant duty of every American to spread this news.

Marking Time on Muscle Shoals

TIME was when the controversy over Muscle Shoals waged principally about the question of government ownership and operation. Those were the days of Secretary BAKER and the U. S. Fixed Nitrogen Corporation. Both have since passed into the discard and the stage is held by competing bidders whose fortunes wax and wane almost with each succeeding moon. At the present writing Mr. FORD holds a distinct advantage. The House Committee on Military Affairs has made a majority report recommending that Mr. FORD'S offer to lease the power projects and buy the nitrate plants be accepted. The committee finds that "the Ford proposal was the only proposal worthy of serious consideration," also that it is "the only proposal sufficiently comprehensive in its terms to meet the requirements of . . . the national defense act." Neither does the minority report reject the Ford offer. In fact it would accept it in whole, whereas the majority report approves it only in part and with certain modifications. But there is a third group that has revolted against Mr. FORD and will have none of his proposal. At first there were only two who bolted, but according to last reports there are now eight members of the House who violently denounce the Ford plan.

Aside from the fact that the name of FORD is one to conjure with in industry, it is not difficult to see why Congress is favorably impressed with his offer. The committee finds that "it is the continuing considerations to be performed by Mr. FORD and his company over a long period of about 100 years which gives to his proposal its merit." What are these "continuing considerations"? First, nitrogen preparedness in the form of Nitrate Plant No. 2 maintained in readiness for production, at full capacity, of nitrogen to be used in the manufacture of explosives. This is cited as a contribution to the national defense for the next hundred years. Second, Mr. FORD proposes for his company that "continuously throughout the lease period . . . it will manufacture nitrogen or other commercial fertilizers . . . at Nitrate Plant No. 2," and that "the annual production of these fertilizers shall have a nitrogen content of at least forty thousand tons of fixed nitrogen, which is the present annual capacity of Nitrate Plant

No. 2." Third, the company agrees that its maximum net profit on the manufacture and sale of fertilizers shall not exceed 8 per cent of the annual cost of production. There are numerous other provisions, all of which point to the sincerity of the proposal and add to its attractiveness.

It will be observed, however, that the Ford offer still contemplates a payment of only $5,000,000 for the nitrate plants, and a lease of the power project for one hundred years. So far as the latter is concerned the offer of the Alabama Power Company is vastly superior and more equitable to the United States, being in conformity to the terms of the federal waterpower law. There is no comparable offer for the chemical plants, so that we can merely raise the question whether the sale of property having a war-time cost of $106,000,000 for $5,000,000 is too large a price to pay for the assurance of nitrogen preparedness in Nitrate Plant No. 2 for the next hundred years. The probability is that the price is too great, although the House Committee on Military Affairs is disposed to pay it. The Senate Committee on Agriculture, however, with the characteristic lack of unanimity now prevailing in Congress, gives evidence of sentiment in favor of a policy of government control and operation. In fact Chairman NORRIS has announced that he will introduce a bill creating a government corporation for this purpose.

And so the controversy goes merrily on. The stage has been held successively by one plan after another, each emanating from a source whose interest was dominant at the moment. First the government felt that as a measure of preparedness it should operate the plant. Then the Ordnance Department felt reassured by the commercial developments in nitrogen fixation and was content to urge the retention of Muscle Shoals in standby condition. This was followed by a series of proposals from private interests to buy, lease and operate the plants, and now that these offers have been debated for months the pendulum is about to swing back toward the policy of government ownership and operation. By the time this idea is again debated some new scheme will be brought forward to furnish a subject for speechmaking and discordant opinion. At the present writing it looks as though Mr. FORD might get Muscle Shoals, but that great project may yet go down in history as our most fruitful cause of diverse opinion and abortive legislation.

Potash Propaganda

"PROPAGANDA against the duties on potash is afoot and the farmers in large numbers are writing to their Senators asking that they oppose these duties. Some of those favoring the potash provision in the tariff contend that the German syndicate is back of this propaganda." This statement, taken from some of our recent Washington correspondence, is not in itself very startling, for charges of propaganda and lobbying, especially in connection with the potash tariff, have been all too common. However, we have recently come across some concrete evidence of the propaganda being used by the tariff opponents, and certainly we cannot pass it by without very vigorous protest.

We refer to a most deceptive piece of farm-journal advertising—in this particular case appearing in *The Rural New Yorker* for June 3. It purports to be a stirring appeal to safeguard the vital interests of the American farmer and is published over the name of the "Soil and Crop Service, Potash Syndicate, H. A. Huston, Mgr." Not one reference is made to the German producers and the manager appears to have been extremely careful not to explain, as he did before the Senate Finance Committee last December, that "there is only one potash syndicate, which is the German Potash Syndicate."

The advertisement implies that the "propagandists" of the domestic industry have "bluffed" Congress into believing that the farmers are not opposed to the tariff, or otherwise the representatives of the national farm organization would have been heard at the tariff hearings. As a matter of fact it is generally known in Washington that these organizations, after requesting and being granted almost prohibitive duties on agricultural products, are not in a position to deny moderate protection to other American industries. Mr. HUSTON, however, is most anxious "to look after legislation affecting the farmers' interests." "The only effective way to do this," he says, "is for farmers to write to both of their United States Senators in Washington urging them to see that the 'joker' at the end of paragraph 1,635 be struck out and that potash used in fertilizers remain on the free list, where it has always been." Thus we have an explanation, perhaps, for the increasing volume of Senatorial mail to which our Washington correspondent has referred.

That word "joker," which plays a prominent part in this deception, is an inference which we cannot help but resent. It is an implication of subterfuge and evasion on the part of the domestic industry, which has at all times squarely and openly presented its case before Congress. But these are not all of even the most patent attempts to be misleading! Witness this paragraph:

> During the time when foreign potash could not be obtained, potash sold for more than ten times the prewar or the present prices. Then the American producers, some of whom are known as the "Borax Brigade," had the opportunity of profiteering to the limit and of selling at very high prices potash of an inferior and sometimes injurious kind.

To those domestic producers who have weathered the storm of depression and the recent flood of foreign potash these charges of profiteering are but grimly humorous. However, the insinuation of the inferior quality of American potash is most indignantly resented. Eleswhere in these columns we tell of how the Department of Agriculture has officially interred the borax bugaboo. Isn't it about time to do the same with some other of the potash propagandist's insidious misrepresentations?

Errors in Brinell Testing

ATTENTION was recently called, in these columns, to the consistent discrepancies in Brinell hardness of rivet bars from the same heat reported from two government laboratories—a matter worthy of remark because of the impression that accurate tests for hardness are quite easy to make. Only a few years back hardness was an elusive property to measure. Now, with the Brinell ball test and the scleroscope we think we can define the hardness of metal within fairly close limits.

Therefore it may be useful to call attention to the fact that various laboratories making Brinell hardness tests, particularly on soft materials, may show large variations. Usually the metal is reported as being much too soft. For instance, a well-made uniform bar

of a light alloy was sent successively to several metallurgical laboratories. The correct hardness, as reported by the Bureau of Standards, was 91, using a 10-mm. ball and 500-kg. load. The other returns went as low as 63, and seldom approached within ten units of the true figure. Another similar experiment was described by J. V. EMMONS before the Cleveland Steel Treaters. Results on a piece of steel which was truly 170 Brinell units hard varied from 153 to 175!

Five principal precautions are ordinarily mentioned in literature describing the Brinell test. First, the diameter of the ball should be exactly 10 mm.—but by the method of manufacture, hardened balls are usually more accurate than ordinary micrometers. Second, the impression should be carefully measured—as it can be by low-power microscope and line rule, or micrometer eyepiece, except when a very soft metal flows so badly as to round off the edge of the dent. Third, the hardness of the ball should be correct—but that is of little or no moment when measuring hardness below 200. Fourth, the load should be exactly 3,000 kg. (or 500 kg. for soft metal). Here is where many machines are inaccurate, due to defective packing; but the accuracy of the load should often be checked as closely as a good platform scale or tensile testing machine can weigh. Fifth, the full load should be left on the specimen one minute.

Given these things in close adjustment, a large error can easily be made by increasing the speed of loading. In fact, it is so prolific a source of error that it is strange that the rate of loading has not been definitely limited, either by specification or by the construction of the machine.

Most Brinell machines are arranged so that the load is applied by a hydraulic cylinder, wherein the pressure is pumped up by hand and kept from going above the correct figure by a counterweighted piston or float. This seems an admirable and almost foolproof arrangement. But if the pump handle is worked so vigorously that the counterweight finally jumps up suddenly, it is apparent that the pressure in the cylinder—and therefore the weight on the ball—is momentarily lighter than the limiting load by an amount proportional to the friction of the movable parts and their inertia. With the 500-kg. load limit, this excess is a considerable percentage of the total. Consequently a much larger hole is punched into soft metals than their hardness warrants and an abnormal value is obtained.

Heavy Research
In Copper and Brass

MANY vigorous protests have been raised by voices more influential than ours against the scheme, dear to quacks, of gaining reputations by proxy. Thus the fair reputation of engineering has been appropriated by the "financial engineer" or "human engineer," to say nothing of the bright salesman who has just left ribbons and is now selling radio. Our readers will also know that this journal objects to an indiscriminating use of the word "research" whereby it means anything from a hunt through some 'phone directories made by the office boy during a lazy afternoon to the results of the life work of a scholar.

Having these facts in mind, we entertained certain doubts upon learning a year or more ago that the principal copper producers, rolling mills and brass makers had joined in a "Copper and Brass Research Association" headed by such a well-known scientist as the president of the Calumet & Hecla Mining Co. and advised by no less a consulting engineer on publicity than IVY LEE. A call at their offices confirmed these suspicions. Propaganda, not research, was the object; but "research" is a fine-sounding word. It would lend a certain air to the association's activities.

It excites a feeling almost derisive to find that the association is collecting information by offering fourteen prizes ranging from $150 to $10 to "school children and others for the best photographs showing the relative durability of materials which go into the construction of American homes"—for instance, the old oaken bucket, a knocker, name plate, or grandma's preserve kettle, for it must be at least 35 years old. The scheme recalls the request circulated among the grammar grades of the Salt Lake City schools, asking for suggestions whereby that city could become an inland port for ocean-going vessels! (Yes, that actually happened!)

Since the manager of the association frankly admits that research is not its principal aim, he would be well advised to publish the fact by making the name more descriptive of the activities. Otherwise there is grave danger that the lawyers, financiers and business men who direct the copper and brass industry in the United States may conclude that everything possible is being done to extend and recover the old markets and to find new uses for red metal and its alloys. Meanwhile the Morwell electrification installs 700 miles of high-tension conductors of aluminum at a total saving of $500,000 over copper, France is making subsidiary coinage of aluminum and Russia of paper, and toddle tops are made of wood, celluloid, Bakelite and almost anything but brass.

Incapacity
For Fair Play

NOTHING in the history of organized labor has served to alienate its friends and prejudice its cause so effectively as its acts of violence. Whatever the public sentiment may be, or wherever popular sympathy may lie in any particular labor controversy, there is an instinctive revolt against the side that resorts to violence. Usually labor has been the sufferer.

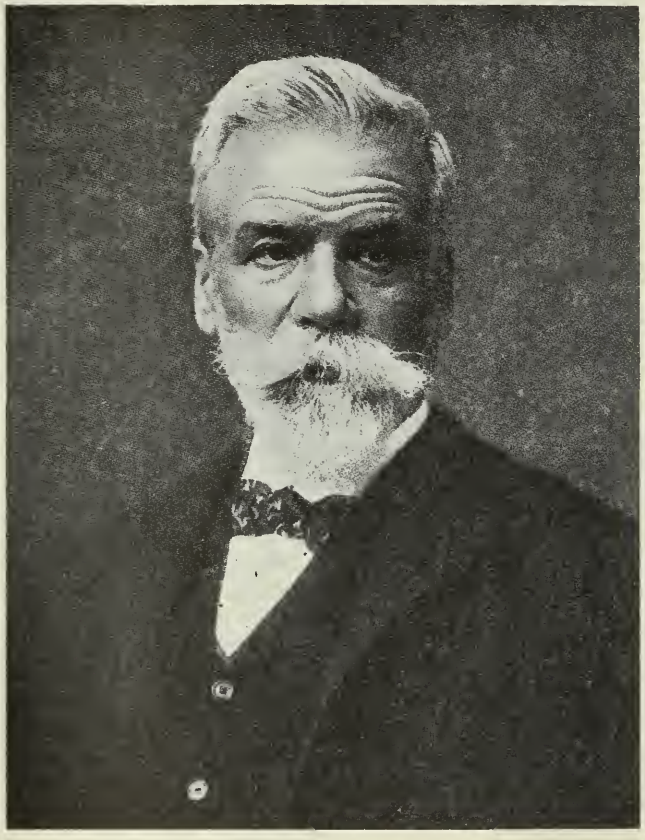
The recent riot and civil warfare that occurred in Illinois is a particularly atrocious example of the intolerance of organized labor which, in the minds of many of its friends, marks its incapacity for fair play. Reports of the fight recall the stories of atrocities that marked the bitterness of the late war. And instead of reprimand or punishment of any kind President LEWIS publicly announced that members of his union were "justified in treating this crowd as an outlaw organization and in viewing its members in the same light as they would view any other common strikebreakers." A noble industrial policy! A high and lofty plan! If a man does not belong to your organization and wants to work when you will not, he is an outlaw and you treat him as you would "any other common strikebreaker." Evidently the approved form is to shoot him down and then proceed with mob violence to destroy property so that nobody can work unless you can get a job on your own terms.

It is beyond all understanding how the presumably intelligent leaders of labor, to say nothing of their followers, expect to gain permanent victories by pursuing this policy. Public decency is only outraged and public opinion reacts against those who commit or condone the crime.

Ernest Solvay, 1838-1922

MAY 26, marks the death, at the age of 84, of a man to whom the chemical industry owes one of its most remarkable developments—Ernest Solvay, the genial creator of the ammonia-soda process. If the introduction of this process, about 60 years ago, marks a memorable milestone in the history of the chemical industry, then there is gleaned from the life of the inventor a moral lesson of the highest order, for it shows us what sustained will power can do when obstinately directed toward the goal it has set for itself.

The early youth of Ernest Solvay was not of the easiest sort. He was born on April 16, 1838, in the little Brabantian village of Rebecq-Rognon, where his father performed simultaneously the duties of master of quarries, salt refiner and wholesale commission agent dealing in oils, soaps and groceries. The diversity of his occupations, however, failed to make him rich and unfortunately he was obliged to renounce the dream he had nourished of permitting his son to take up a complete scientific course in college. He sent him, however, when scarcely 16 years of age, to his uncle Semet, director of the gas works of Schaerbeek, one of the suburbs of Brussels. There the young man was put into a rather crude school, but nevertheless all the more wholesome for his future. There he acquired fundamental knowledge of gas technology; and it was there that he conceived the idea of condensing the residual ammoniacal liquors in order to make their handling more economical and later to recover them by distillation from lime. Finally, studying the compounds of ammonia, he was led one day, in 1860, to his scheme for producing bicarbonate of soda, by observing, it is said, the reaction he provoked by grinding ammonium bicarbonate in a mortar and mixing it with sea water. It is, however, not in this discovery that the great merit of Solvay lies. This reaction, which was later completely to revolutionize an industry, was already known—Dyar and Hemming had discovered it in 1838—and several chemists had even foreseen its industrial application. The glory of Solvay was the research with unexampled tenacity into the causes of the difficulties in the process, and finally to surmount innumerable obstacles and bring his process to a successful industrial status.



ERNEST SOLVAY

On April 15, 1861, he took out his first patent in Belgium; the following year he installed a modest experimental factory near the Place du Marché in Schaerbeek. There, with the help of his brother Alfred, he undertook the elaboration of his discovery. The first experiments resulted in the modest yield of 130 kilos of soda in 12 hours. In 1863 a limited company was established with a capital of 136,000 francs, and a factory was built at Couillet, near Charleroi, but after 5 months the production was still only 227 kilos per day. Thereafter, however, the yield curve rose rapidly; in June, 1866, production had reached 1,500 kilos per day, and double that in December, 1867. In that year, which must always be considered as marking the beginning of the industrial era of the ammonia-soda process, an output of 40,000 tons per year was reached. In 1860 374,000 tons of Leblanc soda was manufactured, and only 300 tons of Solvay soda; in 1902, out of a total production of 1,760,000 tons, the Leblanc process could claim but 150,000 tons.

After the Couillet factory, others sprang up, in France, England, Germany, Russia, Austria and America. Fortune was rewarding the efforts of the inventor, and he was at last able to consecrate himself to occupations of a different character and reveal himself as philanthropist and sociologist of rare conception and accomplishment.

Numerous were the distinctions which consecrated the merit of this eminent man. In 1898 he was made doctor *honoris causa* of the University of Brussels, on which he never ceased to bestow the tokens of his solicitude; the following year the Royal Society of Great Britain elected him an honorary member; on June 18, 1917, he was appointed, almost unanimously, a corresponding member of the chemical department of the Academy of Sciences. He was Grand Officer of the Legion of Honor as well as of the Order of Leopold. Furthermore, he was one of the most illustrious and most representative honorary members of the Société de Chimie Industrielle.

None of those who had the good fortune to come in contact with this octogenarian, who in spite of his age was still so surprisingly alert, will ever forget the impression of meditative and active energy which emanated from him. Ernest Solvay has left us a luminous example of that most intimate co-operation of pure and applied science, but most of all he will forever be remembered, with all the force of this expression, as a truly great citizen. PAUL KESTNER.

EDITOR'S NOTE: We desire to express our appreciation to the Société de Chimie Industrielle, to whose official organ, *Chimie et Industrie*, we are indebted for this photograph of Ernest Solvay and his intimate biography by Dr. Paul Kestner.

Progress in Dust-Explosion Prevention*

The Flour-Milling Industry and Dust Explosions—The Federal Investigation of Dust Explosions—Summary of Dust-Explosion Losses in Various Industries—Progress of Dust Collection and Removal and of Adoption of Methods of Preventing Explosions

By DAVID J. PRICE
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THE flour-milling industry has given considerable attention to dust-explosion prevention and to the development of effective control methods. The explosion in Minneapolis in 1878 may have been largely instrumental in bringing about this interest and resulting in the progress which has been made by this particular industry. The flour millers have co-operated very effectively with the federal government in conducting special research investigations in connection with this problem, and it has been found that the millers were ready to make quick application of any methods of prevention which proved to be effective.

The principal object in presenting this paper is to develop the fact that the flour-milling industry has made significant progress in controlling dust explosions and reducing the losses from this particular cause. It is desired to suggest that recognition be given to this industry, which has demonstrated very definitely that progress can be made in dust-explosion prevention by the application of dust control measures. If similar progress could be made in other representative industries in which explosive dusts are created during operating processes, it is felt that the large losses of life, grain and property in the United States and Canada would be considerably reduced.

An erroneous impression prevails throughout the United States and Canada to the effect that flour mills are a particular hazard. We desire to take this occasion to correct this impression and state that the fire prevention engineers should no longer take the position that an extreme hazard exists in flour milling, and single out this particular industry in referring to our dust-explosion losses. A natural tendency seems to be to class all mills as flour mills. A thorough study of dust explosions for a number of years has definitely shown that the dust-explosion hazard can be classified as it relates to various industries and in this respect the flour-milling industry has made progress that is worthy of recognition.

Origin of Federal Dust-Explosion Investigation

It is scarcely necessary to state that the investigations now being conducted by the federal government were brought about as a result of the interest manifested by the millers of the country, particularly of western New York, following the disastrous explosion at the Husted Milling Co. plant in Buffalo in 1913. The millers' committee, consisting of L. E. Harmon, then president of the Buffalo Cereal Co., F. F. Henry, manager of the Washburn-Crosby Co., and George P. Urban, of the Urban Milling Co., made it possible for the federal Bureau of Mines to co-operate with the milling industry in a thorough study of the causes of these dust explosions with a view to developing some methods of prevention. The active interest manifested by this committee and the provision made by it for conducting both the necessary engineering and chemical research investigations has been of unmeasured value to American industries.

This work, started by the millers, has resulted in its extension to various types of industries in which disastrous losses have occurred from these dust explosions and fires. It has also led to a thorough investigation of explosions and fires in grain-threshing machines during threshing operations. These explosions occurred about the time the millers made provision for undertaking the work. and the investigations have resulted in the suggestion and adoption of control measures which have been very effective on grain separators, particularly in the Pacific Northwest. It has also extended to the study of fires in cotton gins in the South, in which extensive losses have been experienced. The information obtained in the dust-explosion investigations made possible effective precautionary measures for the control of these cotton-gin fires. In fact the data obtained in the dust-explosion investigations as a whole have found application in the study of various types of explosions.[1] Certain causes have been established that were previously unknown, and methods of prevention applied which had not previously been considered. Reference is made to this extension and development in order to indicate the value of the dust-explosion work.

Recent Dust-Explosion Losses

Although for some time the natural tendency seemed to be to associate dust explosions with dust arising during the handling or milling of grain, investigations have shown that these explosions may occur in any type of representative industry where carbonaceous dusts are created during operating processes. In fact a number of disasters have occurred in recent years in industries in which they had not previously been experienced. In thirteen explosions 154 lives have been lost, more than 200 persons injured and property damaged in excess of $16,250,000.

One of the so-called new kind of explosions occurred in the manufacture of lime sulphur insecticide in powdered form, in which a number of explosions occurred during the handling and collecting of the material. Explosions of aluminum dust, hard rubber dust, wood dust and similar industrial plant dusts have occurred accompanied by loss of life and considerable damage. Some of these explosions have been associated

*Paper read at Millers National Federation Mass Convention, Kansas City, June 1, 1922.

[1]See article, "Engineering Problems in Dust Explosion Prevention," by David J. Price, CHEM. & MET. ENG., vol. 24, No. 1. Jan. 5, 1921.

with our method of handling and collecting dust, which has been quite an important recent development. It appears that certain material can be electrified during the process of collecting and handling and explosions originate in modern dust-collecting systems due to the ignition of the dust by sparks of static electricity. In fact, some recent explosions have indicated that electric sparks in the dust collector have been responsible for the primary dust ignition. This is a significant development, especially in view of the fact that dust was being collected by means of a suction fan instead of a blower fan, the former type of fan being generally considered preferable to the latter when considering the hazard or possibility of dust ignition by a spark within the fan.

Contribution of Minneapolis Explosion to Dust-Explosion Knowledge

The Minneapolis explosion in 1878 made a significant contribution to our knowledge of dust explosions. The experiments of Professors Peck and Peckham of the University of Minnesota in connection with the coroner's inquest have been of very great value to investigators in recent years. In a lecture delivered June 1, 1878, at Association Hall, Minneapolis, Professor Peck demonstrated by a few simple experiments that all combustible material, when finely divided, forming a dust or powder would, under proper conditions, burn with explosive rapidity.

It is well recognized that the explosion resulted in the elimination of the old stive or dust room and led to the introduction of improved types of dust-collecting systems. The improvement in the method of dust collection in the flour-milling industry has been very marked indeed, with the result that today the average modern flour mill is maintained up to a high standard. This explains to a great degree the localizing or minor effect of these explosions when they do occur in flour mills. It is significant to note that the damage is much smaller than explosions from comparative causes in other branches of industry. The efficiency of the dust-collecting systems has made it possible to keep the mill clean and prevent the dust from collecting in dangerous quantities throughout different parts of the plant.

Comparison of Dust-Explosion Losses

Flour Mills

Although the explosion in the Washburn-Crosby Mills, Minneapolis, on May 2, 1878, is referred to as the first dust explosion in this country, the records show that from 1860 to 1878 there were at least seven explosions in flour mills, principally of a minor nature, however. Five of these explosions were caused by the use of open-flame lanterns. The Minneapolis explosion resulted in the loss of eighteen lives and property damage to the extent of $800,000, with the destruction of five separate mill buildings.

From 1878 to the present time records have been obtained of twenty-seven explosions in flour mills. Of this number the explosions at Cleveland, Ohio, in 1888, at Litchfield, Ill., in 1893, and at Portland, Ore., in 1909, stand out as the most prominent. These explosions since 1878 have been of limited proportions and have not caused as extensive damage as has occurred in other lines of industry. It is a safe statement, therefore, that the flour-milling industry has made more progress in dust-explosion control than any other representative industry, and considering the large number of flour mills and the small number of explosions and the limited proportions, it must be recognized that this industry has made progress in connection with this problem. The explosion on March 15 in one of the modern flour mills in Kansas City has been thoroughly investigated by the Bureau of Chemistry and has confirmed the conclusion that when dust explosions occur in this industry both the extent of the explosion and the damage done are limited. It is the feeling of the engineers of the Bureau of Chemistry that the flour mills of the country are maintained on a very high standard and that the operating millers fully understand the problems of dust-explosion control and therefore adopt the necessary precautionary measures.

From 1860 to the present time the Department of Agriculture has record of thirty-five explosions in flour mills, and although figures are not available for the loss in all of these explosions, in thirteen cases it has amounted to $2,537,000, an average of approximately $181,000. The largest damage was in Minneapolis in 1878, amounting to $800,000, with eighteen lives lost. It is significant to note that since 1878 there has not been a flour-mill explosion resulting in such extensive loss of life and property. The records indicate that only four lives have been lost and nine persons injured in flour-mill explosions since 1878. It is therefore well recognized that the necessary steps for dust-explosion control do not apply as much to flour milling as to some of the other grain-handling plants. The high standard in which flour mills are maintained, together with the efficient mechanical equipment, has made it possible for the industry to control the extent of these dust explosions and the resulting damage. The field of service in dust-explosion prevention lies among the other types of grain-handling plants and their methods of operation. It is hoped that the flour-milling industry will continue to maintain this control, and that the insurance companies will recognize the progress made.

Grain Elevators

It is desired to contrast the increase in dust-explosion losses in other industries with the reduction in losses in the flour-milling industry. In considering grain elevators, we find that the first explosion of any importance reported to the department occurred in Toledo in 1898, 20 years after the Minneapolis explosion, with the loss of ten lives and injuries to five others. In Richford, Vt., 1908, ten years later, an explosion in an elevator caused the loss of seventeen lives and injuries to three others. Two women on the railroad track adjoining the plant were killed as a result of the explosion.

There have been thirty-six explosions reported as occurring in grain elevators since 1898. It is observed that up to 1916 the losses from explosions in grain elevators had been minor. During that year an explosion in an elevator in Peoria, Ill., caused a loss of $600,000 and in the same year an explosion in an elevator at Baltimore caused the death of seven workmen, injuries to twenty-two others, and $1,500,000 property damage.

In 1917 a large elevator in Brooklyn, N. Y., was destroyed by an explosion, with losses reaching to $1,750,000 and the destruction of sufficient grain to feed 200,000 persons for an entire year. In 1919 the Canadian Government elevator at Port Colborne, Ont., was wrecked by a dust explosion causing the loss of ten lives, injuries to ten others and $1,500,000 property damage. A month later, in September, 1919, an explosion in an elevator in Kansas City killed fourteen work-

men and injured ten others and destroyed property to the extent of $500,000.

The most disastrous grain-elevator explosion on record occurred in the North Western Elevator operated by the Armour Grain Co., at South Chicago, Ill., March 19, 1921. All the workmen in the elevator at the time (six in number) were killed. The total damage approximated $4,000,000. This amount was equally divided between grain loss and property damage.

In twenty-six explosions in grain elevators in which figures are available, the damage has amounted to $11,722,555, an average of $450,000 for every explosion. In seven of these explosions there have been sixty-seven lives lost and seventy-two persons injured.

The field of work in this problem lies in the development of preventive methods for dust-explosion control in grain elevators. The large scale of operation, the size of our plants, the large quantity of dust produced during the handling, elevating and storage of grain and the introduction of new ignition sources make necessary thorough investigations of this particular phase of dust-explosion control.

Cereal and Feed Mills

One of the first explosions of any size reported as occurring in cereal and feed mills took place in Cedar Rapids, Iowa, in 1902. This was followed in 1905 by a similar explosion in the same plant causing $1,000,000 property damage. In 1910 a Buffalo feed-grinding plant was wrecked by an explosion in which five lives were lost and seven workmen were injured. In 1913, which is really the epoch year in dust-explosion investigations (the year in which the present study began), an explosion in a feed-grinding plant in Buffalo resulted in the death of thirty-three workmen, injuries to eighty, and $465,000 property damage. Probably one of the most damaging explosions in a feed-grinding plant occurred in Petersborough, Canada, in 1916, in which seventeen lives were lost, sixteen persons were injured and $2,000,000 worth of property was destroyed.

The Department of Agriculture has obtained records of twenty-nine explosions in cereal and feed mills. In twenty-two of these explosions the loss has been $4,959,600, an average of $225,436. In seven of these explosions sixty lives have been lost and in ten explosions 128 persons were injured.

Starch and Corn Products

In 1908, in Providence, R. I., a starch-dust explosion caused the loss of seven lives. In 1912 an explosion in a starch factory in Illinois resulted in the loss of fourteen lives and injuries to nineteen others. The most destructive dust explosion on record in this country occurred in Cedar Rapids, Iowa, in a starch factory in 1919. Forty-three lives were lost, thirty persons were injured and more than $3,000,000 worth of property was damaged.

In seven of these starch-dust explosions, seventy-two lives were lost and eighty-nine persons were injured. The total money loss in ten has been about $3,811,000.

Miscellaneous Explosions

In 1917 an explosion of pulverized sugar dust in New York caused the loss of twelve lives and twenty-four injuries and more than $1,000,000 property damage. There are ten sugar dust explosions on record.

Violent explosions of chocolate and cocoa dust have also occurred. In one instance an explosion in a New England chocolate plant caused the loss of three lives and $750,000 property damage. Among miscellaneous explosions may be included explosions in rice mills, fertilizer plants, paper works, wood-working establishments and tanneries. In 1899 in Rhode Island an explosion of soapine dust resulted in the loss of two lives and injuries to nine persons. The department has investigated explosions of cork dust, spice dust, sulphur dust, powdered milk dust and many others. In 1920 an explosion of aluminum dust in connection with the manufacture of aluminum goods in a Wisconsin plant caused the death of six girls and injuries to six others. A few months later an explosion of hard rubber dust in Michigan caused the death of eight workmen and considerable property damage.

European Explosions

Records have been obtained of twenty-four dust explosions in European countries. In eleven of these explosions ninety-one lives have been lost and more than 200 people injured. In an explosion in a meal mill in Liverpool in 1911, thirty-nine persons were killed and 101 injured. In 1908 in a sugar dust explosion in Paris, three workmen were killed and forty-nine injured.

Totals

A total of 242 dust explosions in industrial plants in the United States and foreign countries has been reported to the department. In fifty-two of these explosions, 379 lives have been lost and in sixty-nine of them 651 persons have been injured. The total money loss in 110 explosions in which figures are available has been approximately $30,000,000, an average of more than $270,000 for each explosion.

This does not include the losses in connection with the thresher explosions or cotton gin fires, and is confined entirely to the losses occurring from these dust explosions in industrial plants. In the Pacific Northwest thresher explosions and fires have resulted in approximately $1,000,000 damage and the losses from cotton gin fires in the South have also been very great.

The results of the investigations of the Department of Agriculture from the time the work was initiated by the millers are about to be published in book form by the National Fire Protection Association.

Grain Elevators and the Dust Problem

Dust-explosion control has been brought about in representative industries by effective dust collection and removal. This has been possible in industries where the dust means commercial product with a market value. However, the matter as it relates to grain elevators in the United States and Canada needs special attention. We stand in the same position today in which we always have stood, so far as the dust-explosion problem relates to this type of grain-handling plant.

We cannot expect to control these explosions in grain elevators until some advancement similar to that made in flour milling, in so far as dust collecting is concerned, can be brought about. Mechanical methods of dust collection consisting of the necessary fans and piping systems are essential for dust control. It has been found on grain-threshing machines that dust-collecting fans remove the explosive smut dust and reduce the explosion hazard. The principle has been applied successfully on a commercial scale and now awaits application in grain elevators.

At the present time, existing commercial regulations

prohibit the installation of equipment of this kind in the grain elevators of the United States and Canada. These regulations are not based in any way on the explosion phase of the problem, but have to do with possible abuses leading to difficulty in checking weights, thereby affecting the shipper.

It appears that difficulty has always been experienced in maintaining the weights between shipper and receiver on grain entering the terminal markets. This has led, in some instances, to special provision whereby the grain elevator operator is prohibited from taking any steps which might in any way interfere with the weight of grain going into the plant.

Although these regulations were put into effect before science had determined that the dust was highly explosive, the application affects the proposition just the same. It is well recognized by the dust-explosion prevention engineers and the grain industry as a whole that it will be necessary for the dust to be removed effectively by mechanical systems before we can make the necessary progress. At the present time the dust escapes from the grain-handling equipment and settles on ledges, beams and girders throughout the plant. When the original ignition of dust occurs, there is sufficient concussion to shake this dust loose and propagate flame, resulting in a secondary explosion of large proportions. If the dust is effectively removed, of course the explosion is localized and the damage minor in extent, such as has been referred to in the explosions that have been occurring in flour mills.

Dust Removal in Grain Elevators

This phase of the problem is possibly the most important one that the department is now called upon to study. The Canadian Government has appointed a representative committee, in co-operation with the Dominion Fire Protection Association, to co-operate with similar agencies in the United States to determine the practical possibilities of dust removal in grain-handling plants. The National Board of Fire Underwriters, in conjunction with the National Fire Protection Association, the National Safety Council and other representative agencies in this country, has recently appointed a similar committee for co-operation with the Canadian officials. The object and purpose of the committee will have to do with finding some uniform method of removing and controlling the dust in the grain elevators of both countries.

The Industrial Commission of Wisconsin has recognized the importance and necessity of this provision. Some months ago steps were taken to require the installation of exhaust systems in the grain elevators in the State of Wisconsin, particularly at points such as Milwaukee, Manitowoc and Superior. The request of the commission not being complied with, a conference was called in Madison, March 21, at which the operators were called upon to give the reason why the order of the commission had not been obeyed. It developed that although the grain operators were in hearty sympathy with the object and purposes of the commission and felt that this provision should be made, it would probably discriminate against Milwaukee as a terminal market. This was especially true if points such as Chicago, Minneapolis and other large grain-handling markets were not required to make similar provision. A general conference of all grain-handling states was suggested and is now in the course of consideration. The Department of Agriculture has been called upon to co-operate and has already advised the commission that the department is in hearty sympathy with the plan and will give all possible help and assistance.

Adoption of Preventive Measures

Is it going to require a series of disastrous dust explosions causing larger loss of life and extensive property damage before the importance of adopting effective preventive measures in grain elevators is fully appreciated? It has already been stated that 154 lives have been lost in recent dust explosions in industrial plants, with a large number injured and considerable property and foodstuffs destroyed. It appears, however, that it is only too true that we too often measure progress in safety by catastrophe. There is a difference in work of this nature between killing 154 people in thirteen explosions occurring in different parts of the United States and killing that number in one explosion. Unfortunately as a rule the interest in the subject is measured locally by the extent of life loss and damage by the explosion. Will it require a catastrophe such as the Iroquois Theater fire in Chicago or the Knickerbocker Theater disaster in Washington to concentrate attention on the importance of readjusting our commercial practices in so far as grain elevators are concerned?

We must regard the dust as explosive material such as dynamite, powder or gasoline and take the necessary steps for protection of life, foodstuffs and property. Are we ready for these steps, or must we wait for more explosions, accompanied by extensive loss of life?

Co-operation by Flour-Milling Industry

We have endeavored in this brief paper to call attention to the very effective steps which have been taken by the flour-milling industry to control the dust-explosion hazard. We have also attempted to outline a future program in which it is hoped that the dust-explosion prevention work can be brought to the attention of the operators of grain elevators and other types of dusty industries in such a way that they may profit by the experience of the flour millers and reduce their explosion losses by adopting efficient methods of dust collection and removal.

The flour millers of the United States and Canada are in a position to render valuable assistance in this work and their co-operation is earnestly requested. Many mills are operated in connection with grain elevators or vice versa, and here the operators have an opportunity to see that the same precautions for the protection of life and property which have proved effective in the mill are adopted in the elevator. In business association an opportunity is also frequently offered for the careful operator to call to the attention of the negligent ones the saving which can be effected in both life and property by the adoption of effective dust-collecting and removal methods, and in this way render valuable assistance both to the industry and the country. The Department of Agriculture asks for a continuation of co-operation with the flour-milling industry in the efforts now being put forth to develop methods of prevention that will prove effective in reducing our dust-explosion losses. The interest in explosion control manifested by the industries has assisted in the adoption of effective precautionary measures developed by engineers in the Bureau of Chemistry. The results of recent investigations can be obtained upon request.

Strength and Elasticity of Boiler Plate at Elevated Temperatures

Proportional Limit Maintained or Increased With First Temperature Rise — Tensile Strength Has a Slight Maximum at About 250 Deg. C., but Both Fall Off Badly at Higher Temperatures— Reduction and Elongation Have a Minimum at About 260 Deg. C., but Recover Their Original Value Around 450 Deg. C.

By H. J. FRENCH
Physicist, Bureau of Standards

Previous Investigations

IT HAS long been known that temperature above the ordinary atmosphere is accompanied by changes in steels, particularly in strength and ductility. A large number of interesting and important papers dealing with various phases of this subject have appeared from time to time, but our knowledge is still unsatisfactory and a better understanding of these changes will undoubtedly be of benefit to industry. Howe[1] long ago called attention to the apparent anomalies found in the effects of work at moderate temperatures upon the properties of wrought iron and steel used in boiler construction. Certainly from the standpoint of engineering design it is important to know how the proportional limit varies with changes in temperature, but unfortunately this is the most difficult to determine, and available data are conflicting.

In Fig. 1 is given a summary of results obtained in some of the more important published investigations of the tensile properties of wrought iron at high temperatures. Increase in strength with first rise in temperature above that of the room is reported by Huntington,[2] Epps and Jones,[3] while J. E. Howard[4] finds a slight decrease between about 50 and 150 deg. C. (125 and 300 deg. F.), which is followed by increase to a maximum between 205 and 345 deg. C. (400 and 600 deg. F.). In a very complete series of tests of steels of varying carbon contents Howard further found that the minimum tensile strength occurring with first rise in temperature was generally more quickly reached the lower the carbon content and that the higher carbon steels attained their maximum strength at lower temperatures than medium- or low-carbon alloys.

Elastic Properties

Various investigators have from time to time reported decrease in elastic properties with increase in temperature. Epps and Jones obtained first a decrease then an increase at a slightly higher temperature, with maximum at about 180 deg. C.

In his tests Howard found that the interval between the elastic limit and the maximum stress showed particularly interesting features. Several of the different steels tested showed a yield point at the elastic limit, this period being marked by rapid stretching, which, once begun, continued under reduced loads. Such yielding rarely occurs in testing steel at room temperature, but was observed by Howard up to about 260 deg. C. (500 deg. F.) in tests of mild steels and at temperatures somewhat below this in the higher carbon alloys. Bars tested between about 95 and 205 deg. C. (200 and 400 deg. F.) showed alternate periods of relaxation and rigidity under increasing stress resembling a succession of yield points apparently indicating some remarkable changes taking place within the metal in this temperature range.

There is more general agreement in various publications regarding changes in ductility as measured by elongation and reduction of area. Elongation decreases

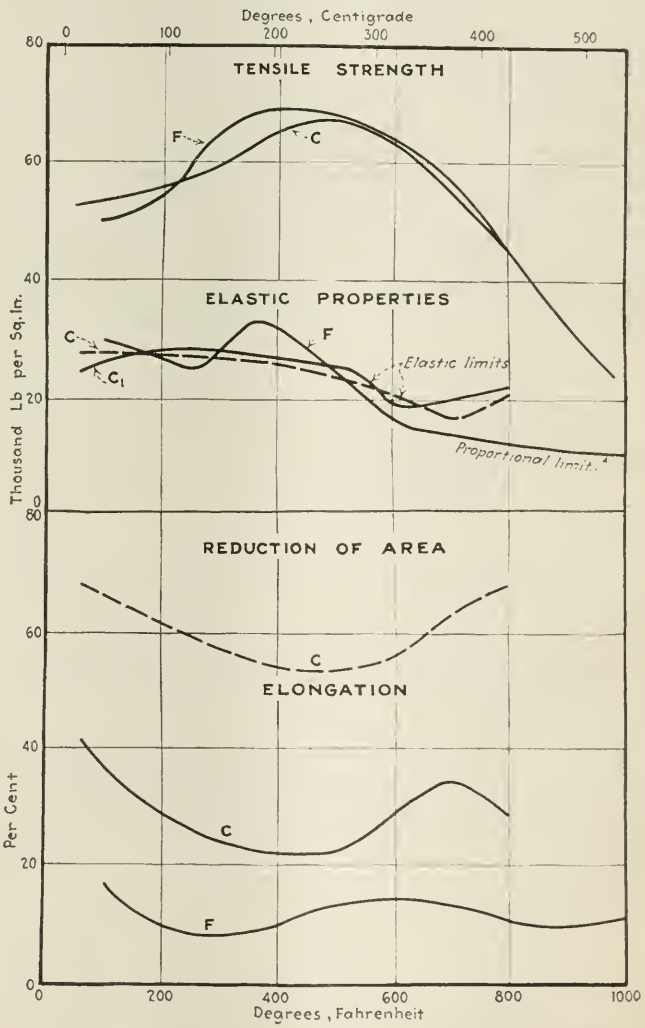

FIG. 1—TENSILE PROPERTIES OF WROUGHT IRON AND STEEL AT VARIOUS TEMPERATURES

C, reported by Huntington for mild steel, C_1 for wrought iron, and *F* by Epps and Jones for wrought iron.

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[1] "The Metallurgy of Steel," 1891.

[2] *J. Inst. Metals*, p. 126 (1912).

[3] Met. & Chem. Eng., vol. 17, p. 67 (1917).

[4] *Iron Age*, vol. 45, p. 585 (1890).

slowly just above room temperature and thereafter more rapidly to a minimum variously reported as occurring between 125 and about 200 deg. C. (255 and 390 deg. F.). It then increases rapidly. Reduction of area likewise decreases but little just above the temperature of the room, but then drops rapidly to a minimum reported to occur between 200 and 300 deg. C. (390 and 570 deg. F.) and is followed by rapid increase in values. Howard also found a tendency for bars broken at temperatures between 205 and 315 deg. C. (400 and 600 deg. F.) to fracture in an oblique shearing direction.

Steels Tested

The steels tested in this investigation were received as half-inch boiler plates of firebox and marine grades. The specified tensile strength and composition for each are shown in Table I, but the third class listed showed

TABLE I—STEELS TESTED

Series	Grade	Specified Tensile Strength Lb. Per Sq. In.	Composition, Per Cent C	Mn	P	S
1	A. S. T. M. firebox*...	52–62,000	0.19	0.43	0.020	0.031
2	Marine.....	60–70,000	0.25	0.38	0.019	0.031
3	Railway firebox.....	45–55,000	0.17	0.36	0.024	0.031
4	Railway firebox.....	45–55,000	0.18	0.43	0.017	0.035

* American Society for Testing Materials firebox steel. Specification A30-18.

slightly higher tensile values than the limits prescribed and was supplemented by class 4. The former was, however, used and the tensile properties at high temperatures of the hot-rolled steel were determined, because the number of plates of the first two series was insufficient for completion of the desired tests.

The steels were made in the basic open hearth and the baths kept in a boiling condition up to the moment of casting. Such metal is often referred to as "open steel." It is porous in its cast condition and shows some segregation, but is nearly free from pipe. Variations in composition have, however, been kept to a minimum by cutting the patterns from which the test specimens were machined from steel originally in the central and least segregated portion of the ingot.

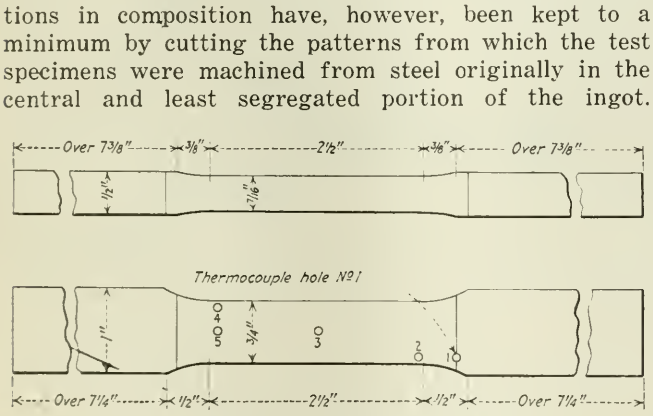


FIG. 2—FORM OF TEST-BAR USED

Small circles numbered 2, 3, 4 and 5 represent thermocouple holes drilled in one sample only, to explore uniformity of temperature distribution.

Check analyses made from time to time during the progress of these tests show excellent uniformity and agree closely with the compositions shown in Table I.

Flat test-bars, with long dimension in the direction of rolling, were cut from patterns taken from these plates and machined to the form shown in Fig. 2.

Apparatus for Determination of Proportional Limit

At the outset emphasis is laid on the fact that, for the work required throughout the various sections of this investigation, suitable and readily manipulated apparatus and not the most accurate mechanism available was sought. The material under test is lacking in entire uniformity, so it appeared undesirable to erect elaborate equipment requiring a great deal more time in development and actual test.

The apparatus used in determination of the limit of proportionality at various temperatures is substantially as described by the writer in CHEMICAL & METALLURGICAL ENGINEERING, Jan. 19, 1921, vol. 24, p. 131, "Motion Pictures in Physical Testing Laboratory."

The smallest division on the instruments used was equal to 0.001 in., but estimated readings to the nearest 0.0001 in. were readily obtained.

Heating Furnace

The test specimens were heated by means of an electric tube furnace 11 in. long. For heating elements two spiral resistors in series were used. One covered the entire outer surface of the tube and the other was concentrated at the ends, the two requiring about 80 ft. of 22-gage nichrome wire. Yokes and major part of the 18-in. test-bar and rods were contained in the heating chamber. A comparatively small temperature gradient was obtained under suitable operating conditions, as the effective heating length during a determination was about 3 in. and located at the center of the tube length.

Test Procedure

The method of setting up the apparatus, together with procedure followed in actually carrying out the tests, was substantially as follows: A specimen was marked on one surface with a double-pointed center punch leaving marks 2 in. apart. Next yokes were attached to the specimen, fixing a setscrew into these impressions. Then, by lightly tapping the opposite side of the yoke, containing two screws, an impression of their exact location on the test-bar was obtained. These points were then enlarged by the use of the double-pointed center punch and the yokes carrying rods and frames were firmly attached to the test-piece.

The specimen was then passed up through the furnace until the rods appeared above the top, when the upper frame spanning the furnace was lowered into position and fastened to the rods. After the furnace was placed on a stand and the specimen was in the jaws of the testing machine, the dials were attached to the frame and adjusted to zero. The completely assembled apparatus is shown in the article in these columns referred to just above.

When thermal equilibrium at the desired temperature was reached, an initial load of about 1,500 lb. per sq.in. was applied, and the dials read or, as a matter of convenience, again set at zero. Readings were then taken at increments of 500 or 1,000 lb. actual load until the proportional limit was passed. The dials were then removed and the specimen was broken in the usual

TABLE II—TEMPERATURE SURVEY

Desired Temperature, Deg. C.	Temperature of Specimen at Positions Indicated in Fig. 2: 1	2	3	4	5	Time After Couple No. 1 First Reached Desired Temperature, Minutes	Average Temperature of Couples 2, 3, 4 and 5, Deg. C.	Maximum Temperature Variation, Deg. C.
165	165	173	167	158	165	15	166	15
320	310	327	327	310	322	0	322	17
	325	334	334	320	329	5	329	14
	325	336	334	318	332	20	330	16
400	402	415	412	393	402	10	405	22
	402	415	412	393	402	20	405	22

manner with a low rate of extension which approximated the intermittent increases of stress applied during determination of the limit of proportionality. Tests at each temperature were made in duplicate or triplicate and the proportional limit was obtained from a stress-strain diagram. Temperature was measured by a 22-gage standardized chromel-alumel couple connected to a Leeds & Northrup portable potentiometer. The end of the couple was inserted directly into a small hole drilled in the specimen at the fillet.

Thermal Equilibrium

In order to obtain reliable and satisfactory results with the method described in the preceding paragraphs, thermal equilibrium must be reached prior to the start of the loading and maintained during the actual 8 to 15 minutes during which the test is being carried out. An adjustable resistance in series is used to balance the loss of heat from the furnace and specimen. The effect of temperature variations may be large unless care is taken to allow sufficient time for the specimen to become uniformly heated throughout after the potentiometer has once indicated the desired temperature. The dial readings will assist in determining when equilibrium has been reached and is being maintained.

Temperature determinations under actual test conditions made by placing thermocouple in holes located at various points in a specimen carrying entire auxiliary apparatus show that the position chosen for the single thermocouple (in the fillet) is representative of about the mean of the gradient throughout the gage length, where the temperature gradually decreased from top to bottom (see Table II for partial reproduction of these variations). This variation is within 30 deg. C. (54 deg. F.) during the upper temperature ranges under consideration and does not exceed 20 deg. C. (36 deg. F.) at the lower temperatures used. However, as the thermocouple, specimen with auxiliary apparatus and furnace are in the same relative position in each test, the results obtained at various temperatures throughout the range 20 to 465 deg. C. (70 to 870 deg. F.) are comparable.

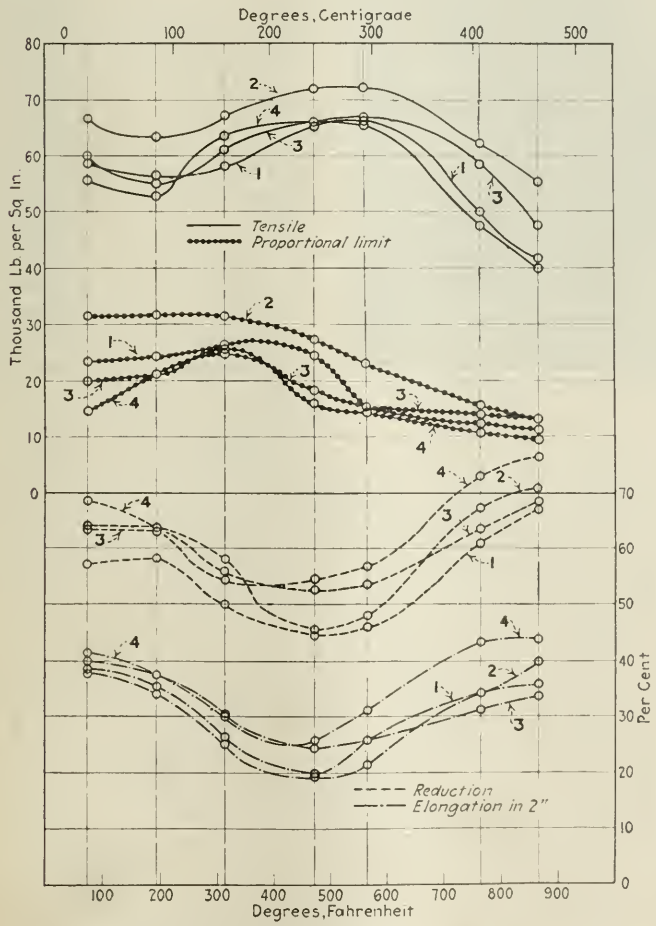


FIG. 3—TENSILE PROPERTIES OF FOUR GRADES OF BOILER PLATE MADE OF OPEN-HEARTH STEEL

Tensile Properties of Hot-Rolled Boiler Plate at Elevated Temperatures

Tensile tests were made on the four grades listed in Table I. Results obtained are graphically represented in Fig. 3.

In all grades of plates increase in temperature above the ordinary atmospheric range is accompanied by distinct changes in strength and ductility, viz.:

(a) Tensile strength decreases a few thousand pounds per square inch in the neighborhood of 95 deg. C. (200 deg. F.). This is followed by a maximum which occurs at 290 deg. C. (550 deg. F.) in plates of the first three series and at about 250 deg. C. (480 deg. F.) in series 4, representing plates of lowest tensile strength. With further increase in temperature the strength decreases and again approximates ordinary atmospheric temperature values in the range 370 to 400 deg. C. (700 to 750 deg. F.).

(b) The limit of proportionality increases to a maximum in the neighborhood of 150 deg. C. (300 deg. F.). Firebox-grade increases more markedly and it is maintained to a higher temperature than marine plate. The latter has in effect constant proportional limit up to about 175 deg. C. (350 deg. F.). While such differences are noticeable at these relatively low temperatures, the proportional limit of the higher tensile strength marine plate is practically the same at 365 deg. C. (870 deg. F.) as that of series 1 and 3 firebox-grade plates and but slightly higher than that of the fourth series (railway firebox plate of lowest tensile strength).

(*c*) Only a slight decrease in elongation is observed until a temperature of about 95 deg. C. (200 deg. F.) is reached, above which the rate of decrease is much higher and a minimum is reached at about 245 deg. C. (470 deg. F.). Elongation then increases, but does not, throughout the range under consideration, reach the ordinary atmospheric temperature value in the marine plate (rated at 60,000 to 70,000 lb. tensile strength) and but slightly exceeds its room temperature value in the fourth series at 465 deg. C. (870 deg. F.).

(*d*) Reduction of area closely follows the inflections registered in the curves for elongation, but reaches a minimum at a slightly higher temperature except for the lowest tensile strength firebox plate, where the minimum occurs at practically the same temperature as that for elongation. At 465 deg. C. (870 deg. F.) reduction of area is greater than the value obtained at atmospheric temperature in each of the four series of plates tested.

It is to be noted that maximum tensile strength does not coincide with minimum reduction of area or maximum proportional limit, but examination of Fig. 3 indicates that the inflections in the curves for reduction of area are in general more nearly coincident with the reverse inflections in the curves for tensile strength and that elongation and proportional limit may be similarly paired.

C. R. DeLong, Chief, Chemical Division, Department of Commerce

MORE than usual significance attaches to Secretary Hoover's recent announcement that a commodity division devoted exclusively to chemicals and related products is to be established within the organization of the Bureau of Foreign and Domestic Commerce. Ever since the bureau was reorganized on a commodity basis there has been an evident need for this recognition of the chemical and allied industries. The actual organizing of the chemical division has been delayed, however, due both to the lack of available funds and to an apparent unwillingness on the part of a small minority of the chemical industry to join with Secretary Hoover in his efforts to make the Department of Commerce an active, vital aid to industry.

Photo by Clinedinst, Washington.

C. R. DeLONG, CHIEF, CHEMICAL DIVISION

Selecting a man to head this important division has not been an easy task for the department, but the recent news that the position has been offered to C. R. DeLong, chief of the chemical staff of the United States Tariff Commission, would appear to meet with the unanimous approval of the chemical industry. For a number of years Mr. DeLong has been very closely identified with, and in many cases largely responsible for, the Tariff Commission's excellent investigations and reports on the chemical industries. This work has given him an unusually broad knowledge of conditions in the domestic industry, particularly as it has been affected by the competition of the foreign manufacturers of chemicals. Experience of this sort cannot help but be of greatest assistance to him in analyzing the needs of the chemical industry and wisely interpreting them to the Bureau of Foreign and Domestic Commerce.

Carl Ray DeLong, who on Aug. 1 will assume his new duties as Chief of the Chemical Division, was born and educated in Ohio. He was graduated from the Ohio State University, Columbus, Ohio, in 1914, receiving the degree of Bachelor of Science in Chemical Engineering. After finishing his college training he was employed for a year and a half by the Ohio State Geological Survey and under the direction of Prof. James R. Withrow he completed a comprehensive survey of the industrial water supplies of Ohio. This work was followed by industrial experience in Kingsport, Tenn., in the manufacture of electrochemical products and dye intermediates. In 1917 this manufacturing experience led to a position with the Electron Chemical Co., of Portland, Me., where Mr. DeLong was engaged in research work on the commercial production of acetic anhydride and certain related organic compounds. In January, 1918, when the U. S. Tariff Commission began its more intensive investigations in the chemical industry, Mr. DeLong was selected to carry on a responsible share of that work. His first duties were largely in connection with the so-called tariff information surveys, especially those dealing with heavy chemicals and electrochemical products. His report on "Barytes, Lithopone and the Barium-Chemical Industry" is an outstanding example of thorough investigation and the accumulation of data of value not only to the government but to the industry itself. Following the resignation of Dr. Grinnell Jones in 1920, Mr. DeLong was put in direct charge of all the investigational work of the chemical division of the commission. Under his direction a great many valuable reports of economic conditions within the different chemical industries have been prepared and published. Most widely known among these, perhaps, are the four editions of the *Census of Dyes and Coal-Tar Chemicals* (1917-1920), the *Tariff Information Surveys* on Schedule A (19 pamphlets) and on chemical products of the Free List (12 pamphlets), and the two editions of the *Summary of Tariff Information* prepared respectively for the Ways and Means Committee and the Senate Finance Committee.

During the actual framing of the permanent tariff bill and the various legislative measures designed for the protection of the domestic dye industry, Mr. DeLong was in active and intimate contact with the Congressional committees in charge. The value placed on his services in that connection was recognized not long ago by Congressman Nicholas Longworth who, in explaining to Congress the vast amount of technical work involved in the preparation of the chemical schedule of the tariff bill, made public acknowledgement of the invaluable assistance which Mr. DeLong had given to the Ways and Means Committee.

Thus it may readily be seen that Mr. DeLong is unusually well qualified to carry on the important work of the new division. Many of the contacts already made with individuals and associations within the chemical industries will prove of inestimable value to him. A number of important industrial groups have already offered their whole-hearted co-operation—and it is confidently expected that the entire chemical industry will stand squarely behind the new division and give it the support that will make it a factor in speeding the return of prosperity to American business.

S. D. KIRKPATRICK.

Recovery of Glycerine From Spent Soap Lyes

Composition of Spent Soap Lyes—Removal of Impurities by Single and Double Treatments—Concentration of Purified Lyes in Single-Effect Evaporator Unit—Practical Data on the Equipment Required and Methods of Operating It to Obtain Maximum Efficiency

By WALTER E. SANGER
Chemical Engineer, Chicago, Ill.

ALL true animal and vegetable fats and oils are combinations of glycerine and various organic acids. The most common of these compounds are stearin, olein and palmitin, which are combinations of glycerine with stearic acid, oleic acid and palmitic acid respectively.

Glycerine is obtained upon the saponification of a triglyceride, the chemical reaction being as follows:

$$(R.COO)_3C_3H_5 + 3MOH = C_3H_5(OH)_3 + 3R.COOM$$

In this equation, *M* stands for hydrogen or a monovalent metal and *R* represents the alkyl radical of any fatty acid.

In soap-kettle practice, the fat or oil is usually saponified with caustic soda. Taking, then, the saponification of the glyceride tristearin, the reaction is

$$\underset{\text{Tristearin}}{(C_{17}H_{35}COO)_3C_3H_5} + \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{3NaOH} = \underset{\text{Glycerine}}{C_3H_5(OH)_3} + \underset{\substack{\text{Sodium stearate}\\\text{(soap)}}}{3C_{17}H_{35}COONa}$$

and it is thus seen that upon the saponification of a tri-glyceride with caustic soda there is produced glycerine and a sodium soap. Sodium soap is soluble in water, but is practically insoluble in brine.

After the glyceride is thoroughly saponified, sodium chloride is added to the charge in the kettle in order to separate the soap. The charge then separates into three layers—soap (which floats on the top of the charge), nigre (which remains suspended just below the soap and which is made up of soap, water and impurities) and spent soap lye (which settles to the bottom of the kettle and which contains most of the glycerine).

Composition of Spent Soap Lyes

Spent soap lyes as they are drawn from the soap kettle consist, in general, of glycerine, salt, caustic soda, sodium carbonate, soap, fatty acids and water in addition to albuminous and oleaginous matter. The proportions of these ingredients vary considerably with kettle practice and also with the various stocks saponified. The most valuable ingredient is glycerine, the percentage of which will vary with the stock used and the amount of lye drawn from the kettle.

The first lye drawn from the kettle will contain the highest percentage of glycerine, while as many as thirty succeeding draw-offs will show glycerine on analysis. The amount of lye to be drawn from a kettle will depend on the price of glycerine. If lyes are removed with too low a glycerine content, the cost of recovery will exceed the value of the glycerine obtained.

The following results were obtained by the writer in a test saponifying about 30,000 lb. of tallow, containing 85.3 per cent of neutral fat:

	Weight, Lb.	Glycerol, Per Cent
1. Killing change	12,742	8.47
2. Rosin change	7,202	4.65
3. First wash	5,263	3.76
4. Second wash	3,787	3.30
5. Third wash	8,033	2.80
6. Fourth wash	7,202	2.36
7. Fifth wash	7,479	2.10
8. Sixth wash	8,033	1.96

Necessity for Removal of Impurities Before Evaporation

Spent lyes are treated for the purpose of increasing the glycerol content of the crude glycerine obtained on evaporation. The most important impurities to be removed before evaporation are soap and fatty acids, together with the oleaginous and albuminous matter. For this purpose there is usually used a metallic salt such as sulphate of alumina, $Al_2(SO_4)_3$. Soap and some of the fatty acids combine with the salt to form an aluminum soap which is insoluble in water. Some of the salt forms aluminum hydroxide, $Al(OH)_3$, which apparently carries down oleaginous and albuminous matter together with some fatty acids mechanically.

Specifications for Soap Lye Crude Glycerine

The importance of proper treatment is seen on reference to the specifications for soap lye crude glycerine, which are as follows:

> Analysis to be made in accordance with the International Standard Methods (I.S.M., 1911).
>
> *Glycerol.* The standard shall be 80 per cent glycerol. Any crude glycerine tendered which tests 81 per cent glycerol or over shall be paid for at a pro rata increase, calculated as from the standard of 80 per cent. Any crude glycerine which tests under 80 per cent, but is 78 per cent or over, shall be subject to a reduction of one and one-half times the shortage calculated at pro rata price as from 80 per cent. If the test falls below 78 per cent, the buyer shall have the right of rejection.
>
> *Ash.* The standard shall be 10 per cent. In the event of the percentage of ash exceeding 10 per cent, but not exceeding 10.5 per cent, a percentage deduction shall be made for the excess calculated as from 10 per cent at contract price, and if the percentage of ash exceeds 10.5 per cent, an additional percentage reduction shall be made equal to double the amount in excess of 10.5 per cent. If the amount of ash exceeds 11 per cent, the buyer shall have the right to reject the parcel.
>
> *Organic Residue.* The standard shall be 3 per cent. A percentage deduction shall be made of three times the amount in excess of the standard of 3 per cent calculated at contract price. The buyer shall have the right to reject any parcel which tests over 3.75 per cent.

An untreated lye, on concentration, will yield a crude glycerine analyzing about 40 per cent glycerol. On reference to the penalties imposed as above outlined, it will be seen that at the present time crude glycerine obtained from an untreated lye has practically no mar-

ket value to the producer when he offers it for sale to glycerine refiners.

As much soap as possible should be removed from the lyes before they go to the lye treatment department. For this purpose there should be available enough storage capacity between the kettles and the lye treatment department so that the lyes may cool sufficiently to separate the soap. The usual practice is to have sufficient storage to hold the spent lye produced during any week.

Lye Purification by Single Treatment

The simplest and probably most common method of lye treatment is that known as the single treatment, which is herewith outlined in detail.

Cooled and settled lyes from which the soap has been skimmed are pumped to a treatment tank which is filled to about 24 in. from the top so as to allow space for agitation. After the proper amount of lye has been run in, preferably a steam blower or ejector is turned on for the double purpose of stirring the lye with air and at the same time heating it. After a few minutes of agitation, a sample is withdrawn before any metallic salt or acid is added.

Metallic salts commonly used are sulphate of alumina and ferric chloride. The former is usually purchased as such, while the latter is usually made by dissolving ferric oxide in muriatic acid.

Either 60 deg. sulphuric acid or 20 deg. muriatic acid may be used. Sulphuric acid is most commonly employed because of its lower cost, although it is objectionable on account of the formation of sulphates which have but little efficiency in separating the soap from water in the kettle. When the sodium chloride which is used for separating the soap from the water, etc., in the kettle contains about 25 per cent of sulphates, the separating or "graining" action is much impaired. If as much as 30 per cent of sulphates is present, it is very difficult to grain the soap.

For simplicity of discussion, we shall assume that sulphate of alumina and 60 deg. sulphuric acid are used.

After a sample has been withdrawn from the treatment tank, from 3 to 5 lb. of sulphate of alumina is added to the tank for each 1,000 lb. of spent lye. The amount to be added is usually determined by experience and will vary with various kettle practices and also with various stocks saponified.

Chemical Control of Treatment

The sample of fresh lye is next filtered and tested. It is most convenient to make the test on 10 c.c. samples, using $N/4$ NaOH and $N/4$ H_2SO_4, since 1 c.c. of standard solution is then equivalent to practically 0.1 per cent of acid or alkali (respectively) in the sample. Phenolphthalein is used as indicator, 1 g. being dissolved in 50 c.c. of alcohol and neutralized with caustic soda to form the stock solution.

We shall assume that the treatment tank is 8 ft. inside diameter and 8 ft. deep inside and that it is filled to a depth of 70 in. with spent lye. A tank of this diameter holds 261.4 lb. of water per inch of depth, so that 70 in. would weigh 18,298 lb. Spent lye is somewhat heavier than water, but calculations are made on water weights to avoid using an excess of materials and so that errors will be made on the correct side.

After adding three or four drops of indicator to a 10-c.c. sample of the filtered fresh lye, $N/4$ acid is run in from a burette until the pink color has been discharged and then an excess of about 4 c.c. is added to neutralize any carbonates or bicarbonates which may be present. Let us assume that the total amount of $N/4$ acid added is 7.2 c.c. After boiling vigorously to expel carbon dioxide, the solution is cooled and the excess acid is titrated with the $N/4$ NaOH until the sample remains pink on standing a short time. Assuming that 2.5 c.c. was required, the difference between 7.2 and 2.5, or 4.7 c.c., is the amount of $N/4$ acid necessary to neutralize the alkali in the sample, or since each c.c. of $N/4$ acid is equivalent to 0.1 per cent of alkali, the original spent lye contained 0.47 per cent of alkali.

In the treatment tank there is 18,298 lb. of spent lye testing 0.47 per cent alkaline or containing 0.47 per cent of NaOH; 18,298 times 0.0047 equals 86.0 lb. of NaOH which must be neutralized.

Assume that the lye under consideration required 3 lb. of sulphate of alumina for each 1,000 lb. of spent lye and that this salt was added *after* the first sample was taken.

Accordingly, 48 lb. of sulphate of alumina was added to the treatment tank after the first sample was taken.

This salt neutralizes about one-third of its weight of NaOH, therefore about 16 lb. of NaOH has been neutralized, leaving 70 lb. still to be neutralized. Since 1.57 lb. of 60 deg. sulphuric acid will neutralize 1 lb. of NaOH, 70 $\times$ 1.57, or 110 lb., of 60 deg. H_2SO_4 is added to the treatment tank and the charge is thoroughly agitated for about 5 minutes.

A second sample is then taken, filtered, and 10 c.c. tested exactly as before. Assume 4.2 cc. $N/4$ H_2SO_4 added and 3.6 c.c. $N/4$ NaOH required to titrate back. The lye is still slightly alkaline—0.06 per cent—and since the original charge of 18,298 lb. has been increased by 95 lb., 18,393 $\times$ 0.0006, or 11 lb., of NaOH still remains to be neutralized, requiring 17 lb. of 60 deg. H_2SO_4. This is added, the mixture thoroughly agitated for a few minutes and another sample taken, filtered and tested exactly as before. Assume readings of 4.7 and 4.6 c.c. for acid and alkali respectively. This indicates an alkalinity of 0.01 per cent, which is satisfactory. For normal operating conditions the limits are 0.01 per cent acid to 0.02 per cent alkaline.

Check on Complete Precipitation of Impurities

Spent soap lye treatment is most efficient when all matter which can be precipitated has been separated in this form. As a further check on the treatment, three clear filtered samples are placed in separate test tubes. One sample is neutralized and there is added a drop or two of 10 per cent solution of sulphate of alumina. If sufficient of this salt has been added, the sample will not show a precipitate. If there is a precipitate formed, more salt should be added to the treatment tank. To the second sample there is added a slight excess of ammonium hydroxide and to the third sample a slight excess of dilute sulphuric acid. If the lye has been properly treated, there will be no precipitate formed in either of these two latter samples or else there will be formed the same amount of precipitate in both.

After the above tests have been made and the spent lye is found to be satisfactory, it is pumped through a filter press. Uusally the first filtrate from the press runs cloudy (this is especially true if the lye is cold) and is returned to the treatment tank. After the lye

runs clear it is run to the evaporator feed tank, whence it is fed to the evaporator.

Double Treatment of Spent Soap Lyes

In the double treatment of spent soap lyes, the settled, cooled and skimmed lye is pumped to the treatment tank.

Sulphate of alumina is added to the first treatment tank, the amount being usually determined by experience with the general quality of lye produced. The charge is then stirred violently and warmed, if necessary, by any convenient means. Sulphuric acid (60 deg.) is slowly run into the tank so that the acid is neutralized almost as soon as it enters the tank.

An experienced operator can judge by the appearance of the lye when enough acid has been added. An inexperienced operator can test the charge from time to time by dipping a piece of blue litmus paper in the charge. After there has been added just sufficient acid to turn the blue litmus paper red, the charge is agitated for several minutes to insure thorough mixing and is then finally tested with litmus.

When the lye is in such condition that it just turns blue litmus, it is filtered into a second treatment tank, where caustic soda of any desired strength is added until a sample will just turn red litmus blue. A filtered sample of the lye is tested with a few drops of a 10 per cent solution of sulphate of alumina. If the sample becomes cloudy, more sulphate of alumina is added to the second treatment tank to precipitate everything which can be precipitated by this salt.

When the treatment is satisfactory, the lye is filtered through a press and is ready for evaporation. The caustic treated lye should never be filtered through a press which has in it any filter press cake from an acid filtration, as this would dissolve some of the precipitate obtained in the acid treatment.

The ideal condition of a spent lye for evaporation would be to have it in such condition that there is present sufficient acid to drive off all volatile fatty acids which can be boiled off in the evaporator. The objection to evaporating lyes in this condition is that the corrosion on the evaporator would be excessive. If a spent soap lye is evaporated testing as high as 0.04 per cent acid, the corrosive action of the vapor is quite marked.

Other Methods of Treatment

The treatment of spent lye is by no means limited to the two methods here outlined. There are various other methods of treatment where there are used ferrous sulphate, calcium chloride, milk of lime, sodium carbonate, barium hydroxide, etc., besides treatment at various stages of concentration of the spent soap lye. These treatments are used to meet particular conditions in various factories and do not have a general application.

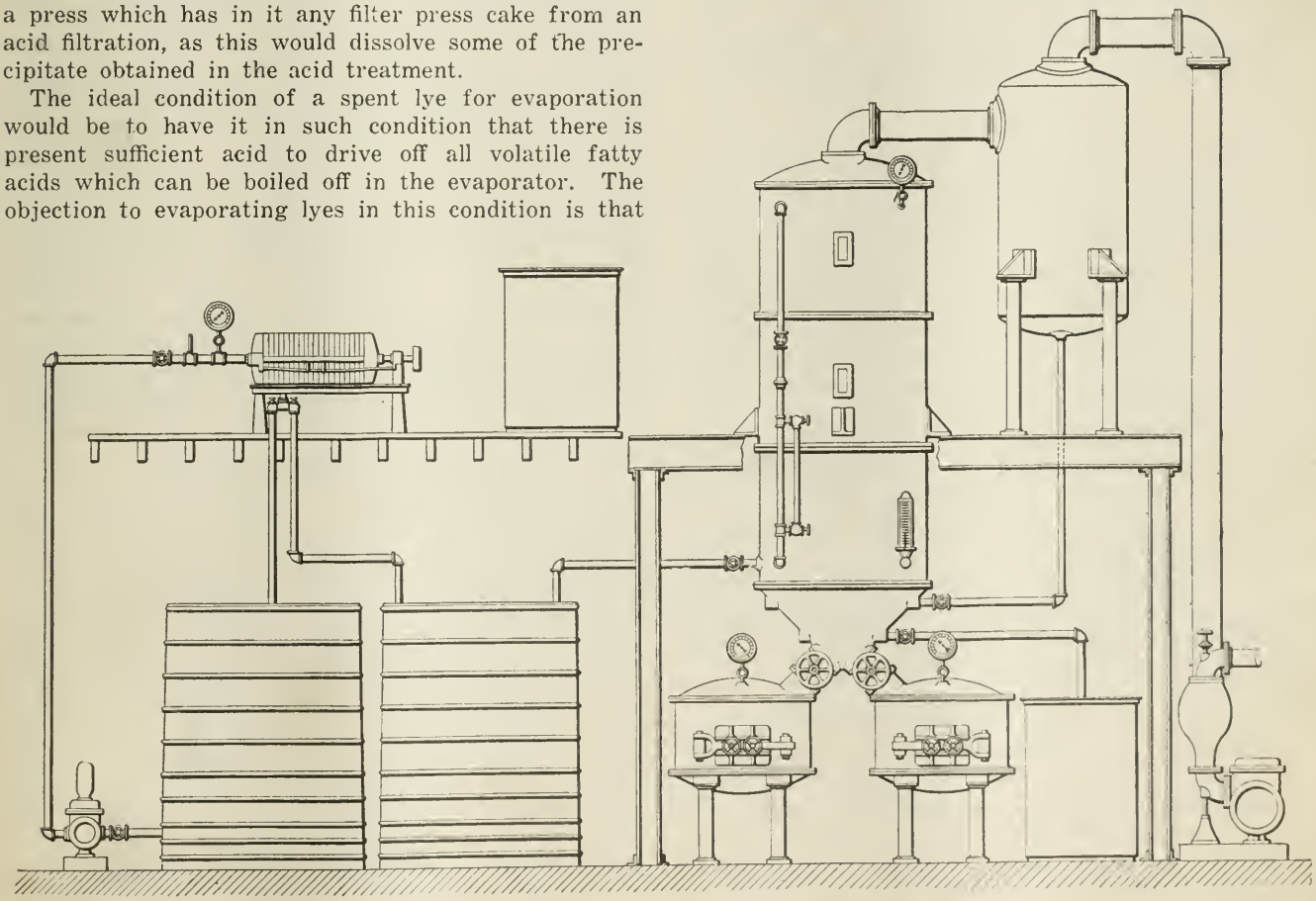
Evaporation of Purified Lyes

The evaporation of spent soap lyes may be carried on in various types of equipment. Probably the simplest type is an open soap kettle equipped with closed coils, but, due to objectionable features, this method of evaporation is practically obsolete.

Evaporation is usually carried on under vacuum in single or double effect. A double-effect evaporator will require about one-half the steam necessary for a single effect of the same capacity and is frequently employed where large volumes of lye are handled. The single-effect evaporator is the type used by most soap works.

For purposes of this discussion we shall assume that evaporation is carried on in a single-effect evaporator, with two salt boxes.

Equipment comprising an evaporator unit consists of the evaporator, salt boxes, catchall, condenser,



EQUIPMENT FOR RECOVERY OF GLYCERINE FROM SPENT SOAP LYES

vacuum pump, vapor lines, liquor lines, instruments and gages.

The evaporator consists of the vapor belt, calandria or steam chest, cover and bottom. It should be equipped with a water-gage column, thermometer and vacuum gage, together with the necessary openings for liquor, steam and vapor pipe connections.

The vapor belt should be equipped with suitable deflector plates to aid in circulation and also to aid in the prevention of glycerine losses through entrainment. It should also have sight glass openings so that boiling of the liquor may be observed.

Calandria

The calandria is usually of the standard vertical tube type. A common arrangement is to have copper tubes expanded into copper tube sheets, the body of the calandria being of cast iron. There has been considerable discussion about an electrolytic action being set up between the copper and the cast iron. The conditions for such an action are present, but the writer is acquainted with evaporators which have been in service for as long as 10 years wherein there is no perceptible deterioration due to such an electrolytic action and which appear to be good for an indefinite number of years of further service. The calandria should be so designed that there is free and positive circulation of the liquor in order that the tubes will not become salted. It should be equipped with baffle plates to aid the circulation of steam and to sweep out any non-condensible gases. It is further equipped with a steam inlet connection and condensation drain.

The cover may be equipped with a faced flange for vapor pipe connection or this connection may be taken from the vapor belt.

The bottom should be of the conical type tapped for liquor lines and with openings for drawing off the salt.

Salt Boxes

Salt boxes are used for the purpose of receiving the salt thrown out of solution upon concentration of the spent lye. They are connected to the bottom of the evaporator by means of salt valves, which are usually of the double wedge gate type. The bottoms of the boxes are connected back into the body of the evaporator above the calandria by means of salt box return lines. These lines should be equipped with valves and fittings so that steam or water may be passed to the salt boxes or to the evaporator.

A catchall is used for decreasing losses by entrainment and also as a separator if a charge is pulled over from the evaporator. It should be equipped with a drain line running to the evaporator and also with a water-gage column.

The condenser may be of the barometric type or else of the jet type directly connected to the vacuum pump. A barometric condenser serves to maintain a more even vacuum than is obtained with the jet type.

Operation of a Single-Effect Unit

In starting the evaporator in operation, the salt valves should be closed, the salt box return lines should be open and all other lines should be closed. The vacuum pump is started and a small amount of water turned on to the condenser. Under these conditions vacuum is pulled on the whole system.

After the vacuum reaches 15 in. or is sufficiently high to pull lye into the evaporator, it is filled to about one-half the height of the calandria. When the vacuum reaches 23 in. or more, a small amount of steam is turned into the calandria. Experience soon teaches just how much steam should be turned on. This should be done slowly enough so that boiling of the lye starts when the vacuum reaches about 25 in. Boiling should start slowly enough so that there is a drop in vacuum not to exceed 2 in. If the vacuum falls more than this, there is great danger of loss of liquor when the vacuum again rises, which it does quite rapidly as soon as the vapors reach the condensing water.

As soon as boiling commences, more water is turned into the condenser so that vacuum may be maintained. When the lye begins to boil, more steam is slowly turned into the calandria and more lye is fed to the evaporator to maintain a level about two-thirds of the height of the calandria. When the lye is boiling well the level in the evaporator is raised and the level of the liquor so maintained that the tubes are continually wet. Steam is increased until there is just a positive pressure on the condensation drain from the calandria. Under such conditions the evaporator is doing its normal work.

Filling the Salt Boxes

After a period depending on the salt content of the lye, salt will begin to crystallize out of the liquor and will drop into the bottom of the evaporator. The presence of salt may be detected in the liquor which is thrown against the sight glasses on the vapor belt. After salt begins to form the lye has no further value in dissolving salt remaining on the tubes from a previous run, as it is then a supersaturated salt solution, the salt valve on one salt box is opened, the steam is turned off of the evaporator momentarily and the charge is dropped into the salt box. The salt valve is left open and the evaporator body is again filled with fresh lye to the former level. While fresh lye is being fed, steam is turned on the calandria, so that the lye is heated to the boiling point as it is fed to the evaporator.

As evaporation continues, the lye again becomes a supersaturated salt solution and salt crystals will fall into the bottom of the evaporator, whence they drop into the salt box. Evaporation is continued and when the salt box is full the salt valve connecting this box to the evaporator is closed and the valve on the salt box return line is opened. The salt valve on the second salt box is opened and the charge is dropped from the evaporator into the second salt box as above described.

Drying and Removing Salt

The salt in the first box is now ready for drying. The salt box return line is open, thus connecting the bottom of the box with the body of the evaporator above the calandria. The vacuum breaker, which is a valve at the end of a nipple, is opened. This breaks vacuum or puts atmospheric pressure on the top of the salt and liquor in the salt box, whereas the bottom of the box is under vacuum through being connected into the evaporator which is under vacuum. The liquor mixed with the salt will draw through the salt and pass back into the evaporator body. It can be determined when the liquor is passing through by feeling of the salt return line, which becomes warm, or the level of the liquor may be seen in sight glasses in the salt box.

After the liquor starts to pass off from the salt box, the vacuum breaker is closed and steam is turned on

to the top of the salt. Enough steam is kept on to show a very low pressure on the box. After the liquor has all been drawn off into the evaporator body, steam is kept turned on for 15 to 30 minutes to dry the salt. When the salt is dry, steam is turned off and the valve on the salt box return line is closed. The salt box is now completely separated from the evaporator. The vacuum breaker is opened. The salt door is opened and the salt removed.

When the salt box is empty, the salt door is closed, and the valve on the salt box return line is opened very slowly to pull vacuum on the salt box so that it will be ready for dropping the next charge from the evaporator.

Concentrating and Finishing

The operation of filling and emptying the salt boxes is repeated as often as necessary until the half-crude stage of glycerine is reached. The half-crude stage is readily recognized, because at this time, maintaining the same level in the evaporator and the same amount of steam on the calandria, both the vacuum on the equipment and the pressure on the calandria tend to rise quite markedly. Steam is then gradually reduced until there is about 5 lb. of pressure on the condensation drain with but little steam turned on the calandria.

With these conditions obtaining and with one salt valve open, the feed to the evaporator is shut off and the charge in the evaporator is concentrated until the liquor has a temperature of about 165 deg. F. under 26 in. of vacuum, or 170 deg. F. under 25 in. of vacuum. The salt valve is closed and the charge in the evaporator is not dropped again. The salt box is steamed as usual and the charge in the evaporator is concentrated until it has a temperature of 200 deg. F. under not less than 27 in. of vacuum.

If the spent lye has been properly treated, this finishing condition will produce a crude glycerine containing in excess of 80 per cent glycerol. Analyses of the crude produced should be made from time to time and the finishing temperature decreased if possible, as there is some loss of glycerine when finishing at 200 deg. Good crude glycerine has been obtained with a finishing temperature of 170 deg. F.

Advantages of Evaporating Under Vacuum

Evaporation under vacuum is carried on primarily for the purpose of increasing the rate of evaporation and not for the saving of steam, as will be seen from the following:

Under atmospheric pressure, saturated steam has a total heat of 1150.4 B.t.u., while under 26.85 in. of vacuum it has a total heat of 1110.6 B.t.u. The difference in total heat is 39.8 B.t.u., or 3.46 per cent. The saving in heat units by evaporating under this vacuum is then 3.46 per cent, but against this saving there are the charges for steam consumed by the vacuum pump and also the condensing water required.

The advantages of evaporating spent lye under vacuum are primarily that to evaporate a given quantity of lye there is a saving in equipment and floor space required and also less loss of glycerine through being able to make crude glycerine at a lower temperature.

Rate of evaporation is approximately proportional to the difference in temperature between the heating medium and the medium being heated. Taking, then, the case of evaporating water on which accurate temperature figures are available,[1] assume the steam pressure on the calandria to be 5.3 lb., at which pressure the temperature of steam is 228 deg. F. Under atmospheric pressure the boiling point of water is 212 deg. F. and under 26.85 in. of vacuum the boiling point of water is 116 deg. F. Boiling under atmospheric pressure, the temperature drop would be 16 deg., whereas boiling under a vacuum of 26.85 in., the temperature drop would be 112 deg. F. Since the rate of evaporation is roughly proportional to the temperature drop, the rate of evaporation under the above vacuum would be about seven times as great as under atmospheric pressure.

Necessity for Avoiding Sudden Rise in Vacuum

Vacuum decreases the temperature at which a liquid will boil. In the case of water it will boil at a temperature as low as 32 deg. F. under perfect vacuum. This fact makes it very important that no sudden rise in vacuum take place in the evaporator.

If water is boiling in an evaporator under 20.04 in. of vacuum, its temperature is 161 deg. F. If the vacuum is 26.85 in., its boiling point is 116 deg. F. If there is present in the evaporator 2,000 lb. of water boiling under a vacuum of 20.04 in., the total number of B.t.u. present is 2,000 times 1129.9, or 2,259,800. The total amount of heat present in this amount of water under 26.85 in. of vacuum is 2,000 times 1110.6, or 2,221,200 B.t.u.

If the vacuum is suddenly increased from 20.04 in. to 26.85 in., water is present in the evaporator, which water has a boiling point of 116 deg. F. and the temperature of which is 161 deg. F. There is then available the difference between the two total heats, or 38,600 B.t.u., which energy very quickly expends itself in converting some of the water into steam. While the amount of steam generated with this excess of heat is only about 35 lb., yet this steam has a volume in excess of 6,000 cu.ft. which is generated suddenly throughout the 2,000 lb. of water and will mechanically carry over most of the water to a point beyond the evaporator. When the above conditions exist, the charge may be seen in the catchall, or if there is no efficient catchall, it may be seen in the discharge of the vacuum pump.

In a properly designed evaporator this is probably the most prolific source of glycerine losses. For this reason it is advisable to have all evaporators equipped with a recording gage (either thermometer or vacuum gage) so that there may be kept a check on how the evaporator is run for the full period of operation.

Entrainment Losses of Glycerine

Entrainment losses of glycerine usually consist in the passing over of small particles of the solution being evaporated. These extremely fine drops may pass from the surface of the boiling liquor as such or may be the result of breaking up of larger drops by impingement or the breaking of bubbles. It can be demonstrated mathematically that comparatively large drops of liquor may be carried away with the vapors from the glycerine evaporator.

Causes and Remedies for Decreased Rate of Evaporation

Decrease in the rate of evaporation of any given glycerine evaporator is most frequently due to the salt-

[1] Marks and Davis Steam Tables.

ing up of the tubes. This condition is largely a function of the design of the calandria and the salt content of the spent soap lye.

If there is a marked decrease in the rate of evaporation the manholes should be opened so that the calandria may be inspected. If the calandria is clean, the calandria and condensation drain should be tested under water pressure. If the calandria is salted, the manholes should be closed and the evaporator filled with water so that the calandria is completely immersed and this water boiled for about 15 minutes. It should then be drained into a storage tank so that the glycerine may be recovered. This water should be tested with a hydrometer and if it has a Baumé higher than 23 deg., it may be concluded that it is saturated with salt. A second charge of water should then be boiled and tested. If this second wash water tests less than 23 deg. Bé., this water should be run to waste. The manholes should be opened and the calandria examined to see if it is free from salt. It frequently happens that there is a small leakage in the steam valve on the calandria so that when the evaporator is shut down at night the salt deposit on the calandria and tubes is baked on very hard. Under these conditions, boiling with water for a short time will not dissolve all of the salt, so that the Baumé test may show the presence of only a small amount of salt in solution while the calandria is still coated. It is good practice to fill a glycerine evaporator with water when it is shut down for any considerable period of time. The necessity of doing this will vary in different soap works where different types of lye are handled and is a matter which can best be determined by experience.

The condensation drain of the evaporator should be equipped with a compound gage (pressure and vacuum) so that any leakage in the calandria may be easily detected. Small pinhole leaks usually can be located only by putting a water pressure test on the calandria.

Legal Notes

By Wellington Gustin

If Performance of Contract Is Impossible at Time Specified Both Parties Are Discharged

In Edward Maurer Co., Inc., vs. Tubeless Tire Co., 272 Fed., 990, plaintiff sued to recover damages for the refusal of defendant to accept and pay for certain rubber yet undelivered upon two contracts. The first contract was made May 3, 1918, and the second May 14, 1918, both covering 45 tons of rubber, deliveries to be in equal monthly installments from May to December, 1918.

About 21,000 lb. of rubber was shipped in May and June, 1918, which was accepted and paid for by defendant. On Sept. 27, 1918, plaintiff shipped 11,204 lb. more, which defendant refused to accept and which was afterward returned to plaintiff and resold by it at a loss of 4c. per lb. No further deliveries were made.

When the contracts were made both parties knew the United States contemplated fixing a maximum price for rubber and restricting its importation from overseas and that such regulations might be announced at any time. On May 7 these regulations were promulgated, whereby plaintiff was not permitted to import any new rubber for delivery under these contracts unless defendant obtained an allocation certificate from the War Industries Board authorizing the defendant to buy and use it.

The allocation of rubber among manufacturers was made on the basis of their consumption of rubber during the preceding year, and inasmuch as defendant's plant was during that period in the construction and experimental stage, defendant was able to have allocated only 180 lb. a month. Plaintiff depended on importation of rubber and therefore since it could not import it could not deliver to defendant. These restrictions were lifted Dec. 13, 1918, and by April, 1919, plaintiff had imported rubber and was then in a position to make further deliveries. Formal tender of delivery was made in June, 1919, and acceptance was then refused. At this time the price of rubber was 40c. per lb.—that is, 22c. less than the contract price. Suit was then brought to recover damages, measured by this difference between market price at time of tender and the contract price.

Plaintiff contended that these contracts, properly construed, merely postponed or suspended delivery during the period that performance was prevented by governmental interference and that when the restrictions were removed the contract remained in full force and effect, with an obligation upon the plaintiff thereafter to deliver, and upon the defendant to accept and pay. By provision in the contract it was "subject to all the rules and regulations imposed by the United States Government."

Government Regulations Voided Contract

The court said plaintiff's contention could not be sustained, since the contract in its entirety was made subject to the rules and regulations imposed by the United States Government. It is not deliveries only, but the contract obligation itself, which is made to depend upon these conditions.

Again the court points out that in contracts to deliver and to accept and pay for an article of commerce, the market value of which is fluctuating, time is an essential element. The failure or refusal of the seller to deliver or tender the monthly quantities at the time is a breach which would discharge the buyer from further obligation to accept and pay. The buyer of an article thus fluctuating in value cannot be held to an obligation to accept and pay at other times and under different conditions when its market value may have greatly changed.

The rule of law applicable is that if performance of the contract is made impossible by a subsequent valid act of law or governmental authority, both parties are discharged. If a contract is made subject in its entirety to a condition, and that condition happens, the rule is that both parties are discharged, and not that performance is suspended until the condition is overcome. The court says that neither party could have in mind merely a suspension or postponement of delivery during the war or while governmental regulations were in force, because no one could then foresee how long the war would continue, nor anticipate market or manufacturing conditions at the end of the war and after the restrictions were lifted. It would require clear and apt language in a contract before a court would be justified in finding such to be the intent of the contracting parties. Therefore the federal District Court gave judgment for the defendant.

Some Economic Aspects of Ammonia Oxidation*

Cost of Concentrating Weak Nitric Acid Produced by Ammonia Oxidation at Present More Than Offsets Advantages Due to Lower Conversion and Nitrogen Costs — An Economic Study of the Factors That Determine When Ammonia Can Profitably Replace Saltpeter as a Source of Nitric Acid

By GUY B. TAYLOR
Experimental Station, E. I. du Pont de Nemours & Co.

IF THE primary product obtained by oxidizing ammonia were strong nitric acid, then ammonia on a price parity basis with Chilean saltpeter would be incomparably cheaper than saltpeter as a source for nitric acid. Unfortunately the primary product is nitric oxide and the cost of conversion of this oxide of nitrogen into strong nitric acid is considerable, in spite of the fact that the raw materials, water and air, required for doing so, cost practically nothing. The industrial uses for weak nitric acid are so limited in extent that the oxidation of ammonia for the production of weak acid is of minor interest in the discussion. The question, then, of when it is economical to oxidize ammonia and when not to oxidize ammonia centers largely around the question of the cost of concentrating nitric acid. This state of affairs will continue as long as a small price differential exists between Chilean saltpeter nitrogen and ammonia nitrogen. With the development of processes for synthetic-ammonia manufacture, the price differential is likely to change in favor of ammonia and the relative importance of nitric-acid concentration will vary as a factor in the situation.

The next most important factor, after raw materials cost and concentration cost, is the scale upon which manufacture is conducted. Nitric acid is an extremely corrosive liquid and on this account its transport is difficult and expensive. As a consequence nearly all large users manufacture at the place of consumption. Ammonia oxidation plants are not inexpensive to build and the first cost per ton of rated capacity is naturally greater the smaller the output. It might pay to construct a new plant to produce nitric acid by oxidizing ammonia, while under a similar set of circumstances it would not pay to scrap a going retort process.

Comparison of Equipment and Manufacturing Processes

Before proceeding to more detailed comparisons, it is advisable to outline briefly the character of the plants required for the two processes. The essential units in the equipment are:

Ammonia Oxidation	Chilean Saltpeter
1. Ammonia liquor storage.	1. Soda storage.
2. Ammonia gas plant.	2. Sulphuric acid storage.
3. Ammonia converters.	3. Retorts.
4. Absorption system.	4. Condensers and receivers.
5. Nitric acid concentration.	5. Absorption system.

In the ammonia-oxidation plant ammonia gas is distilled from liquor and mixed with air. The gas mixture is then put through a catalyst in the converter whereby nitric oxide and water vapor are produced. The gas then passes to the absorption system, where, coming in contact with water and air, the nitrogen oxides are converted to weak nitric acid with a strength of about 50 per cent. This weak acid is converted to 90+ per cent HNO_3 by distillation from sulphuric acid. This results in the production of weak sulphuric acid, from which the water must be boiled out in order that it may be used again.

In the saltpeter process sodium nitrate and sulphuric acid are charged into cast-iron retorts and strong nitric acid is distilled out and condensed. Toward the end of the distillation the distillate weakens somewhat due to thermal decomposition of HNO_3 and the release of water from the charge, previously held by the sulphuric acid. This weaker distillate is in some cases caught in a separate receiver and in others mixed with the strong distillate. Some nitrogen peroxide is evolved and recovered as dilute acid in the absorption system. The dilute absorption system acid and the weak distillate together seldom amount to more than 10 per cent of the yield.

In the ammonia-oxidation process all of the output is recovered first as dilute acid, which must be concentrated, while in the saltpeter or retort process upward of 90 per cent of the output is directly recovered as strong acid. On the other hand, the retort process consumes sulphuric acid in about equal tonnage with Chilean saltpeter and the ammonia-oxidation process consumes none.[1]

Fixed Charges—Construction and Operation

As a basis of comparing the two processes let us take a case favorable to ammonia oxidation. Let us assume that a new plant for nitric-acid manufacture is to be built in a locality favorable to large-scale production, say a place where 25,000 tons of HNO_3 per year can be disposed of. This is a convenient capacity rating to assume, because it approaches the largest conceivable peace-time production in any one place and because a plant of this size was actually built in this country during the war (U. S. Nitrate Plant No. 1). This gives us a line on probable plant cost. Such a plant will cost, say, $1,000,000, or $40 per ton-year. The first cost of a retort plant on this scale will amount to, let us say, $12 per ton-year, or less than one-third as much. The cost of operating the two plants will vary from time to time, but our estimate is that this cost will average about the same for each—that is, $10 per ton of product figured as 100 per cent HNO_3. This item, hereafter designated "operating cost," includes operating labor, repair labor, repair material and replacement, fuel and power, and superintendence. In the case of the ammonia-oxidation process the operat-

*A paper presented before the Acid Symposium at the fourteenth semi-annual meeting of the American Institute of Chemical Engineers, Niagara Falls, Canada, June 19 to 22, 1922.

[1]Except the small quantity lost in repeated reconcentration of sulphuric acid required for dehydrating weak nitric acid.

ing cost of the concentration unit is excluded. The retort process requires about 1.4 tons of sulphuric acid per ton HNO_3. If this acid costs $16 per ton, the sulphuric acid cost per ton of HNO_3 will be about $20, making due allowance for niter cake credit.

In order to eliminate what may be termed the minor variables in the problem, let us assume the cost factors arrived at above are constants and study the major variables—nitrogen costs, yields and concentration costs. The assumed constants may then be summed up as follows and the sum designated "conversion cost":

	Ammonia Oxidation (As 50 Per Cent Acid)	Chilean Saltpeter (As 90+ Per Cent Acid)
Operating cost	$10	$10
Fixed charges at 15 per cent[2]	6	2
Sulphuric acid	0	20
Conversion cost, per ton of HNO_3	$16	$32

Nitrogen Costs

In the chart shown in Fig. 1 the relations between the nitrogen costs of the raw materials and the finished product for various conversion efficiencies are presented graphically. The ordinate shows the costs of ammonia and sodium nitrate at parity in cents per pound and the

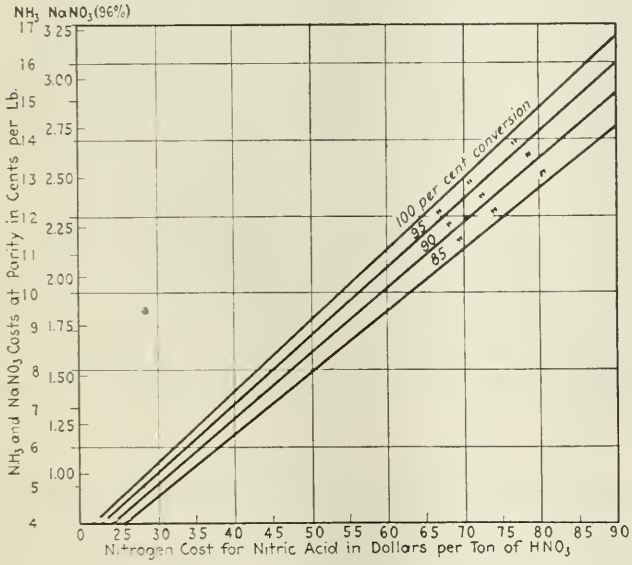

NH3 NaNO3(96%)
NH3 and NaNO3 Costs at Parity in Cents per Lb.
Nitrogen Cost for Nitric Acid in Dollars per Ton of HNO3
100 per cent conversion
95 " "
90 " "
85 " "
0 25 30 35 40 45 50 55 60 65 70 75 80 85 90

FIG. 1—NITROGEN COST OF NITRIC ACID VS. THE COST OF AMMONIA AND SODIUM NITRATE FOR VARIOUS CONVERSION EFFICIENCIES

abscissa the corresponding nitrogen cost for nitric acid in dollars per ton of HNO_3 at various conversion efficiencies. The nitrate is figured as 96 per cent pure.

The yield from nitrate may be conservatively put at 98 per cent and that from ammonia at 90 per cent (95 per cent oxidation efficiency and 95 per cent absorption efficiency). At these yields, with ammonia and nitrate at parity, and varying in price from 8c. to 15c. for NH_3 and 1.5c. to 2.9c. for nitrate, the total cost for nitric acid from ammonia varies from $64 to $106 per ton and for nitrate from $76 to $115 per ton. The spread between the two processes is only $12 at the lower nitrogen cost and $9 at the higher. That is to say, if 50 per cent nitric acid can be concentrated for much less than $10 per ton, it pays to oxidize ammonia when ammonia and nitrate costs are on a parity basis.

[2]Includes the items of taxes, insurance, interest, amortization and obsolescence.

The following tabulation gives a few examples of the spread between the two processes when nitrogen costs are not on a parity basis:

Cost of NH_3 Per Lb.	Cost of $NaNO_3$ Per Lb.	Ammonia Oxidation Cost of HNO_3 Per Ton (50 Per Cent)	Chilean Saltpeter Cost of HNO_3 Per Ton (90+ Per Cent)
8c.	1.75c.	$64	$82
10	2.25	76	97
12	2.50	88	103
12 5	2.25	91	97

The first three cases in the above tabulation are taken at prices showing not unusual disparities in price quotations between ammonia and nitrate, and in favor of ammonia. In the last case, ammonia is relatively the higher priced and is about the condition of affairs that obtained in the early months of this year. From the above it will be observed that ammonia as a source of weak nitric acid is cheaper than saltpeter at any disparity in nitrogen cost that is likely to occur.

It is doubtful whether the overall yield of an ammonia-oxidation plant can ever closely approach the efficiency of the retort process, which in well-conducted works averages 98 to 99 per cent. The catalytic oxidation efficiency to be expected under the best conditions can scarcely be more than 95 per cent and absorption efficiency 98 per cent, or an overall of 93 per cent. On a nitrogen parity, then, nitrogen for the ammonia-oxidation plant must always cost more, but this is more than balanced by sulphuric acid used in the retort process. As a matter of fact, based on prices in normal years, the nitrogen costs of the two processes would have been about the same in the past, because ammonia commanded a less price per pound of nitrogen than did nitrate. The thing to be emphasized in considering yield is the relative importance of yield gains to any probable operating economies. An addition of 1 per cent to the yield means more in dollars and cents than a reduction of 10 per cent in operation cost or fixed charges.

Costs of Concentration

The concentration cost, the most important item under present conditions militating against any widespread adoption of ammonia oxidation, is a difficult matter to estimate. Nitric acid has never been concentrated in this country on the scale assumed in our comparisons, except under war conditions. The cost of this operation will probably lie between $20 and $40 per ton of HNO_3. Assuming that it can be done for the lower figure, what price can we afford to pay for ammonia in order to compete with Chilean saltpeter? In the following tabulation the first column shows an assumed price for saltpeter, the second column the corresponding cost of ammonia at parity, the third column the price to which ammonia would have to fall to break even with saltpeter, and the fourth the estimated cost of nitric acid at the break-even condition. Yield from nitrate is taken at 98 per cent and from ammonia at 90 per cent. The conversion cost of ammonia is taken at $16 and of nitrate $32 per ton HNO_3; $20 is added to the ammonia-oxidation process for concentration.

Cost of Chilean Saltpeter, Cents Per Lb.	Cost of Ammonia—At Parity, Cents Per Lb.	Cost of Ammonia—Competing Price, Cents Per Lb.	Cost of HNO_3 Dollars Per Ton
2.0	10.5	8.8	89.00
2.5	13.0	11.2	103.50
3.0	15.6	13.7	118 00

The above tabulation shows that ammonia must be obtainable for at least 2c. per lb. less than the parity price in order to show any considerable saving over Chilean saltpeter at 2c. to 3c. per lb. as a source for strong nitric acid.

The catalytic oxidation of ammonia gas to nitric oxide—that is, the ammonia-conversion step in the process—may be considered as in a very satisfactory state. Obviously, from what has been said above, the point of attack in improving the process is to solve the problem of more cheaply converting nitrogen oxides to concentrated nitric acid. Seventy per cent of the plant cost is swallowed up in huge absorption towers recovering weak acid. And this weak acid must be concentrated. This problem in connection with the arc process, in which these features are greatly magnified, has received much attention abroad, as witnessed by an extensive patent literature. But not one of these proposals looks promising even on paper, and needless to say none has ever reached the commercial stage of development.

Conclusions

All things considered, it may be concluded as a result of this study that under present conditions, as a source for strong nitric acid, saltpeter has a slight advantage over ammonia. The conversion cost and the nitrogen cost (usually) of ammonia are less than corresponding costs of sodium nitrate, but this advantage is more than offset by the necessity for concentrating nitric acid in the ammonia process. The advantage of the retort process probably increases as the scale of manufacture decreases. If the price of ammonia falls, as is likely with the coming into production of synthetic-ammonia plants on a large scale, then the slight advantage of the retort process will disappear. It is conceivable that the time may come when it will no longer pay to import Chilean saltpeter at all as a source of nitric acid.[3]

There are two uses for which ammonia oxidation may be profitably employed immediately. In the writer's opinion all lead chamber or "nitration" sulphuric acid plants should be equipped with ammonia converters. In this case the plant investment is relatively small. The nitrogen oxides are used as such, no absorption system of any kind being needed. The ease of control and uniformity of supply ought to be of considerable advantage to the sulphuric acid plant operation. The second possible immediate use for ammonia oxidation is for the production of weak nitric acid. There are a few industries utilizing weak acid having no use for strong acid. If the requirements are sufficiently large, it would pay to oxidize ammonia.

[3]In this connection it should be remembered that the export duty on Chilean saltpeter from Chile is a considerable fraction of its total cost. This tax will no doubt be reduced to meet competition with ammonia, should the market for saltpeter be seriously threatened.

Hydro-electric Development in Italy

Hydro-electric power in Italy as of Jan. 1, 1922, is reported by Consul Sycks, Turin, as 1,191,797 hp. In addition to the hydro-electric plants now in operation, new ones are in course of construction, of which those in Lombardy will produce 121,934 hp. and those nearing completion in Piedmont will produce 109,386 hp. The total electric power now generated by the hydro-electric plants (1,191,797 hp.) is estimated at 60 per cent of the capacity of the total number of centrals for which concessions have been granted.

The Application of Chemical Research to the Cotton Oil Industry*

By David Wesson
Technical Director, Southern Cotton Oil Co.

During the past forty years accumulated experience aided by scientific research has brought about enormous changes in the milling of cotton seed and the refining of cottonseed oil. A knowledge of the fundamental principles of refining and hydrogenation has replaced the irregular evil-flavored oils of the early days with tasteless, odorless products which have taken much of the prestige from the oil of the olive and the fat of the hog.

Although much has been learned, let us not for a moment imagine that there are no new fields to conquer. We should know the breeds of cotton producing the seed which will carry the longest fibers and at the same time yield the most oil. We know that cake and meal are rich in protein, but we know comparatively little about the protein itself. Cottonseed oil has been bleached for the last forty years with fullers earth. How much do we know about why the earth does the bleaching and what is its effect on the oil itself? What is the nature of the color removed by the earth? How much do we know about the various mixed glycerides produced at different stages of the hydrogenation process? We know that all fats turn rancid, but we know very little about the causes and the products formed in the process. This is a matter of great practical importance.

In buying and selling crude oil our transactions are governed by a rule-of-thumb test which, in a way, approximates the time-honored but barbarous means employed in the refining kettle.

One of the most promising signs for the future is the spirit of the Department of Agriculture, which has started in on a fundamental research primarily to benefit the farmer, but incidentally of great use to the vegetable oil industry.

It seems to me that the time is ripe for co-operative research for the good of the industry as a whole. The day has gone by when there is anything to be gained by a lot of technical men getting together and all keeping their mouths shut for fear they might tell something that would be of use to the other fellow. A free interchange of ideas will, in my opinion, do more good to the industry as a whole than the past practice of silence and secrecy. There should be free converse about the chemical nature and the constitution of the materials which we all handle, but when it comes to the details of erecting and operating plants to obtain certain results, then we are treading on dangerous ground, and it is only right and proper to maintain secrecy.

*Extracts from an address before the thirteenth convention of the American Oil Chemists Society, New Orleans, June 5 and 6, 1922.

Revised List of Research Chemicals

The National Research Council has issued a new edition of its circular "American Research Chemicals" giving a more complete listing of the companies manufacturing research chemicals, biological stains and indicators, vital stains and hydrogen ion indicators. This list gives for each chemical the names of the companies which have reported to the committee that they are manufacturing that product. In a few cases distributors are also listed. A copy of the list can be obtained on application to C. J. West, National Research Council, Washington.

Fire Hazards at Quenching Tanks

AN IMPORTANT report from the committee on manufacturing risks and special hazards was considered at the May meeting of the National Fire Protection Association, on the "Regulations for Use of Volatiles in Manufacturing Processes." In introducing its report the committee states:

> The use of dip tanks containing highly flammable compounds subject to flashing at ordinary temperatures and giving off flammable vapors and possibly vapors forming explosive mixtures presents a severe fire hazard. Manufacturing requirements in some industries, the automobile industry for example, involve extremely large tanks, there being often three or four of them in a single room, each having a capacity of possibly 10,000 gal. The mixtures found in dip tanks may include various amounts of naphtha, benzine, benzene, amyl acetate, bisulphide of carbon, alcohol, which represent the principal flammable liquids. Of a slightly less hazardous nature are tanks containing paints, turpentine, kerosene, heated asphaltum, paraffine and tempering oils. Tanks containing mixtures with more or less benzine and naphtha represent a large majority of those in use.

Samples of air taken from dip and quenching rooms seldom show a content of volatile hydrocarbons which approach the point where danger from explosion exists. However, it is essential that means be provided to prevent the accumulation of heavy vapors at low points in the room; for somewhere between the rich, low-lying mixtures and the lean upper layers is an exact proportion which will explode from a small spark or flame. Furthermore, ventilation should be directed to the outside air; otherwise dangerous concentrations will occur in passageways leading to other rooms which act as ventilating corridors.

Dipping Room Fires Difficult to Extinguish

The fire hazard in dipping rooms is extreme in any case, as the nature of the compounds in the dip tanks is such that a fire in them produces serious results. Ordinary methods of extinguishment cannot often be applied with success to such a fire. Even if the room is fire resistive and contains no other combustibles, the heat from the burning compounds will ordinarily cause a severe loss to the most superior construction and even complete destruction has sometimes occurred. Such a fire will distort, with large loss, unprotected steel work and machinery in the room, as well as cause a heavy damage to the other contents.

Moreover, a dip tank on fire will burn for a very long time because a sufficient amount of air cannot get to the limited surface to consume the contents quickly. A tank containing an ordinary mixture, 2 ft. deep, would probably burn fiercely for 2 or 3 hours. The only way to extinguish such a fire is to smother it promptly. If too much water is applied to the tanks they will overflow and the burning volatiles will flow around the room wherever the water carrying the burning liquid on its surface may run, thereby spreading the fire. Provision for the safe disposal of the liquids is essential where water is likely to be used.

Hose Streams Spread Fire

The use of hose streams in rooms containing uncovered and unsecured tanks on fire has resulted in serious losses through the displacement of the burning liquids by the water, the heavy streams often splashing the liquid about the room and upsetting the containers. Too much care cannot be taken in using hose lines on such fires. There are a great many cases in the fire record where the light spray from the sprinklers has extinguished fires in open dip tanks, which effect has been largely due to the cooling power of the sprinkler spray, but even with sprinklers there is a danger of seriously overflowing the tanks. If hose streams are used, effort should be made to spray the water and confine work to cooling the building until the contents of the tanks burn.

Regulations Recommended

Section 4, on quenching tanks, proceeds:

> Where a continuous process tempering machine is used, pumps or other means shall be provided for circulating the oil from the tempering tank to the cooling tank, sufficient pumping capacity and the relations of the speed of the machinery to be so adjusted as to prevent the oil rising to a temperature dangerously near its flash point. An automatic cooling or refrigerating system arranged to regulate the temperature of the oil exactly is preferred. Automatic machines feeding hot parts to the oil preferably should be so arranged that they will stop automatically through the operation of a thermostat placed in the oil when dangerous temperatures are reached.
>
> Hot oil tanks, unless located under a very high or fire-resistive ceiling, should be provided with a noncombustible hood and tube passing to outside the building to serve as a vent in case of fire. In some cases a fan may be necessary, but its use should be avoided where adequate ventilation otherwise can be obtained. Care should be taken in providing such a hood to minimize interference with the protection of the building by hose streams and the hood should be slightly larger than the tank to shed from the oil tank water so applied. All such tubes should be treated as flues and kept well away from flammable roofs or other combustibles.
>
> Tanks shall not be located on or near combustible floors. Combustible stock and other combustible materials should be kept well away from them. Door sills into other rooms, if near, should be raised to prevent the flow of oil or water carrying burning oil through them, except that this provision may be waived when floors are provided with otherwise adequate drainage. Tanks shall be located a safe distance from furnaces or other such hazards likely to flash fire to the tank or its vapors.
>
> Overflow pipe shall be provided to prevent the oil rising to a point nearer than 4 in. of the top of the tank and a drain should be provided at the bottom of the tank. These may be combined with the circulating system if desired or arranged independently, to drain the oil to a safe place.
>
> The inspection department having jurisdiction shall be consulted as to whether the valve in the drain shall be operated automatically with approved heat release devices or manually, and if the latter, whether the valve should be arranged for operation from a distance.
>
> Inspection departments having jurisdiction shall be consulted as to whether standard automatic means for extinguishment should be provided and whether automatic should be combined with manually operated devices. If automatic foam extinguishing systems are used, they should be standard.
>
> An approved 40-gal. foam type extinguisher on wheels and other standard first aid apparatus should be provided.

Natural Sodium Compounds and Borates in 1921

The production of natural sodium compounds in the United States in 1921 amounted to 25,000 short tons valued at $894,000. This was a decrease of about 41 per cent in both quantity and value from the 1920 figures. The material was marketed as the carbonate, bicarbonate, sulphate and borate and as trona, a double salt of carbonate and bicarbonate.

The production of boron ores in 1921 was approximately 50,000 short tons valued at $1,320,000 and marketed as borax and colemanite. This represents a decrease of over 58 per cent from the quantity shipped in 1920.

Cleveland Meeting, National Lime Association

Varied Technical Program Covers All Phases of Association Activities—Experience With Mount Kilns at Rockland, Me.—Lime Burning in Rotary Kilns—Symposium on Lime for Chemical Industries—Effect of Lime in Concrete—Work of the Chemical Department

IN OPENING the fourth annual convention of the National Lime Association, at the Hotel Statler, Cleveland, June 13, President Charles Warner said that from one point of view it was fortunate that the industry did not comprise thousands of producers, for it enabled the members to get together in a way which would not be possible in a large organization. This spirit of good fellowship was manifest throughout the various phases of the convention activities.

In addition to the technical program, some features of which are noted below, there were inspiring luncheon addresses by Hon. Newton D. Baker, former Secretary of War, H. Elmo Martin and George A. Coulton, vice-president of the Union Trust Co., Cleveland.

Experience With Mount Kilns at Rockland, Me.

Successful operation for nearly a year has served to dispel the skepticism regarding the Rockland & Rockport Lime Corporation's venture at Rockland, Me. The battery of six continuous-discharge vertical Mount kilns has proved to be nearly automatic, only 10 men being required for 24-hr. operation—3 foremen, 3 gas producer tenders, 2 skip operators and 2 handy men (day only). It has been found possible to produce 125 to 130 tons per day of 24 hr. with 5 kilns.

As would naturally be expected, experience developed the desirability of making certain changes in the original plans. Some of the more important of these were discussed and illustrated by N. L. Rockwood, editor of *Rock Products*.

In order to study the action of different sizes of stone in the kilns, the shaking grizzly has been replaced by a revolving screen giving four sizes. It was found necessary to design special bin gates to withstand the rough service in feeding the kiln-charging skips. The two suction fans on top of the kilns did not maintain sufficient draft and they were temporarily speeded up to twice their normal capacity but are now being replaced by larger fans. With these it will be possible to control the burning by regulating a draft damper.

An average of 6 tons of lime is produced per ton of coal, including that used under the boilers. Lime is discharged practically cold while the flue gas temperature is only 250 deg. C. Water used for cooling the gas valves goes to the boilers.

In effect this plant is a huge laboratory for the lime industry, where the effects of various factors can be determined under operating conditions.

Lime Burning in Rotary Kilns

Problems encountered in attempting to burn lime in rotary kilns were considered in a very comprehensive manner by Irving Warner, plants manager, Charles Warner Co. Because of different conditions, it is not possible to follow cement mill practice too closely and yet it is difficult to determine the proper modifications because of the limited number of rotary kilns in the lime industry. The capacity of this type of kiln is so great that few lime manufacturers have more than one, with the result that experimental work is very limited. With only one kiln, heat recovery systems are hardly profitable and the same may be said of separate powdered coal systems, such as are found in cement mills. There are on the market self-contained powdered coal units which could be used with a single kiln and it is planned to install one of these in connection with the 8 x 150 ft. rotary at the Cedar Hollow plant, which is now using excess producer gas from the Mount kiln unit.

Small stone (from $\frac{1}{4}$ to $\frac{5}{8}$ in.) was found to work best, although in order to avoid crushing the kiln is actually run on $\frac{5}{8}$- to $1\frac{1}{4}$-in. stone. A constant ratio should be maintained between the feed and the speed of the kiln. For controlling the latter a variable speed motor may be used. The inclination of the kiln under discussion was $\frac{3}{4}$-in. per ft. but $\frac{1}{2}$- to $\frac{5}{8}$-in. is better, since a greater inclination cuts down speed and agitation of the charge.

In discussion it was brought out that while silica brick work very well in Mount kilns, they cannot be used in the rotary type because of the tendency to spall, the high heat conductivity which would increase radiation losses and the high coefficient of expansion.

Symposium on Lime for Chemical Industries

Parts of the Thursday afternoon and Friday morning sessions were devoted to very practical and instructive

discussions of the application of lime in several branches of the chemical industry.

Paper Pulp and Glass

Data on the use of lime in the preparation of cooking acid for sulphite pulp were presented by P. A. Paulson, consulting engineer, Appleton, Wis.

In liberating cellulose from wood by treatment with acids, many of the inorganic acids yield insoluble, dark-colored decomposition products. When compounds such as calcium and magnesium bisulphites are used, this difficulty is overcome, as the decomposition products remain in solution. Two systems are employed for making the cooking acid—the milk-of-lime and the tower. In the former, high-magnesia lime is slaked, made up to a 1 deg. Bé. milk of lime and saturated with sulphur dioxide. In the latter, high-calcium limestone is placed in a tower through which water and sulphur dioxide pass counter-currently, the cooking acid being removed at the base of the tower. The two bisulphites differ somewhat in their action. Calcium bisulphite is unstable when heated, forming a precipitate of calcium sulphite, and tends to give a harsh transparent pulp. The magnesium salt is more stable so that the liberation of SO_2 during the cooking is more gradual. The resulting pulp is softer, whiter and purer. For these reasons many mills prefer to use a cooking acid containing both bisulphites.

R. P. Shiveley, of the Monongah Glass Co., outlined briefly the uses of lime in the glass industry. Constant physical properties are required in glass for use on machines, since the machines cannot allow for variations as did the hand operators. Also producer gas is less uniform than the natural gas formerly used, so that more attention must be paid to the uniformity of raw materials. Limestone, quicklime and hydrated lime are used, the former being cheaper but more difficult to melt than either quicklime or hydrate. As a rule, high magnesia content is desirable for pressed glass while blown glass requires high-calcium lime.

Causticizing problems were taken up by G. K. Spence, chief chemist, New York and Pennsylvania Paper Co., Johnsonburg, Pa. Waste of time and material is now avoided by testing each shipment for active CaO before acceptance. The lime should contain not less than 90 per cent active CaO nor more than 1½ per cent MgO or SiO_2. Sludge is being reburned or dried for use as agricultural lime or whiting.

Water Softening

A paper by S. C. Hadden, editor of *Municipal & County Engineering*, was read by G. J. Fink. It was a strong plea for the centralized softening of public water supplies. The lime-soda ash process is about the only one available for whole municipalities. After-deposits can be eliminated if the filtration plant is properly designed. From data on 338 municipalities in Illinois, a conservative estimate of the amount of lime which could be used throughout the country is 1.000,000 tons per year, which contrasted with the present 30,000 tons indicates a market only 3 per cent developed.

Textile Industry

Opportunities for increased use of lime in the textile industry were indicated by Prof. Elton R. Darling, of James Millikin University. In boiling-out in closed kilns, lime has many advantages over caustic soda. It gives an even boil, leaves the goods with a proper bottom for sizing and completely removes the waxy materials by its combined saponifying and emulsifying action. If lime could be substituted for caustic soda wherever it would be advantageous to do so, it is estimated that the increased demand for lime would amount to about 200,000 tons a year.

Effect of Lime in Concrete

W. E. Emley, of the Bureau of Standards, summarized some very important findings on the effect of adding lime to concrete. Additions of 5, 10 and 15 per cent of hydrated lime were made to the following concretes: 1:1½:3; 1:2:4; 1:2½:5; 1:3:6. Different amounts of water were added and compressive strength and flow plotted against per cent water by weight. Results may be summarized as follows: If water is added to a given concrete, but no lime, the flow increases while the strength decreases; if lime is added but no water, flow decreases while strength increases. The effect depends also upon the properties of the original concrete and the net effect of adding both water and lime may be plus, minus or zero.

Interesting Properties of Lime

Prof. F. C. Mathers, of the University of Indiana, made some interesting observations on the effect of addition agents on the slaking time and on the rate of settling of hydrate. Thus, 5 per cent HCl decreased the slaking time from 12 min. to ⅓ min., while a small amount of sugar in the water used for slaking increased the time to 2 hrs. Similarly, sugar decreases the rate of settling of hydrate while $CaCl_2$ hastens settling.

When hydrated lime is reburned at 840 deg. F., a very active form of lime results. The addition agents noted above are without effect upon it. It would seem to be very effective for the preparation of absolute alcohol as it combines almost instantly with the water in 95 per cent alcohol.

Value of Research to Industrial Associations

In discussing the value of research to industrial associations, E. R. Weidlein, director of Mellon Institute, emphasized the fact that America now leads the world in the application of science to industry and that this is due in no small measure to the tendency away from the secrecy which formerly surrounded industrial developments.

A centralized research laboratory maintained by an association is particularly valuable to the small manufacturer and it also prevents much unnecessary repetition. It should function to create improvements in technical processes, to disseminate the knowledge thus obtained and to maintain systematic co-operation through contact with other branches of industry. A fact which should not be lost sight of is that both labor and capital benefit from improvements in technology, for if a product is made cheaper the demand increases, while if it is made better, new markets are attracted.

Officers for Next Year

The following officers were elected to serve for the year 1922 to 1923: President, Charles Warner, of Charles Warner Co., Wilmington, Del. and Philadelphia, Pa.; vice-president, George Nicholson; treasurer, Milton McDermott; secretary and general manager, N. G. Phillips. The following division managers were appointed: Agricultural division, J. A. Slipher; construction division, W. A. Freret; chemical division, M. A. Holmes.

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

American Potash Now Said to Meet Government Purity Standard

American potash is now of a degree of purity well within the standard set by the United States Department of Agriculture, according to a statement by the Bureau of Soils. Under the present method of producing potash at Searles Lake, Cal., there no longer exists the former danger to crops from the presence of borax in the fertilizer.

The department has followed closely the course of American potash production, not only with a view to assisting in establishing commercial sources of potash but also to maintaining a quality that would be suitable for use as fertilizer without fear of injury to crops. During the summer of 1919, the attention of the department was directed to injury to crops by the use of fertilizers. The injury was widespread and serious especially to the tobacco and cotton crops of the eastern districts of North and South Carolina and to the Maine potato crop.

The discovery of the ill effects of borax led the department to issue an order limiting the amount of borax that could be present in a mixed fertilizer, unless specifically labeled, to an amount that would be equivalent to not more than 2 lb. per acre in the applications used by the growers. The department also forbade the sale to farmers, as straight goods, of potash salts containing more than ½ of 1 per cent of anhydrous borax.

As originally obtained by the producers, the potash salts which were the cause of crop injury ranged in content of borax from 4 to 14 per cent. Immediate steps were taken to improve the methods of recovery and to eliminate the borax as far as practicable. The results of the refinement of methods show that it is practicable to produce potash salts from the Searles Lake brine with a borax content well within the limit of safety set by the department. Analyses show that in the salts produced during the period 1920 to 1922 the borax content ranged from 0.27 to 0.50 per cent, which compares favorably with the content of borax in sodium nitrate.

Bounty for Domestic Potash Agreeable to Producers

Opposition from the farmers to the proposed duties on potash has been an important factor in inducing the Finance Committee of the Senate to revise further the tariff bill by placing potash on the free list and bringing in a proposal for a bounty which would offer a financial encouragement to the American industry equivalent to the protection carried in the bill passed by the House.

Chairman McCumber, of the Finance Committee, pointed out that if the bounty were made effective today, nothing would be paid out, as he says there is no potash being produced domestically. Even during the height of the war when potash rose to $450 per ton, the maximum production was 54,000 tons, he pointed out. If the domestic production were to reach 50,000 tons a year during the 5-year period over which the bounty would apply, bounty payments would not exceed $2,500,000 for the first year; $2,500,000 for the second year; $2,000,000 for the third year; $1,500,000 for the fourth year and $1,000,000 for the fifth year.

The representatives in Washington of the domestic industry seem to be entirely willing to accept the bounty proposal, but it is predicted in some quarters that the attitude of the potash producers will change. This is based largely on the experience with the sugar bounty. A direct payment of public money to an industry seems to arouse much greater resentment than does the payment of even a larger amount of tax at the custom house.

Delay of Dye Embargo Vote Pleases Opponents

Consideration by the Senate of the naval appropriation bill and debate on the policy with regard to soldiers' bonus had the effect of displacing the tariff bill during the greater portion of the past week and as a consequence the vote on the dye embargo was deferred.

There is increased reason to believe that the embargo proposal has the support of sufficient votes to secure its adoption. This practically has been admitted by its opponents and their policy is to delay its consideration as long as possible in the hope that something may happen to make the plan less popular.

Latest Muscle Shoals Minority Report Augments Growing Opposition to Ford Proposal

Since the introduction of bills more than two weeks ago, emanating from the Committee on Military Affairs of the House of Representatives, proposing the acceptance of Henry Ford's offer for the government Muscle Shoals properties in one case and the acceptance of the offer minus the Gorgas steam plant in the other, the matter of a Muscle Shoals policy has been uppermost in the minds of the majority leaders in each House. No formal announcement has been made but it is believed that they oppose any vote on the proposition at this time.

During the two weeks that members of Congress have had in their hands the reports of three groups within the Military Affairs Committee, the opposition to the acceptance of the Ford offer has grown steadily. This trend was augmented greatly when Representative Kearns of Ohio brought out another minority report signed by seven of his colleagues on the Military Affairs Committee. This report assails the Ford offer in vigorous fashion. "If we were believers in fables, or had faith to believe in the pranks of fairies," says this report, "then we might think Mr. Ford is the reincarnation of Alladin plus his lamp."

Weeks Displeased With Fertilizer Clause

Emphasis is laid on the fertilizer feature of the Ford offer in this report. It points out the fact that Mr. Ford has always refused to allow himself or his company to be bound without qualification to the continuous manufacture of fertilizer at Muscle Shoals, provided this plant is turned over to him. It recalls the testimony of Secretary Weeks before the committee in which the War Secretary stated that Mr. Ford had flatly refused to guarantee to continue to manufacture fertilizer during the life of the contract. Moreover, the manufacturer let it be distinctly understood that he would stop the manufacture of fertilizer if he could not make it profitably. The report points out that the precise meaning of "profitably" is unknown. Because of this frank admission and many kindred statements, continues the report, Secretary Weeks was entirely dipleased with the language in the so-called fertilizer clause in the Ford offer. Later testimony in support of the fertilizer clause does not change his attitude.

Report Points Out Jokers in Fertilizer Provisions

The report acknowledges that a great part of the farm lands of the United States is in great need of plant food and that Congress would be justified in departing from its old policies and traveling a long way to assist in getting fertilizers cheaply for the farmers. It is felt, however, that the Ford offer is a hollow promise made to enlist the support of the farmers and not absolutely binding on any fact contained in the contract or existing outside of the contract. These statements are made and sent broadcast throughout

the country without regard to truth. The bold declaration is made that Mr. Ford will manufacture fertilizer at the Muscle Shoals plant and bring down the price one-half. Nothing is ever said that the principal business of Mr. Ford—should he get this gigantic plant—would be the manufacturing of other articles which he would be allowed to sell at any price that he might see fit. The only thing that is kept before the public is that he is to make fertilizer and sell it cheaply to the farmer, only charging for himself a profit of 8 per cent on the production. No one has ever suggested how he could make fertilizers and sell them cheaply or what means he would employ. The bold claim is made and Congress and the country must take the statement as absolute truth or be forever condemned by this crowd of wicked propagandists.

While the minority headed by Mr. Kearns points out the comparative advantages which would come from the distribution of this power by the Alabama Power Co., subject as it is to the control of public utilities commissions, the acceptance of that company's offer is not recommended. On the contrary, it is suggested that the government should complete the dams and that the Secretary of War should call for new bids with the understanding that neither of the nitrate plants is to be sold. If these were leased along with the dam, it is pointed out that the government could exercise control and regulation.

Agricultural Interests Back Ford

The American Farm Bureau Federation in a formal statement reiterates its statement that the acceptance of the Ford offer means that there will be reasonable expectation that fertilizers will be produced at Muscle Shoals and delivered to the farmer for about one-half what he would pay for them otherwise.

The Farm Bureau Federation, which is the largest of the national organizations of farmers, also denounces in no uncertain terms the minority report submitted by Representative Kearns. The statement says in part:

"We resent the statement that the Ford offer contemplates a fraud. It seems to be the familiar cry of 'stop thief!' while the selfish interests get away with the goods.

"We have studied this Muscle Shoals project and have investigated it carefully from every angle. The farmer well knows what can be done at Muscle Shoals under the Ford plan and does not need the protection of self-appointed guardians from the big fertilizer distributing centers and those who represent the selfish interest groups in the upper eastern section of the country, a section which, although it raises but one week's supply of cereal and meat for itself continually has undertaken to block the farmer in his efforts to secure cheaper food production and better living conditions.

"In the matter of fertilizer production at Muscle Shoals, the farmers need no such experts to advise them as Hugh L. Cooper, who represents the du Pont interests, the Aluminum Company of America and the General Electric Company."

Would Make Appropriation Contingent on Acceptance of Offer

When the $7,500,000 appropriation comes to a vote in the House, an effort will be made to attach a condition that it will not become available until the Ford offer either has been accepted or rejected. The idea is that if the Ford offer is accepted, then the appropriation should be applied under the terms of that proposition. If the Ford plan should be rejected an effort will be made to condition the appropriation so that it may be applied under the plan for government operation.

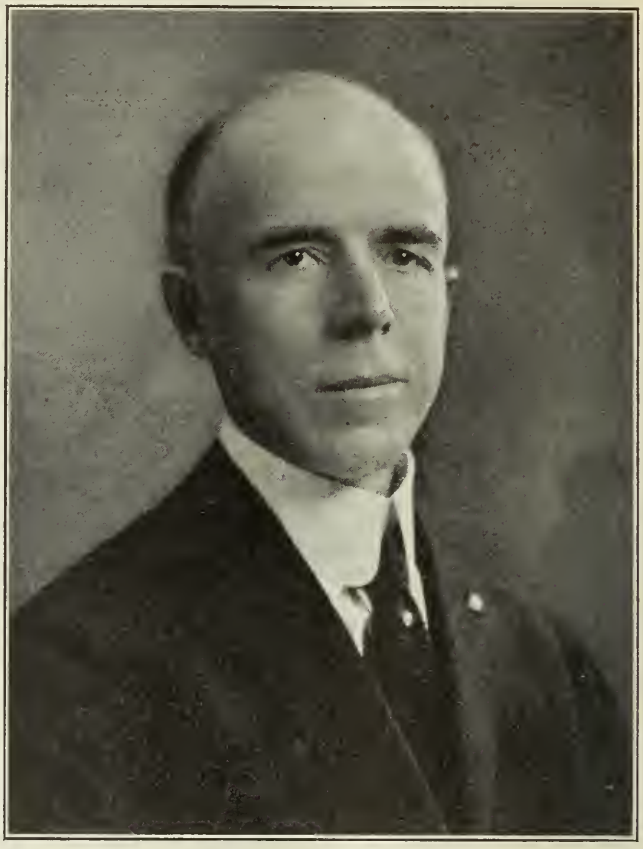
Chemical Warfare Service Granted Increase in Appropriation

An appropriation of $600,000 for the Chemical Warfare Service for the next fiscal year was agreed upon by the conferees on the War Department appropriation bill on June 22. It will be remembered that the bill as passed by the House carried $500,000 for the Chemical Warfare Service. This amount was raised by the Senate to $750,000. The compromise figure of $600,000 was decided upon after an extended discussion.

Plans Maturing for Pittsburgh Meeting of American Chemical Society

Preliminary plans for the Pittsburgh meeting of the American Chemical Society have been announced by the local section. It is expected that the convention will bring about 2,000 visitors to the steel city September 4 to 9.

James O. Handy, director of the Pittsburgh Testing Laboratory, is chairman of the Pittsburgh Section of the Society and is actively engaged in arranging the details



JAMES O. HANDY

of the meetings and entertainment features that are scheduled as features of the convention. The Council meeting will be held Monday, Sept. 4, followed by a dinner at the Duquesne Club and a theater party. The first general meeting will be at Carnegie Music Hall on Tuesday morning. Scientific papers of general interest to chemists and the public and several addresses by officials will be given. The general meeting will be continued in the afternoon and followed by a smoker at Syria Mosque in the evening.

Divisional and sectional meetings will begin on Wednesday and will continue through Thursday. A large number of papers have already been scheduled for the technical sessions. The public meeting, which is to be held in Carnegie Music Hall, will be featured by the address of Edgar F. Smith, president of the Society. Friday will be devoted to excursions to industrial plants in the vicinity of Pittsburgh. Plans are also under way for social features and entertainment of visiting ladies.

A novel event which is scheduled in connection with the convention is the installation of a chapter of Iota Sigma Pi composed of about 50 women chemists. This group, each member of which is following chemistry as a profession, has applied for a charter and expects to be installed at that time.

Water Pollution Conference to Be Called

An international conference of maritime nations to consider means for prevention of the pollution of navigable waters by oil burning steamers is provided in the bill recently passed by the Senate. The bill, which is now before the President for his signature, authorizes the Chief Executive to call the conference..

Manufacturing Chemists' Association Fiftieth Annual Meeting

The Manufacturing Chemists' Association of the United States celebrated its golden anniversary at its recent annual meeting held at the Whitehall Club in New York City on June 16. The salient features of the business to be conducted were the election of officers and the reading of Chairman Henry Howard's comprehensive report of the Executive Committee. This report outlined the action taken by the association on important legislative matters, such as the pending tariff and the proposed American valuation feature, the revival of the German patent treaty, the soldiers' bonus, and the bill to prohibit commercial bribery. The co-operation with such agencies as the Chemical Foundation, the Industrial Conference Board and National Foreign Trade Council was reviewed in the committee's report.

The report also contained the first public announcement of the association's negotiations with Secretary Hoover in connection with the publication of production statistics. A committee composed of President Charles L. Reese, Henry Howard and W. H. Nicholls Jr. had gone into the matter very thoroughly and concluded that the compilation of the information sought would entail considerable work and expense to the manufacturers and would more than negative any possible good coming from their publication. This was explained to Mr. Hoover and the project was abandoned.

The officers elected for the coming year are referred to under "Personal."

Chemical Exposition Back to Grand Central Palace This Year

Owing to the fact that the project to turn the Grand Central Palace, New York, into an office building has been abandoned, the Eighth National Exposition of Chemical Industries will again go back to its original home at the Palace when it is held this year during the week of Sept. 11. Last September the proposed plan of remodeling the Palace forced the Chemical Exposition to seek other quarters. The only other building, large enough and suitable for the purpose, which was available in New York was the Eighth Coast Artillery Armory.

The central location of this year's exposition, combined with the fact that the chemical industry is once again looking upward after a slump of eighteen months, is the basis for laying plans to accommodate a record attendance. Conservative estimates place the number of exhibitors who are expected to display their goods at the Exposition this year at a minimum of 450.

Personal

William P. Allen, assistant general manager of the Cellulose Products Department of E. I. du Pont de Nemours & Co., Wilmington, Del., has been appointed general manager to succeed R. R. M. Carpenter, vice-president of the company, who has been acting in this capacity during the reorganization period since last October and who will retire from the office on June 30.

Alfred Cotton Bedford, chairman of the board of directors of the Standard Oil Company of New Jersey, had conferred upon him the honorary degree of Doctor of Laws at the commencement of the University of Pittsburgh on June 14. This honor was bestowed upon Mr. Bedford in recognition of his activities in the development of the American petroleum industry and for his foresight in the encouragement of the application of scientific research.

Prof. William L. DeBaufre, chairman of the department of mechanical engineering of the University of Nebraska, is spending the summer in Washington as a member of the technical staff of the Bureau of Mines cryogenic laboratory.

C. R. DeLong, chief chemist of the U. S. Tariff Commission, has been selected to head the new chemical division of the Bureau of Foreign and Domestic Commerce, Department of Commerce. It is understood that the division will commence its work on Aug. 1.

Dr. Elbert C. Lathrop of Wilmington, Del., will shortly sever his connection with the du Pont company, where he has been manager of the standards division of the chemical department, and will join the organization of Samuel P. Sadtler & Son, Inc., as vice-president and treasurer. The arrangement will be effective on July 1.

Paul W. Litchfield, vice-president and factory manager of the Goodyear Tire & Rubber Co., Akron, Ohio, has sailed for Europe, to be absent on business for about 7 weeks. He will make a survey of current conditions in the industry in England, Scotland, Belgium, France and Germany.

Tillman D. Lynch, an engineer with the Westinghouse Electric & Manufacturing Co., has received the nomination for the presidency of the American Society for Steel Treating.

Charles L. Reese, of the du Pont Company, was elected president of the Manufacturing Chemists' Association, New York, at the annual meeting held at the Whitehall Club, June 16. C. Wilbur Miller, of the Davison Chemical Co., was elected vice-president; M. C. Whitaker, of the U. S. Industrial Alcohol Co., second vice-president; S. W. Wilder, of the Merrimac Chemical Co., treasurer, and John I. Tierney, of Washington, D. C., secretary.

Dr. J. W. Turrentine, formerly director of the experimental kelp-potash plant of the U. S. Department of Agriculture at Summerland, Calif., has obtained a furlough from the department for 6 months to act as consulting chemist for the U. S. Kelp Products Corporation, the newly organized concern which has purchased the government's plant and is now proceeding with the manufacture of kelp products.

Edward R. Weidlein, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, addressed the fourth annual convention of the National Lime Association, June 16, on "The Value of Research to Industrial Associations." The convention was held in Cleveland, Ohio.

W. Woodward Williams, formerly of Pittsburgh, Pa., has been elected vice-president of the Titan Iron & Steel Co., Inc., Newark, N. J.

E. G. Zies of the Geophysical Laboratory, who expected to spend this summer in Hawaii investigating the gases from the volcanic eruptions there, has returned to Washington. Plans for the trip were materially changed because the expected lava flows from Kilauea did not materialize and the lava is now receding rapidly in the crater.

Recent appointment to industrial fellowships in the Mellon Institute of Industrial Research of the University of Pittsburgh include the following: E. R. Clark (B. A. Yale); H. E. Dietrich (A. B., Kansas); Marc Darrin (B. S. and M. S., Washington); O. B. J. Fraser (B. S., Queen's University); A. W. Harvey (B. S., Syracuse; M. S. and Ph. D., Pittsburgh); C. R. Texter (B. S., Pennsylvania State); and B. B. Wescott (B. S. and M. S., Pittsburgh).

Obituary

William G. Grieb, of Scarsdale, N. Y., one of the founders of the Ajax Rubber Co., Trenton, N. J., and former president of the company, died suddenly at his home, June 13, aged 64 years. He was actively connected with the company from its inception in 1908 until 1918, when he retired to give his services to the government during the war period. He is survived by his wife and six children.

John Craig Havemeyer, of Yonkers, N. Y., retired sugar refiner and well known throughout this industry, died at his residence, June 8, in his ninetieth year. He began in the sugar-refining business at the age of 21, and later was associated with his brother in the firm of Havemeyer & Co., with refinery at Greenpoint, L. I. He retired from active business in 1880 on account of poor health.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

The Coal and Coke Situation

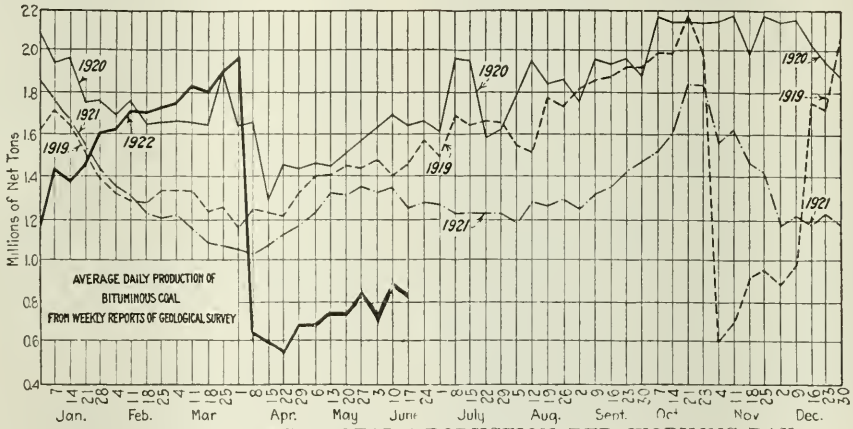
As the coal strike enters its thirteenth week, a few of the consuming industries are beginning to show a little more interest in the trend of production at the mines and in the marketing situation as it affects existing stocks. With this in mind a study has been made of the current production statistics being issued by the U. S. Geological Survey and of the market analyses appearing in the weekly issues of *Coal Age*. Barring the recent strife and uprising in the Illinois mines, it would appear that at the present time most interest is concentrated in the constantly recurring rumors of an early settlement in the bituminous coal fields. Most of these rumors are apparently founded on the belief that important interstate negotiations are likely to occur within the near future. So far, however, these have brought forth only vigorous denials from union officials in the Middle Western fields.

Some little anxiety is being shown in the Northwest on account of the fact that practically no coal has been moved to the upper lake docks and it may yet become necessary to meet an unprecedented lake demand, calling for as much as a million tons a week for 15 to 20 weeks. Aside from this situation, however, *Coal Age* is of the opinion that "the condition of the country with respect to bituminous coal on July 1 will not be far from what may be described as normal with respect not only to production and distribution, but also as to stocks."

The most potent influence as regards the market is the set of "reasonable" prices established by Secretary Hoover. These are generally regarded as a bulwark against prohibitive prices, but it is interesting to note that in most districts the coal market has been so inactive that prevailing prices are substantially less than those which Mr. Hoover holds to be adequate and satisfactory. The *Coal Age* index of spot bituminous prices stood at 274 on June 19, as compared with 284 on June 12, 255 on June 5 and slightly over 300 during the last week of May. The June 19 figure represents an average mine price of $3.31 per ton, a drop of 13c. from that of the preceding week.

The Geological Survey's estimates of the average total production of bituminous coal is shown in the accompanying chart from Jan. 1 to June 17, 1922. During the eleventh week of the strike (June 12-17) production was expected to show a decrease from the 5,078,000 net tons produced during the tenth week. Present production is compared with that of a year ago in Table I.

The anthracite situation remains unchanged; production continues to be practically nil. In the tenth week of the strike (June 3-10) the output was limited to 253 cars, all of which, so far as reported to the Geological Survey, was steam coal dredged from the rivers. In the corresponding week a year ago 1,963,000 tons was produced. Production of beehive coke in the week ended June 10 shows no improvement over the two weeks before the Memorial Day holiday. From records of cars of coke loaded at the ovens for shipment, the Geological Survey estimates the total output at 98,000 tons. In the week of May 27 production had been reported to be 97,000 tons.



ESTIMATED AVERAGE TOTAL PRODUCTION PER WORKING DAY OF BITUMINOUS COAL INCLUDING COAL COKED

Byproduct Coke Production

Production of byproduct coke continues to increase despite coal strike conditions, thus reflecting the improved business conditions in the metallurgical industry. In May over 2,500,000 tons of byproduct coke was produced.

TABLE I—ESTIMATED UNITED STATES PRODUCTION OF BITUMINOUS COAL (IN NET TONS)

	Total Bituminous, Including Coal Coked			
	1922		1921	
	Week	Calendar Year to Date	Week	Calendar Year to Date
May 27	4,889,000	162,498,000	8,166,000	158,706,000
Daily average	815,000	1,305,000	1,361,000	1,275,000
June 3	4,616,000	167,114,000	6,835,000	165,541,000
Daily average	769,000	1,280,000	1,330,000	1,277,000
June 10	5,078,000	172,192,000	8,010,000	173,551,000
Daily average	846,000	1,261,000	1,335,000	1,280,000

Thus the total coke output in May was a trifle under 3,000,000 tons. In this connection it is particularly interesting to note that the byproduct coke output of May is practically equal to the average monthly output in 1920, the year of maximum production.

In commenting on byproduct coke activities during recent months, the Survey makes the following statement:

> This increasing activity in the coke industry means an increased demand for coal. In the month of May approximately 4,326,000 tons of raw coal was consumed in coke ovens. In comparison with the monthly average for 1921, this is an increase of 38 per cent. But it is still 32 per cent short of the 1920 average.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	156.97
Last week	156.89

June, 1917	222	June, 1918	272
June, 1920	274	June, 1921	147
April, 1918 (high)	286	April, 1921 (low)	140

The minor price changes in the chemical market during the past week have had but very little effect on the index number. Slightly higher prices were noted for ammonium sulphate, barium chloride, copper sulphate and crude potassium carbonate. Refined glycerine was the only one of the index commodities for which a lower price was being quoted.

Mexican Petroleum's Spectacular Rise

During the week ended June 22 a series of spectacular advances in the stock of the Mexican Petroleum Co. brought its quotation up to 186 as compared with 133 on June 15. This phenomenal jump of 53 points in one week is generally attributed to a professional attempt to crowd out short holdings.

Officials of the New York Stock Exchange on June 23 ordered an investigation of the trading in this stock, requiring each member of the Exchange to render an account of his position in respect to this corporation's stock. The investigation failed to show evidence of any concerted attempt to corner the market, but it did result in a reaction which caused the stock to fall off about 10 points.

It is rather interesting to review the developments which might naturally have been expected to favor this stock. A week ago announcement was made of settlement with Huerta of the Mexican financial problem. This was followed by a tentative agreement over future development work in Mexico and finally by the corporation's annual report, which was made public June 22. This statement showed 1921 earnings of $12,540,684, or $26.82 per share on common stock, the best in the corporation's history.

The Trend of Prices for Laboratory Apparatus

A most interesting study of price tendencies, particularly as related to laboratory apparatus and supplies, has been prepared by S. L. Redman, of the Central Scientific Co., and is published in the June number of *The Chemical Bulletin*. By taking as concrete illustrations eight staple items of laboratory supplies such as a No. 0 evaporating dish, a 250-c.c. Griffin beaker, a 400-c.c. Florence flask, etc., the author was able to show that the average retail prices for these items in 1919 reached a peak of 50 per cent above the pre-war year of 1913 and that the present level is about 38 per cent above the pre-war. This is to be compared with Dun's index of prices for all commodities, which had a 1919 peak 95 per cent above the 1913 level and is at present about 33 per cent above pre-war.

The prices for these items in 1913, 1919 and May, 1922, have been compared with the prices for foreign-made supplies in the following table:

Item	1913	1919	May, 1922 — American Made	May, 1922 — German Made
Evaporating dish, No. 0	$0.19	$0.24	$0.24	$0.35
Griffin beaker, 250 c.c.	.22	.25	.25	.25
Florence flask, 400 c. c.	.24	.27	.27	.32
Cylindrical graduate, 100 c.c.	.50	.63	.60	.89
Thermometer, 110° C.	.80	1.20	1.10	1.10
Bunsen funnel, 3 in.	.18	.43	.35	.38
Soxhlet extraction apparatus, 100 c.c.	2.70	3.85	3.80	4.00
Bunsen burner	.22	.45	.35	2.15

In order to make fair comparisons between the prices of foreign-made and domestic-made apparatus corresponding grades were selected from prominent American and foreign brands. Thus for this purpose, the following brands were assumed to be of equivalent grade: Royal Berlin and Coors porcelain dishes, Jena and Pyrex beakers and flasks, Siebert & Kuhn and Taylor thermometers, and Greiner & Friedrichs and Kimble funnels.

In outlining the present situation, as well as the probable future trend of prices, Mr. Redman summarized his remarks as follows:

"There has been a continued downward trend in the price of laboratory supplies during the past 18 moths, except in those staple lines of glassware and porcelain the prices of which remained stationary during the war and post-war period of rising costs. Prices will probably continue to recede gradually throughout a period of years until the pre-war level is reached. Special instruments, whose cost of development was very high, were introduced at rather high prices and, as the process of manufacture has been perfected, generous price reductions have been made. No immediate relief is to be expected from the importation of German goods, since the difficulties experienced by German manufacturers with raw materials purchased with a depreciated currency, with restricted fuel supplies and labor troubles combine to make prices higher than those of the corresponding grade of American-made materials."

The New York Market

New York, June 26, 1922.

The chemical market during the past week showed signs of irregularity, with the demand in most instances for specialties. One of the outstanding features in the week's trading was the firmer tone displayed in prussiates. An improved demand was also noted for sulphate of ammonia from the Far East and for caustic soda from several foreign countries. Prussiate of soda has shown a strong tendency to recover from its recent slump and prices gained 1c. per lb. during the latter part of the week. Copper sulphate continued along the same steady lines, with spot stocks exceedingly light and prices firmly maintained. Yellow and red prussiate of potash are quoted higher because of the pronounced scarcity. Tartaric and citric acids are moving as usual at this season and prices are quoted fractionally higher on both items.

General and Special Chemicals

Acetic Acid—Commercial 28 per cent is being quoted at 2¼@2½c. per lb. by producers, with the demand only moderate. Glacial is held at 8½@9c. per lb. by second hands. Competition in the higher grade is much keener for passing business.

Ammonium Sulphate—Export inquiry has contributed to the better demand and prices among leading dealers were held around $3.30@$3.40 per 100 lb., f.a.s. New York.

Carbonate of Potash—The 80-85 per cent calcined, on spot, is reported firmer and prices were quoted on the basis of 5@5¼c. per lb. by prominent importers. Business in this product has been rather quiet during the past few weeks.

Caustic Soda—Quotations for 16 per cent solid, standard branch, are named around $3.80@$3.85 per 100 lb. f.a.s. New York. Export inquiries are showing increased proportions and leading factors are of the opinion that business will show a marked increase in volume in the very near future. Domestic resale is quoted at $3.75 per 100 lb. Contracts remain quotably unchanged.

Chlorate of Potash—Imported material has been offered rather freely at 6¼@6¾c. per lb. Domestic makers continue to name 8c. per lb. f.o.b. works and are holding firm at this level.

Chloroform—Producers have reduced prices on U.S.P. goods in quantities of 50 lb. to 25c. per lb., drums extra. Small lot containers are quoted at 28½@32c. per lb., depending upon size.

Citric Acid—The general condition of this market has shown a noticeable improvement with the coming of the hot weather. Some large sales were reported at 45c. per lb. Lesser quantities were held around 45½@46c. per lb.

Prussiate of Potash—Several sales of yellow prussiate were recorded at 32½c. per lb. Goods due to arrive from abroad were offered at 31@31½c. per lb. The market displayed a much firmer note and demand was quite active. The red variety was in exceedingly light supply at 90@95c. per lb.

Prussiate of Soda—Prices during the week have shown a net advance, and 22c. per lb. was named as the low figure. Several heavy arrivals of imported material were reported during the week, but these apparently had no effect on quotations.

Tartaric Acid—Crystals are quoted at 29½c. per lb. and powdered at 30c. Domestic makers continue to quote 30c. per lb.

Zinc Sulphate—Producers report a regular demand from the paint trade and quote carlots at 2¾c. per lb. Smaller lots are named around 3@3½c. per lb., depending upon quantity.

Vegetable Oils

Cottonseed Oil—Trading in the various grades was limited and prices were somewhat irregular.

Linseed Oil—During the early part of the week prices were rather weak and sales were reported down to 80c. per gal. The latter part, however, brought the market to a firmer position and leading crushers advanced their prices to 82c. per gal. The general inquiry was quiet, with the larger consumers content to watch for further developments. English oil displayed a firmer tone and quotations were heard around 76½c. per gal., duty paid.

The Iron and Steel Market

PITTSBURGH, June 23, 1922.

The steel market has grown still quieter in the past week as to the total tonnage turnover, while prices in a general way have shown a stiffening tendency.

The decrease in the tonnage turnover represents a continuance of the trend that has been seen since April, which was the high month for sales, and may perhaps be attributable solely or chiefly to the near approach of the midsummer season and the resulting dull market for steel.

It is no new experience for the steel market to appear to grow firmer as it becomes less active. The point is that when there is a heavy turnover the sales are chiefly for extended delivery, at basis prices. When forward buying decreases in volume the buying for early delivery is forced into prominence. The prompt prices contain delivery premiums, but the appearance is that of higher prices being paid on an average.

STEEL PRICES

The American Sheet & Tin Plate Co. has opened its sheet order books for August and September at former prices, its opening on June 2 having been for July only. The prices are those that became effective early in April, there being an advance of $3 a ton at the time, and are as follows: Blue annealed sheets, 2.40c.; black sheets, 3.15c.; galvanized sheets, 4.15c.; automobile sheets, 4.50c.

The incident is an important illustration of what has come to be recognized as the Steel Corporation's policy to hold its prices substantially at the present level, since advances occurred earlier in the year in the lines that were selling at unreasonably low levels on the basis of production cost. In the majority of lines, including sheets, so many independents have been quoting advanced prices that it would have been entirely feasible for the corporation to establish higher levels.

The finished steel market is quotable as follows: Bars, shapes and plates, 1.60@1.70c.; hoops and bands, 2.40@2.50c.; wire nails, $2.40@$2.50; blue annealed sheets, 2.40@2.50c.; black sheets, 3.15@3.30c.; galvanized sheets, 4.15@4.30c.; automobile sheets, 4.50@4.75c.; tin plate, $4.75; standard steel pipe, 71 per cent basing discount.

Production of steel ingots continues at a rate of about 39,000,000 tons a year, against rates of about 35,000,000 tons on April 1 and 20,000,000 tons in December. On the whole there has been a slight trend toward an increase in the past week or two. The Carnegie Steel Co. has blown in a third furnace at the Farrell plant, giving it thirty-eight furnaces in operation against thirty-four on April 1, while its ingot production is at fully 77 per cent, against an average of not over 70 per cent in the second half of March and during April.

The strike at the union coal mines shows no visible change. In the Connellsville region the return of sympathetic strikers to work in the past 10 days has been sufficient to make a decided increase in coal production, while until recently the gains in the number of workers were scarcely more than enough to show positively that the strikes were not gaining ground. Doubtless on the whole the steel industry has drawn largely upon its stocks of coal, but it certainly exhibits no signs of being forced to reduce its operations in the near future.

ORE, IRON AND COKE MARKETS

Open market transactions in Lake Superior iron ore have been light since the season opened a fortnight ago, the chief business being between producers and consumers having more or less joint ownership. Producers expect to sell little if any ore to Eastern furnaces for the season, because at $5.05 f.o.b. Lake Erie dock for Mesabi non-bessemer ore the cost to Eastern furnaces is computed at $7.07 per ton, or 13.728c. per unit, while foreign ore is quoted at 10.5c. per unit delivered and could probably be bought for less.

The pig iron market in Pittsburgh and the valleys has been very quiet in the past week. Consumers are showing greater power to stay out of the market than was expected. The iron foundries are far from busy, while the steel works that do not produce iron have not been selling their product far ahead. Buyers expect a downward readjustment in pig iron prices when coke becomes less scarce. The market is largely nominal at former quotations, $25 for bessemer and basic and $24@$25 for foundry, f.o.b. valley furnaces.

Not enough Connellsville furnace coke is moving to make a regular market. Miscellaneous consumers, other than blast furnaces, are occasionally forced to buy, paying, say, $7.50 for standard grade, while high-sulphur coke is obtainable at $7. Foundry coke is selling in a limited way at $8@$8.50.

The St. Louis Market

ST. LOUIS, Mo., June 22, 1922.

We wish to confirm our previous reports that there is a continual steady increase in the amount of business being transacted in the industrial chemical market in this locality, and the summer lull which is usually expected at this time has not as yet appeared. We do not believe there will be any great slackening off of business during the summer period for reason that buying is still being done on a conservative basis with a quick turnover in mind, but it is true that buyers are more confident today than a year ago, and are more liberal in placing their requirements. While some few chemicals on the list, particularly the alkalis, showed a decided weakness the majority were very firm and in many instances were stiffened.

ALKALIS

Caustic soda has shown a slight weakening since our last report and regular prices are now being shaded on large-sized orders. Carload business is increasing somewhat and it is in this class of buying where price shading is most evident. *Soda ash* is being offered as low as $2.25 in barrels in lots of 5 to 10 bbl. In the main, however, the nominal price of $2.40 in 5-bbl. lots with a 20c. differential is being maintained. *Sodium bicarbonate* is very unsteady and, as put by one jobber, is being sold for whatever it will bring. $2.25 in 5-bbl. lots seems to be about the average price. *Sal soda* is apparently somewhat of a drug on the market. As low as $1.65 cwt. in barrels has been reported.

GENERAL AND SPECIAL CHEMICALS

The heavy commercial *mineral acids* are showing a decided improvement with prices stiffening in some directions. The demand from the fertilizer trade is very good while that from steel mills has fallen off. *Carbolic* is in good demand with prices firm. Spot stocks of *citric acid* are still very scarce and the demand this season is no greater than last, and for the present we do not believe there will be any advance in price. *Phosphoric acid* is moving in a good way with fairly large sales reported. *White arsenic*, powdered, remains the same in price at 7½c. per lb., f.o.b. St. Louis, but the market has stiffened considerably with a very good demand coming from the insecticide manufacturers. *Carbon bisulphide* has been moving very briskly since our last report and the demand should continue, as we are now in a season when this article will be used very extensively as an insecticide. *Carbon tetrachloride* is holding its own both in price and demand. *Chloroform* is very weak and manufacturers have found it necessary to make a further reduction of 5c. per lb. *Glycerine* has finally responded to prophecies and has declined to 12½c. per lb. in drums with the usual differential on cans. Contracts with protection are being offered at 15c. There has been an unexpected demand for *lithium carbonate* for export and some good-sized orders have been reported. *Potassium cyanide* stocks are very limited and the demand has been from usual channels. *Sodium fluoride* is not moving as freely as should be expected. *Zinc spelter* has stiffened a few points and is now being quoted at $5.35@$5.40 per 100 lb. in carload lots, f.o.b. St. Louis, while the *sulphate* remains the same in price as well as demand.

VEGETABLE OILS AND NAVAL STORES

Castor oil remains firm at 12¾c. in 200-gal. lots with an advance of 1c. for less quantities. Demand is good with a large volume movement. *Linseed oil* has shown some weakness with a decline from $1.07 to 97c. basis raw oil. With the prospective tariff pending this price decline was hardly expected. *Turpentine* is holding its own very nicely having maintained its position around the dollar mark consistently for the last month.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride	lb.	..... –	$0 38 – $0 40
Acetone	lb.	$0 09 – $0 09½	09¼ – 11
Acid, acetic, 28 per cent	100 lbs.	2 25 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	8 50 – 9 00	50 – 9 75
Boric, crystals	lb.	11 – 11½	11¾ – .12
Boric, powder	lb.	11 – 11½	11¾ – 12½
Citric	lb.	..... –	45 – .46
Hydrochloric	100 lb.	1 10 – 1 20	1 25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – 11½	11 – 12
Lactic, 44 per cent tech	lb.	09½ – .10	10¼ – .12
Lactic, 22 per cent tech	lb.	04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3 00 – 3 25	3 30 – 3 75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06 – .06½	06¾ – .07
Nitric, 42 deg.	lb.	.06½ – .06¾	07 – 07¼
Oxalic, crystals	lb.	.14 – .14½	14¾ – .15
Phosphoric, 50 per cent solution	lb.	08 – 08½	08¾ – 09½
Picric	lb.	.22 – 24	.24½ – .30
Pyrogallic, resublimed	lb.	..... –	1.65 – 1 75
Sulphuric, 60 deg., tank cars	ton	9 50 – 10 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	15 00 – 16 00	..... – .....
Sulphuric, 66 deg., drums	ton	19 00 – 20 00	20.50 – 21 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 00 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22 00 – 22 50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31 00 – 32 00	33.00 – 34 00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.29 – .29½
Tartaric acid, imported, powdered	lb.	..... –	.29½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO	lb.	..... –	1 00 – 1 10
Alcohol, ethyl (Cologne spirit)	gal.	..... –	4.75 – 4 95
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.26 – .39
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.26 – .30
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03¾ – .04	.04½ – .05
Alum, chrome lump	lb.	05¼ – 05¾	06 – 06½
Aluminum sulphate, commercial	100 lb.	1 50 – 1.65	1.70 – 2 25
Aluminum sulphate, iron free	lb.	02½ – 02¾	.03 – .03¼
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06¾ – 07¼	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.30½ – .31
Ammonium carbonate, powder	lb.	.07 – .07½	.07¾ – .08
Ammonium nitrate	lb.	.06 – .06½	.06¾ – 07½
Amylacetate tech	gal.	..... –	2 00 – 2 25
Arsenic, white, powdered	lb.	.07½ – 07¼	.07¾ – 08
Arsenic, red, powdered	lb.	.12 – .12¼	.12¾ – .13
Barium carbonate	lb.	.03 – .04	.04¾ – .05
Barium chloride	ton	95.00 –100 00	105.00 –110.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.07 – 07¼	.07½ – .08
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04¼	.04¾ – .04¾
Blanc fixe, dry	lb.	.04 – .04¾	..... – .....
Blanc fixe, pulp	ton	45 00 – 55 00	..... – .....
Bleaching powder	100 lb.	1 60 – 1.75	1 85 – 2.50
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1.75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – 05½
Calcium chloride, fused, lump	ton	24.00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – 02¼
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	15 – 16
Camphor	lb.	..... –	.79 – 83
Carbon bisulphide	lb.	.06½ – .06¾	07 – 07½
Carbon tetrachloride, drums	lb.	.09½ – .10	10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04¼ – .04½	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.05 – .05½	.05¾ – .06
Chloroform	lb.	..... –	.25 – 32
Cobalt oxide	lb.	..... –	2 00 – 2 10
Copperas	ton	20.00 – 22 00	23.00 – 30 00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	6.25 – 6 40	6 45 – 6 65
Cream of tartar	lb.	..... –	.23½ – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.08½ – .08½	.08¾ – .09
Fullers earth, f.o.b. mines	net ton	16 00 – 17 00	..... – .....
Fullers earth—imported powdered—net	ton	30 00 – 32 00	..... – .....
Fusel oil, ref	gal.	..... –	2 25 – 2 65
Fusel oil, crude	gal.	..... –	1 40 – 1 50
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.14½ – .14¾
Iodine, resublimed	lb.	..... –	4 20 – 4 25
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09¾ – .11½
Lead arsenate, powd	lb.	.13 – .13½	.13¾ – .14¼
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07¾ – .08	.08¼ – .09
Magnesium carbonate, technical	lb.	.08½ – .08¾	.09 – .09½
Magnesium sulphate, U. S. P.	100 lb.	2.50 – 2.60	2.65 – 2 85
Magnesium sulphate, technical	100 lb.	..... –	1.00 – 1 80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.10 – .10¼
Phogene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	..... –	.40 – .45
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	09¼ – 10	10½ – 10
Potassium bromide, granular	lb.	..... –	.17 – 25
Potassium carbonate, U. S. P.	lb.	.12 – 12½	.13 – 16
Potassium carbonate, 80-85%	lb.	.05 – .05¼	.05½ – 06
Potassium chlorate powdered and crystals	lb.	.06½ – .07	.07½ – 08
Potassium cyanide	lb.	..... –	.45 – 50
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6 00	6 25 – 6 50
Potassium iodide	lb.	..... –	3.20 – 3.30
Potassium nitrate	lb.	.06¼ – .06½	.07 – .08
Potassium permanganate	lb.	14 – .14½	.14¼ – .15½
Potassium prussiate, red	lb.	..... –	.90 – .95
Potassium prussiate, yellow	lb.	32½ – .33	.33½ – .34
Rochelle salts (see sodium potas tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	06½ – .07	.07½ – .08
Salammoniac, gray, granular	lb.	07¼ – .08	.08¼ – .08½
Salsoda	100 lb.	1 20 – 1 40	1.45 – 1 60
Salt cake (bulk)	ton	20.00 –25.00	..... – .....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1 65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1 80 – 1 90	1.95 – 2 40
Soda ash, dense, in bags, resale	100 lb.	1 90 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.05½ – .06	.06½ – 06¾
Sodium bicarbonate	100 lb.	1.75 – 1.85	1.90 – 2 00
Sodium bichromate	lb.	.07½ – .07¾	.07½ – 08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5 50
Sodium bisulphite powdered, U.S.P.	lb.	.04¼ – .04½	.04½ – .05¼
Sodium chlorate	lb.	.06¼ – .06½	.07 – .07½
Sodium chloride	long ton	12 00 – 13 00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.10 – .10½	.10½ – .11
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3 35 – 3.50	3.80 – 4 00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.80 – 3.85	3.90 – 4.20
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4 00 – 4 15	4.40 – 4 60
Sodium hyposulphite	lb.	.03 – .03½	.03½ – .04
Sodium nitrite	lb.	.08¼ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04¼ – .04½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.22 – .22½	.22½ – .23
Sodium silicate, (40 deg. in drums)	100 lb.	.80 – 1.00	1.05 – 1.25
Sodium silicate, (60 deg. in drums)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.05	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (tone.)	lb.	.04¼ – .04½	.04½ – .05
Sodium sulphite, crystals	lb.	.03¼ – .03⅜	.03⅜ – .04¼
Strontium nitrate, powdered	lb.	.09¾ – .10	.10¼ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18 00 –20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	2.00 – 2.15	2.20 – 2.70
Talc—imported	ton	30 00 –40 00	..... – .....
Talc—domestic powdered	ton	18 00 –25.00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14½ – 15½
Zinc chloride, gran	lb.	.06 – .06½	.06½ – .07
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2.75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$1.00 — $1 05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.14 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1 30
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.80 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.50 — .55
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.23 — .26
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.56 — .65
Cresylic acid, 95-97%, dark, in drums	gal.	.51 — .58
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — 25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.85 — .95
Meta-phenylenediamine	lb.	.95 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.00 — 1.20
Naphthalene crushed, in bbls.	lb.	.06 — .06½
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08
Naphthionate of soda	lb.	.58 — .65
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
N-W acid	lb.	1 15 — 1 30
Ortho-amidophenol	lb.	2.40 — 2.50
Ortho-dichlor-benzene	lb.	2.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	$0 10 —	$0.13
Ortho-toluidine	lb.	.14 —	.18
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbenzene	lb.	.17 —	.20
Paranitroaniline	lb.	.72 —	.75
Para-nitrotoluene	lb.	.55 —	.65
Para-phenylenediamine	lb.	1.55 —	1.60
Para-toluidine	lb.	.90 —	1.00
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1 35
Resorcinol, pure	lb.	1.75 —	1.80
R-salt	lb.	.60 —	.70
Salicylic acid, tech., in bbls	lb.	.25 —	.25½
Salicylic acid, U. S. P	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	.27 —	.32
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.18
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	.28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Candellila, wax	lb.	.40 —	.42

All Other Prices Remain Unchanged

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.60 —	$6.00
Rosin E-I	280 lb.	6.05 —	6.35
Rosin K-N	280 lb.	6.65 —	6.90
Rosin W. G.-W. W	280 lb.	7.70 —	8.35
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	1.25 —	1.27
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	....
Rosin oil, second run	gal.	.38 —	....
Rosin oil, third run	gal.	.46 —	....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.00
Pine oil, pure, dest. dist	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref	gal.		.52

Fertilizers

Ammonium sulphate, f.a.s., N.Y	100 lb.	3.30 —	3.40
Blood, dried, f.o.b., N. Y	unit	3.55 —	3.65
Bone, 3 and 50, ground, raw	ton	27.00 —	28.00
Fish scrap, dom., dried, f.o.b. works	unit	3.10 —	3.20
Nitrate of soda	100 lb.	2.55 —	2.60
Tankage, high grade, f.o.b. Chicago	unit	3.00 —	3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	3.50 —	3.75
Tennessee, 78-80%	ton	7.00 —	7.50
Potassium muriate, 80%	ton	33.00 —	33.50
Potassium sulphate	unit	1.00 —	....

Crude Rubber

Para—Upriver fine	lb.	$0.18 —	.18½
Upriver coarse	lb.	.12½ —	.12¾
Upriver caucho ball	lb.	.13¾ —	.14
Plantation—First latex crepe	lb.	.15⅛ —	.15¼
Ribbed smoked sheets	lb.	.15⅛ —	.15¼
Brown crepe, thin, clean	lb.	.13¾ —	....
Amber crepe No. 1	lb.	.14½ —	....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.11 —	$0.11½
Castor oil, AA, in bbls	lb.	.12 —	.12¼
China wood oil, in bbls	lb.	.13¾ —	.14
Cocoanut oil, Ceylon grade, in bbls	lb.	.08½ —	.08¾
Coconut oil, Cochin grade, in bbls	lb.	.09¼ —	.09½
Corn oil, crude, in bbls	lb.	.11¼ —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	$0.10 —	$0.10
Cottonseed oil, summer yellow	lb.	.11¾ —	.12
Cottonseed oil, winter yellow	lb.	.12½ —	.13
Linseed oil, raw, car lots (domestic)	gal.	.82 —	.83
Linseed oil, raw, tank cars (domestic)	gal.	.78 —	.79
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.87 —	.88
Olive oil, denatured	gal.	1.15 —	1.17
Palm, Lagos	lb.	.07½ —	.07
Palm, Niger	lb.	.06½ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.09¼ —	.10
Peanut oil, refined, in bbls	lb.	.12½ —	.12¾
Rapeseed oil, refined in bbls	gal.	.84 —	.85
Rapeseed oil, blown, in bbls	gal.	.88 —	.89
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.12½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10½ —	....

FISH

Light pressed menhaden	gal.	$0.51 —	....
Yellow bleached menhaden	gal.	.53 —	.54
White bleached menhaden	gal.	.55 —	.56
Blown menhaden	gal.	.61 —	....
Whale Oil, No. 1, crude, tanks, coast	gal.	.45 —	.48

Refractories

Quotations Remain Same as Previous Report

Ferro-Alloys

All Prices Quotably Unchanged

Ores and Semi-finished Products

All f.o.b. New York Unless Otherwise Stated

Bauxite, domestic, crushed and dried	net ton	$6.00 —	$9.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	20.00 —	21.00
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	ton	20 00 —	21.00
Coke, foundry, f.o.b. ovens	net ton	7.50 —	7.75
Coke, furnace, f.o.b. ovens	net ton	7.25 —	7.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	17.50 —	19.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.27 —	.27½
Manganese ore, chemical (MnO_2)	net ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y	lb.	.50 —	.....
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	27.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.10½ —	.11
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.12 —	.13½
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	Nominal	
Rutile, 95% TiO_2 per lb. ore	lb.	.12 —	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.00 —	3.25
Tungsten, wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	3.25 —	3.50
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.25 —	1.75
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½ —	.13½

Miscellaneous Materials

Graphite, Ceylon lump, first quality, f.o.b. N. Y.	lb.	.07 —	.10
Graphite, Ceylon chip	lb.	.05 —	.05½
Graphite, high grade amorphous crude	ton	18.00 —	50.00

All Other Prices Remain Unchanged

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb
Copper, electrolytic	13.75
Aluminum, 98 to 99 per cent	19.00–20.00
Antimony, wholesale lots, Chinese and Japanese	5.10–5 15
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00–33.00
Nickel, ingot and shot, resale	29.00–31.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.375
Lead, New York, spot	5.75
Lead, E. St. Louis, spot	5.50–5.60
Zinc, spot, New York	5.70
Zinc, spot, E. St. Louis	5.35

OTHER METALS

Silver (commercial)	oz.	$0.70⅜
Cadmium	lb.	1.20–1.25
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99 per cent	lb.	1.10
Platinum	oz.	87.50
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00@ 57.50
Mercury	75 lb.	54.00@ 55.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$2.58	$2.58
Soft steel bars	2.48	2.48
Soft steel bar shapes	2.48	2.48
Soft steel bands	2 98	3.08
Plates, ¼ to 1 in. thick	2.58	2.58

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—The Arkansas Foundry Co., manufacturer of gray iron castings, has awarded a contract to the Hermann McCain Construction Co., Little Rock, for the erection of a new 1-story foundry to cost about $20,000. It will be equipped for a capacity of about 20 tons per day.

California

COLTON—The Southern California Gas Co. will make extensions and improvements in its local artificial gas plant to cost about $150,000, increasing the capacity by about 50 per cent. The work will include the installation of two new generators, boilers, purifiers, and auxiliary equipment. H. C. McAllister is division manager.

PITTSBURG—The Columbia Steel Co., 503 Market St., San Francisco, has preliminary plans under way for the erection of a large addition to its local plant, estimated to cost in excess of $1,000,000. W. E. Creed is president.

ANAHEIM—A new 1-story foundry will be erected by the Oil Tool Service Mfg. Co. at Santa Ana and Atchison Sts. M. N. Putnam heads the company.

JOHANNESBURG—The Standard Oil Co. of California, San Francisco, will commence the immediate erection of a new oil-distributing plant on local site, to be used in connection with its operations in the Bakersfield district.

SAN DIEGO—The San Diego Consolidated Gas Co. will construct a new artificial gas container and plant at 12th and K Sts., estimated to cost about $350,000.

Connecticut

NORWALK—The Mecker's Iron Foundry Corp. is reported to be planning for the early rebuilding of the portion of its foundry destroyed by fire, June 15, with loss approximating $60,000.

Florida

JACKSONVILLE—The Federal Phosphoric Co., Birmingham, Ala., is said to have tentative plans under consideration for the establishment of a new fertilizer manufacturing plant on local site. T. L. Long is in charge.

Georgia

ATLANTA—Fire, June 10, destroyed a portion of the plant of the Southern Chemical Products Co., 600 Marietta St., with loss estimated at about $15,000.

GREENSBORO—The Southern Cotton Oil Co. is reported to be planning for enlargements in its local plant.

Illinois

ROCK ISLAND—The Illinois Oil Co., 215 Safety Bldg., has awarded a contract to the R. H. Lorenz Co., Moline, Ill., for the erection of a 3-story plant, 40x150 ft., at 4th Ave and 24th St., estimated to cost about $135,000, including equipment. Frank J. Welsh is president.

Indiana

ANDERSON—The Beaver Products Co., Buffalo, N. Y., a subsidiary of the Beaver Board Companies, Inc., recently organized, has acquired the local plant of the Vulcanite Co., used for the manufacture of paper composition roofing, etc. Operations will be continued as heretofore, and it is said that a number of improvements will be made.

Kansas

CANEY—The C. F. Lutes Window Glass Co. has preliminary plans under consideration for the rebuilding of the portion of its plant destroyed by fire, June 8, with loss estimated at close to $200,000, including equipment. C. F. Lutes is president and manager.

Louisiana

SWARTZ—The Ebon Carbon Co. has plans in progress for the removal of its plant, now located at Cedar Grove, La., to Swartz. The Western Carbon Co., Cedar Grove, is also arranging for the removal of its plant to the same new location. It is expected to increase the output at the new works.

THIBODAUX—The City Council is considering the installation of a new water purification plant at the municipal waterworks.

MONROE—The Southwest Pulp & Paper Co., Joseph G. Mayo, president, 206 Broadway, Norwich, Conn., has perfected its organization under Delaware laws with a capital of $2,500,000, and will soon commence the erection of its proposed new plant on the Monroe-Columbia Highway, estimated to cost approximately $250,000, including equipment. The plant will have an initial output of about 100 tons per day.

NATCHITOCHES—The Natchitoches Cotton Oil Co. and the Planters' Cotton Oil Mill, the latter with plant at Grand Ecore, La., have been consolidated into a new company, under the first-noted name. The Grand Ecore oil mill will be removed to the local site of the Natchitoches company, where a new plant will be constructed, replacing a mill destroyed by fire a number of months ago. New machinery will be installed for considerable increase in capacity. J. H. Williams is president; and W. P. Haynes, general manager.

Maryland

BALTIMORE—The City Architectural Commission has authorized the preparation of plans for the construction of a new filtration plant at Montebello, to cost close to $1,000,000, with equipment. It will have a capacity of about 90,000,000 gal. William W. Emmart, 1101 Union Trust Bldg., Baltimore, is architect.

Massachusetts

BOSTON—K. J. Quinn & Co., Inc., 481 Chelsea St., manufacturer of polishes, etc., has awarded a contract to L. D. Willcut & Sons, 146 Summer St., for the construction of a new 2-story plant, 30x60 ft., estimated to cost about $25,000.

Missouri

COLUMBIA—The City Council is arranging for the purchase of the plant of the Columbia Gas Co., for operation as municipal property. A bond issue of $100,000 will be voted to provide for the acquisition, and proposed additions and improvements.

New Jersey

GARFIELD—The Heyden Chemical Co. of America, Inc., 135 William St., New York, N. Y., has awarded a contract to the Gabler Construction Co., 402 Hudson St., New York, for the construction of a new 5-story plant at Garfield, to cost about $90,000.

TRENTON—The New Jersey Porcelain Co., Pennsylvania Ave., has filed plans for the construction of a new 1-story plant.

MAURER—The United Lead Co., 111 Broadway, New York, N. Y., has preliminary plans under way for the rebuilding of the portion of its plant at Maurer, near Perth Amboy, destroyed by fire on May 16, with loss reported in excess of $1,000,000.

HOBOKEN—The Fisher-Sweeny Bronze Co., 1301 Grand St., will take bids at once for the construction of a new 1- and 2-story foundry, to replace the portion of its works recently destroyed by fire. It will cost close to $80,000. Lockwood, Greene & Co., 101 Park Ave., New York, is architect.

New York

RETSOF—The Retsof Mining Co. has awarded a contract to the John W. Cowper Co., Fidelity Bldg., Buffalo, N. Y., for the construction of its proposed new 1- and 2-story plant for salt mining and refining, estimated to cost in excess of $1,000,000, including machinery. T. F. Courthope is engineer, for the company.

NEW YORK—The Super-Saftee Ink Corp., 219 West 27th St., manufacturer of special non-corrosive inks, chemically treated, is disposing of a preferred stock issue totalling about $250,000, the proceeds to be used for general expansion. Preliminary plans are under way for the establishment of branch plants at Boston, Chicago, St. Louis, Mo., Atlanta, Ga., and other cities.

NORTH TONAWANDA—The Board of Public Works will commence the immediate construction of a new filtration plant on Tonawanda Island for the municipal water works, to cost about $250,000, including equipment. It is proposed to have the plant ready for service early in the coming year.

Ohio

CLEVELAND—The Diamond Glass Co., 1447 West 25th St., is said to be planning for the immediate rebuilding of the portion of its local plant destroyed by fire, June 5, with loss approximating $300,000, including machinery.

CLEVELAND—The Crucible Steel Castings Co., Champlain Ave. and Canal Road, has plans under way for the construction of a new 1-story foundry on Almira Ave. near West 82nd St., estimated to cost close to $100,000, with equipment. The George S. Rider Co., 612 Century Bldg., is engineer.

DENNISON—The local plant of the Dennison Fireclay & Brick Co. has been acquired by John Scott and Walter Moore, Uhrichsville, O., from C. A. Albaugh, trustee in bankruptcy. The new owners will reorganize the company and place the plant in operation at once. A number of extensions and improvements will be made.

Oregon

GRESHAM—The Pacific Malleable Iron Co. is planning for the immediate construction of a new 1-story foundry on local site.

Pennsylvania

FRANKLIN—The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, is said to have plans under way for the rebuilding of the portion of its local plant, operated under the name of the Eclipse Oil Works, recently destroyed by fire, with loss in excess of $90,000, including equipment.

PHILADELPHIA—The H. H. Barton & Son Co., 109 South 3rd St., manufacturer of abrasive papers and materials, will commence the immediate erection of a new building at its plant on Bleigh St., estimated to cost about $25,000. The construction contract has been let to the Roydhouse Arey Co., Fidelity Bldg.

HIGH SPIRE—The Keystone Carbonic Gas Co., Inc., manufacturer of commercial oxygen, hydrogen, etc., will commence the immediate erection of its proposed new local plant for the manufacture of carbonic gas, etc. The company recently acquired a local site.

Tennessee

GRAYSVILLE—The Dixie Coal, Lime & Clay Products Co. has plans under way for the construction of a local plant, comprising a number of 1-story buildings, for the manufacture of brick and other burned clay products. It will be equipped for initial output of about 100,000 bricks per day. O. E. Thomas is president.

Texas

ELECTRA—The Council will commence the immediate construction of a new water-purification plant at the municipal water works, with capacity of about 500 gal.

DALLAS—The Dallas Gas Co. has preliminary plans under way for extensions and improvements in its plant and system, to cost in excess of $300,000. Henry C. Morris is vice-president and general manager.

Virginia

WINCHESTER—The American Gas Improvement Co., 26 Cortlandt St., New York, has acquired the local plant of the Winchester Gas Co., and has plans under way for extensions and improvements. The capacity will be increased with the erection of a new unit on local property recently acquired.

West Virginia

HOOKERSVILLE—The Muddlaty Valley Clay Products Co., recently organized, will soon commence the construction of a new local plant for the manufacture of brick, tile and kindred burned clay products. The initial works will comprise two 1-story structures, each about 25x120 ft. Porter Herold is secretary.

Wisconsin

FORT ATKINSON—The Fort Atkinson Tanning Co. is considering preliminary plans

for the rebuilding of the portion of its leather plant, destroyed by fire, June 11, with loss estimated at close to $100,000, including equipment. The plant occupies about 4 acres of land and five buildings were destroyed.

MILWAUKEE—The Rundle Mfg. Co., 27th St. and Cleveland Ave., has commenced the construction of a new 1-story building, 60x200 ft., at its iron works, to be equipped as a foundry. It will cost about $50,000.

Wyoming

CASPER—The Texas Co., 17 Battery Place, New York, N. Y., is completing plans for the construction of its proposed new local oil refinery on tract of about 500 acres of land, and will commence construction at an early date. It is purposed to have the initial unit ready for operation late in the fall. The works will have a capacity for handling about 5,000 bbl. of crude oil per day, and will include complete byproducts departments for the recovery of gasolene, naphtha and other products.

Canada

NELSON, B. C.—The Consolidated Mining & Smelting Co. of Canada, operating large plants at Nelson and Trail, B. C., is completing plans for the construction of a new concentrating plant, estimated to cost in excess of $1,000,000, with machinery. A power plant will also be constructed. S. G. Blaylock is general manager.

MONTREAL, QUE.—The Dominion Oxygen Co., Ltd., has recently acquired the property of the National Electric Products Co., Ltd., manufacturer of similar commercial oxygen, etc., and has plans under way for plant enlargements and improvements. It is said that a number of branch works will be located in different important Canadian cities. The business of the acquired company will be merged with the Dominion organization.

Mexico

MEXICO CITY—The San Rafael Paper Co., operating a local mill, has plans nearing completion for the erection of a new plant at Merida, Yucatan, for the manufacture of pulp products under a special process. Leaves of the henequin plant will be used as a source of raw material.

New Companies

THE BETHEL TANNING Co., Bethel, Conn., has been incorporated with a capital of $50,000, to manufacture leather products. The incorporators are F. H. Judd, H. E. Mackenzie and David Lane, all of Bethel.

THE W. J. WIX & SONS Co., 104 Market St., Camden, N. J., has been incorporated with a capital of $50,000, to manufacture paints, varnishes, etc. The incorporators are W. J. Wix, Sr. and Jr., and J. C. Wix.

THE CRYSTAL & SCIENTIFIC GLASS PRODUCTS Co., New York, N. Y., care of T. F. Daniels, representative, South Orange, N. J., has been incorporated with a capital of $100,000, to manufacture special glassware specialties. The incorporators are F. and Z. Kafka, and G. C. Volz.

THE BI-CHEMICAL Co., Memphis, Tenn., has been incorporated with a capital of $5,000, to manufacture chemicals and chemical byproducts. The incorporators are H. S. Austin, Karl Wood and R. W. Snell, all of Memphis.

THE AETNA ABRASIVE Co., 1462 West Ohio St., Chicago, Ill., has been incorporated with a capital of $5,000, to manufacture emery wheels and other abrasive products. The incorporators are Anton S. Lux, Frank Cass and John J. Leskee.

THE BOLIVAR FOUNDRY Co., Bolivar, N. Y., care of Bliss & Bliss, Bolivar, has been incorporated with a capital of $50,000, to manufacture iron, steel and other metal castings. The incorporators are W. A. Sherwood, H. J. McIntyre and W. J. Brennen, Bolivar.

THE NEW BEDFORD TILE PRODUCTS Co., New Bedford, Mass., has been incorporated with a capital of $100,000, to manufacture tile and other ceramic products. Elie Blanchette is president; Francois X. Girard, vice-president; and Ulric LeClair, 1020 South Water St., New Bedford, treasurer.

THE ATLASTA TIRE & RUBBER Co., care of Franklin L. Mettler, 832 Market St., Wilmington, Del., representative, has been incorporated under state laws with capital of $500,000, to manufacture tires and other rubber products.

THE LUCKERT-KLEB-GERARD MFG. Co., 61 Wheeler Point Road, Newark, N. J., has filed notice of organization to manufacture washing fluids and other chemical specialties. The company is headed by William Luckert, Louis Kleb and Nicholas Gerard.

THE OHIO REFRACTORIES Co., Portsmouth, O., has been incorporated with a capital of $100,000, to manufacture firebrick and other refractory products. The incorporators are M. K. Hitchcock and H. W. Heer, both of Portsmouth.

THE KEENE TANNING Co., Boston, Mass., has been chartered under state laws to manufacture leather products. Nathan Gans, 13 Lincoln St., Cambridge, Mass., is president and treasurer; Mahlon H. Anderson is vice-president.

THE MARINE RUBBER Co., care of the Delaware Registration Trust Co., 900 Market St., Wilmington, Del., representative, has been incorporated under state laws with a capital of $1,250,000, to manufacture special armored rubber products.

THE CHILDERS BROTHERS CHEMICAL Co., Lake Wales, Tex., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. Reuben R. Childers is president; George E. Childers, vice-president; and P. M. Childers, secretary, all of Lake Wales.

WILLIAM W. WOOD & Co., INC., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of $750,000, to manufacture leather products.

THE WYOMISSING CEMENT PRODUCTS Co., North Wyomissing Heights, Wyomissing, Pa., has been incorporated with a capital of $10,000, to manufacture cement specialties. B. F. Willson, Wyomissing, is treasurer.

THE SUPERIOR OIL CORP., Nashville, Tenn., has been incorporated with a capital of $25,000, to manufacture petroleum products. The incorporators are H. B. Hammond, E. W. Turnley and C. M. Carroll, all of Nashville.

Industrial Developments

CERAMIC—The Pittsburg Clay Products Co., Pittsburgh, Pa., is operating at full capacity at its plants at Walkers' Mills and Beaver Falls, Pa., for the manufacture of face brick. The present output is running to 1,500,000 bricks per month, and it is expected to increase this production to about 2,000,000 bricks at an early date.

All face brick manufacturing plants in the Birmingham, Ala., district are operating on a full-time schedule. The orders taken in May are the largest for any month since the close of the war.

Sankey Brothers, Pittsburgh, Pa., manufacturers of brick, are running at a full-capacity schedule at their local plant, comprising 6 kilns, with average of 300,000 bricks to the kiln.

The Thomas Maddock's Sons Co., Trenton, N. J., manufacturer of sanitary ware, is operating on a full time, full-capacity schedule. Incoming orders are exceeding the output.

OIL—The Wortham Refining Co., Wortham, Tex., has placed its new refining plant in operation, recently completed, under a day and night schedule. The refinery will use crude oil from the Wortham, Currie and Mexia fields.

The Milliken Refining Co., St. Louis, Mo., has resumed operations at its oil refinery at Arkansas City, Kan., following a suspension for about a year past.

RUBBER—The Excel Rubber Co., Wadsworth, O., has been reorganized, following the termination of a receivership, and the plant placed in operation. It is proposed to develop a capacity output at once. The plant specializes in tires and belts, and has been closed for about 6 months past.

The Goodyear Tire & Rubber Co., Akron, O., has adopted an 8-hour shift at its plant, replacing a 10-hour day working basis, allowing employees the same wages for the shorter day. The plant is on a capacity basis.

The United States Rubber Co., New York, N. Y., is arranging for the resumption of operations at its Candee plant at New Haven, Conn., on July 5, following a suspension since May 1.

The plant of the Avalon Rubber Co., Barberton, O., has been sold by the receiver to a syndicate, recently formed, and will be used for another line of manufacture. Production of rubber will be carried out as a subsidiary feature of operations.

The Studebaker-Wulff Rubber Co., Marion, O., has adopted a night shift at its plant, in addition to regular day production. Incoming orders exceed the capacity of the plant.

IRON AND STEEL—The Thomas Furnace Co., Milwaukee, Wis., is planning to blow in its furnace for pig-iron production early in July.

The Donaldson Iron Co., Emaus, Pa., is making ready for operations at its No. 2 foundry, and will place the plant in service at an early date. With this unit on the production list, the company will be operating at full capacity.

The Reading Iron Co., Reading, Pa., has advanced the wages of puddlers at its Columbia, Pa., works from $6.50 to $7 a ton. The pay of laborers has also been increased.

The Petroleum Iron Works, Petroleum, Pa., is arranging to advance production about 20 per cent at its plant, following the booking of several large orders.

Following part-time operation for about a year past, the Buffalo Steel Co., Buffalo, N. Y., has resumed production on a full-capacity basis, with day and night working forces.

The Shelby Iron Co., Birmingham, Ala., has resumed operations at its Shelby, Ala., stack. The company is said to have booked a good volume of orders for its charcoal iron production.

The Minnesota Steel Co., Duluth, Minn., has increased production to a 60 per cent operating basis, and will add about 1,000 men to the working force at once.

The Carpenter Steel Co., Reading, Pa., has advanced the wages of laborers at its mills from 24 to 27 cents an hour. All other workers at the plant will also receive a proportionate increase, effective July 1.

The Guide Plate Bar Mills is planning to blow in another furnace at its Birmingham, Ala., works. The stack will be used for manganese production.

MISCELLANEOUS—The Golden Rod Mining & Smelting Co., Cardin, Okla., will resume operations at once at its No. 7 mill, following a shut-down for more than a year past. The mill is one of the largest concentrating plants in this section, with a rated capacity of about 1,000 tons a day.

The Cleveland Iron Co., Houghton, Mich., has resumed operations on a full-time basis at its iron-ore properties in this district, following a half-time operating schedule for the past year.

Leather tanneries throughout the country devoted to the production of upholstery leather are operating on a full-time basis, with heavy orders booked ahead.

The Corn Products Refining Co., New York, N. Y., has arranged for the resumption of operations at its Edgewater, N. J., refinery, following a suspension from last April. Other plants of the company are now running on a basis of about 65 per cent of capacity.

The Bastrop Pulp & Paper Co., Morehouse Parish, near Monroe, La., has commenced operations at its new local mill, following a curtailment for a number of months. It is proposed to develop capacity output at an early date.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold a summer excursion meeting to Rochester, Montreal, Ottawa, Kingston, Toronto, Hamilton, Niagara Falls and Buffalo, Aug. 13-19.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS is holding its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters are at the Chalfonte-Haddon Hall Hotel.

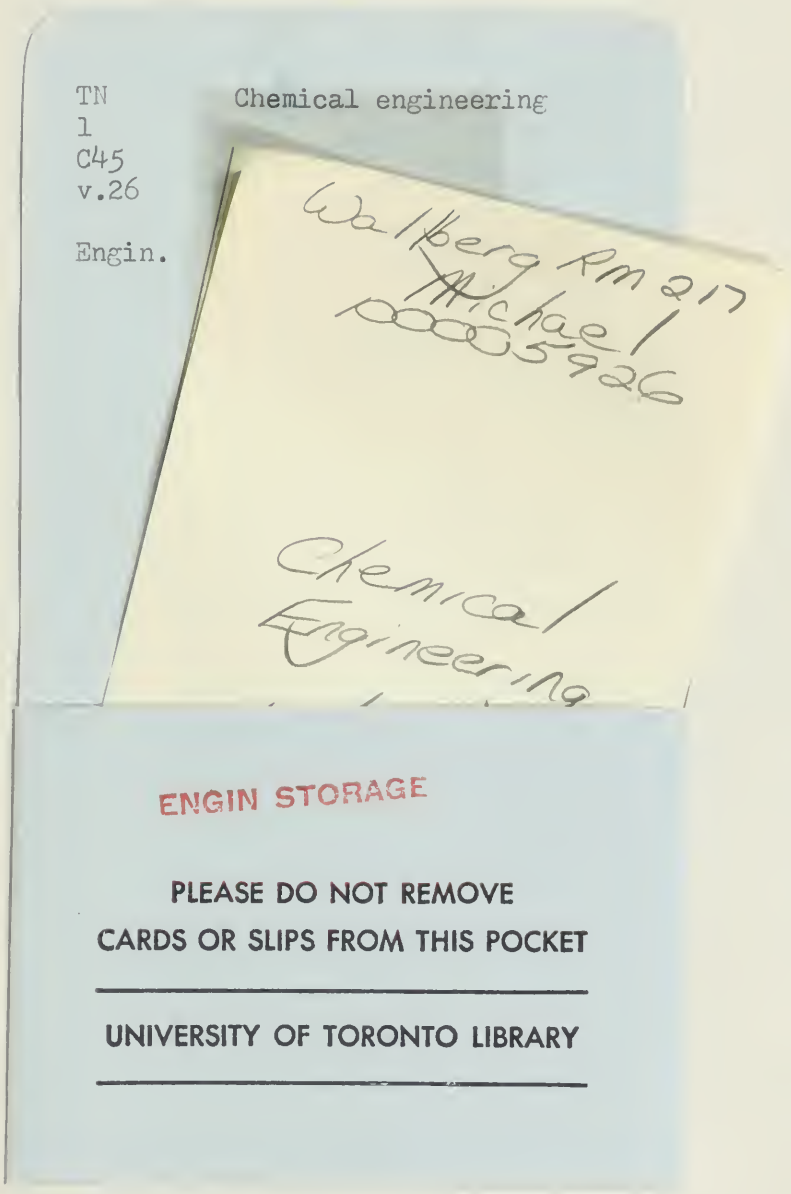
ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.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